2025 PEATLAND SCIENCE SYMPOSIUM

ABSTRACT BOOK

Layout: Kathy Pouliot, Claire Boismenu & Iqra Naeem

Wednesday, February 19, 2025

Biogeoscience Institute, Barrier Lake Station, Kananaskis, Alberta

Aim of the Symposium

The Peatland Science Symposium is a chance for researchers from across Canada to connect and share their work. The event will feature a keynote talk by Yi (Abby) Wang, along with oral and poster presentations from Can-Peat, PERG-GRET, and other research groups.

Note: The content of the abstracts has not been reviewed by the organizing committee.

UNIVERSITY OF WATERLOO | CAN-PEAT   UNIVERSITÉ LAVAL | gret perg Groupe de recherche en écologie des tourbières Peatland Ecology Research Group

Program and Index

Symposium language: English

Note: The asterisk (*) with names indicate student presentations (for the student award vote!)

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14:30 - 14:45	**Science Based Peatland Management - The Premier Tech Example** *Frederic Caron (Premier Tech.)*	**13**
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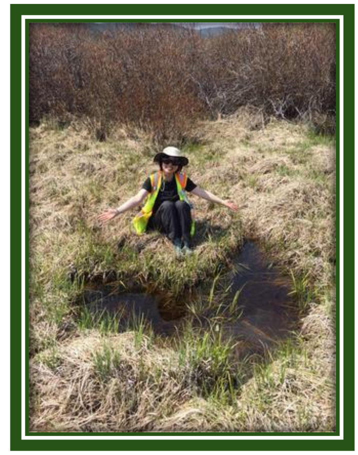
15:45 - 16:15	**COFFEE BREAK + Voting for Student's Awards**	
16:15 - 16:30	**Exploring Alternatives to Straw Mulching for Facilitating *Sphagnum* Establishment in Peatland Restoration: A Mesocosm Experiment** *Tomotsugu Yazaki (U. Laval/ Meiji U.)*	**18**
16:30 - 16:45	**Work in Progress: Sun Gro's Approach to Peatland Restoration in Alberta** *Laura Hjartarson (Sun Gro Hort.)*	**19**
16:45 - 17:00	**Concluding remarks & announcement of best student oral and poster presentations (2 awards each category)** *Line & Maria*	
17:00- 19:00	**HAPPY HOUR & DINNER**	

Poster Presentations:

KEYNOTE SPEAKER



Yi (Abby) Wang is a postdoctoral researcher in the Hydrometeorological Research Group, at the University of Waterloo. Her research focuses on understanding evapotranspiration and carbon exchange processes and their partitioning in boreal and high-elevation wetlands of the Canadian Rocky Mountains. She specializes in developing data-efficient methods to estimate evapotranspiration and its components, and her long-term goal is to advance understanding of wetland hydrology, carbon-water coupling, and their responses to environmental changes.

A Fresh Perspective on Estimating Wetland Evapotranspiration and Its Partitioning: Advances and Challenges

Yi (Abby) Wang[1*] and Richard M. Petrone[1]

[1] Hydrometeorology Research Group, University of Waterloo, Waterloo, Ontario, Canada; *yi.wang1@uwaterloo.ca

Wetlands play a critical role in the global carbon cycle, with their carbon sequestration capacity strongly tied to their hydrological states. Accurately quantifying evapotranspiration (ET) is fundamental to understanding peatland hydrology, as ET, which represents the total water transport from land surface to atmosphere, is a key water balance component and often the largest pathway of water loss in these ecosystems. Historically, wetland ET has been assumed to approximate potential ET due to the water table's proximity to the surface. However, disturbances driven by climate change and resource extraction are leading to drier wetland conditions in many wetland ecosystems in Canada and many other countries. These changes result in actual ET (AET) falling below potential ET, which introduces new challenges in estimating AET and partitioning it into transpiration and evaporation. This presentation addresses the critical challenges in estimating wetland ET and its partitioning, with a particular focus on the complex impacts of ground cover, including bryophytes and litter. Advances in ET partitioning techniques are discussed for their applicability to wetland settings, and a novel perspective is presented on integrating the impacts of ground covers into ET partitioning models. The analyses presented here improve the estimation of wetland ET and its components, which offers an effective approach for analyzing responses of vascular and non-vascular vegetation to disturbances and for quantifying the carbon cycle in wetland ecosystems, since carbon and water processes are tightly linked.

Progress on Mapping Canada's Peatland Carbon Stocks

April S Dalton[1*], Michelle Garneau[2] and Joe R Melton[3]

[1]Centre Geotop, Université du Québec à Montréal, Montreal, QC, Canada; *dalton.april_sue@uqam.ca

[2]Centre Geotop and Department of Geography, Université du Québec à Montréal, Montreal, QC, Canada

[3]Environment and Climate Change Canada, Victoria, BC, Canada

Peatlands are crucial long-term sinks for atmospheric CO_2 and their conservation is important when making land-use decisions in the context of climate change. Previous estimates suggest that Canadian peatlands hold 150-160 Gt of carbon (C), which represents ~25% of the world's peatland C stock. Despite the global importance of Canadian peatlands, we have limited knowledge on their spatial distribution, extent and characteristics, as well as problems with peatland classification and calculating C estimates over large areas. Here, we aim to refine estimates of C in Canadian peatlands using machine learning. This presentation will be an update on progress made so far. We have compiled and mapped 100,000+ measurements of peat depth from a range of published and unpublished sources (e.g. academic literature, government reports, industry studies, and collaborative partnerships). We have also collected Canada-wide peatland predictor datasets (climate, peat bulk density, vegetation/biomass, geomorphology and soil structure) and training set data (e.g. Canadian wetland inventories and peat profile databases). The next step will be integrating these datasets into the machine learning framework. A key result of this work will be a Canada-wide map showing the spatial distribution of peatland C stocks, which will be critical for future iterations of climate change projection models, and for informing land-use decisions in the context of conservation. This work aims also to be shared with Indigenous groups or communities to support better management and conservation practices on First Nation lands.

Multi-Scale Water Balance Analysis of a Thawing Boreal Peatland Complex near the Southern Permafrost Limit in Western Canada

Alexandre Lhosmot[1*], Gabriel Hould Gosselin[1,2], Manuel Helbig[1,3], Julien Fouché[1,4], Youngryel Ryu[5] Matteo Detto[6], Jonathan A. Wang[7], Ryan Connon[8], William Quinton[9], Tim Moore[10] and Oliver Sonnentag[1]

[1]Département de géographie, Université de Montréal, Montréal, QC, Canada; *alexandrelhosmot@gmail.com

[2]Department of Geography and Environmental Sciences, Northumbria University, Newcastle upon Tyne, UK

[3]Department of Physics & Atmospheric Science, Dalhousie University, Halifax, NS, Canada

[4]LISAH, Université de Montpellier, INRAE, IRD, Institut Agro, AgroParisTech, Montpellier, France

[5]Department of Landscape Architecture and Rural Systems Engineering, Seoul National University, Seoul, South Korea

[6]Department of Ecology and Evolutionary Biology, Princeton University, Princeton, NJ, USA

[7]School of Biological Sciences, University of Utah, Salt Lake, UT, USA

[8]Environment and Climate Change, Government of the Northwest Territories, Yellowknife, NT, Canada

[9]Cold Regions Research Centre, Wilfrid Laurier University, Waterloo, ON, Canada

[10]Department of Geography, McGill University, Montréal, QC, Canada

Permafrost thaw profoundly changes landscapes in the Arctic-boreal region, affecting ecosystem composition, structure, function and services and their hydrological controls. Peat-dominated landscapes represent a large carbon stock, but its fate remains highly uncertain. Lateral carbon fluxes between downstream ecosystems and vertical carbon fluxes of carbon dioxide and methane between ecosystems and the atmosphere strongly depend on hydrological conditions as characterized by the water balance. However, the water balance of small- ($<10^1$ km²) and meso-scale basins (10^1-10^3 km²) in thawing landscapes remains poorly understood. Here, we conducted an observational study in three small-scale basins ("sub-basins", 0.1-0.3 km²) of a thawing boreal peatland complex. The sub-basins were situated in the headwater portion of Scotty Creek, a meso-scale low-relief basin (130-202 km²) near the southern permafrost limit in the Taiga Plains ecozone in western Canada. By measuring water losses (discharge, evapotranspiration [ET]), inputs (rainfall [R], snow water equivalent [SWE]) and storage change (ΔS), and calculating runoff (Q), we (1) aimed at quantifying growing season (May-September, 2014-2016) sub-basin water balances. After (2) comparing monthly sub-basin- and corresponding basin water losses through ET and Q, we aimed at (3) assessing the long-term (1996-2022) annual basin water balance using publicly available observations of discharge (and thus calculated Q), R and SWE in combination

with simulated ET. (1) Growing season water balance residuals (RES) for the sub-basins ranged from -81 to 122 mm. For two sub-basins, we provide two different drainage area estimates highlighting the challenge of automated terrain analysis using digital elevation models in low-relief landscapes. Drainage areas were similar for one sub-basin but exhibited a fivefold difference for the other. This discrepancy was attributed to the high degree of landscape heterogeneity and resulting hydrological connectivity with implications for Q calculations and RES. (2) The spring freshet contributed 41 to 100 % (sub-basins) and 50 to 79 % (basin) of the April-September Q. Spring freshet peaks were comparable, except for the driest year (2014), when basin Q was more than ten times lower than in the sub-basins. At both scales ET was the dominating water loss, more than twice Q. (3) Over the long-term (1996-2022), the increase of basin runoff ratio from 1996 to 2012 (0.1 to 0.5) has been attributed to the increasing connectivity of wetlands to the drainage network caused by permafrost thaw. However, the smaller average and more variable runoff ratio from 2013 to 2022 may be due to wetland drying and/or changes in precipitation patterns.

Quantifying the Potential for Restoration to Reduce Greenhouse Gas Emissions from Horticulturally Extracted Peatlands in Canada

Melanie Bird[1*] and Maria Strack[1]

[1]Department of Geography and Environmental Management, University of Waterloo, Waterloo, Ontario, Canada; mbird@uwaterloo.ca

The UN Environment Program's Global Peatlands Initiative (GPI) has identified peatlands as key nature-based solutions to help mitigate climate change and meet Canada's 2030 greenhouse gas (GHG) emission targets. It is therefore necessary to reduce uncertainty in how peatland management actions such as ecological restoration will impact GHG emissions coming from anthropogenically disturbed areas. Additional policy supporting tools such as strategy-specific emission reductions factors, and easy to measure predictors of returned net carbon (C) sink function, will also be valuable to decision makers. To address these needs, this study is synthesizing historical GHG exchange data from restoration and reclamation trials nation-wide, starting with those from restored horticulturally extracted peatlands.

While restoration trials for peatlands extracted for horticultural peat have demonstrated reduced C emissions compared to unrestored conditions, the quantity and timing of returned C sink function reported across these studies vary due to differences in restoration approach, local peatland setting, and measurement timing post restoration. To synthesize these results, data were gathered from published and unpublished datasets available from 16 studies measuring chamber-based carbon dioxide (CO_2) and methane (CH_4) fluxes from sites treated with restoration activities. Approximately 17,000 CO_2 and 5,000 CH_4 fluxes were recorded across 500 unique plots distributed among natural, unrestored, and restored treatments. Categorized by restoration approach and assessed using mixed-effects models to account for over-representation and pseudo-replication biases of individual datasets, preliminary strategy specific emissions reduction factors have been developed. Results confirm restoration activities reduce net C emissions when compared to leaving a site unrestored but differences in specific approach outcomes will be presented. As a returned net C sink predictor, the degree of restored C function was better estimated with plant percent cover than the age of the restored site. Final compiled data will be available through the Can-Peat meta-data repository allowing for ongoing refinement of these policy tools as new datasets become available.

Overview of Pipeline for Cleaning CanPeat Eddy-Covariance Data

Rosie Howard[1*], Zoran Nesic[2], June Skeeter[3], Paul Moore[1] and Sara Knox[1]

[1] McGill University, Montreal QC, Canada; *rosemary.howard@mcgill.ca

[2] University of British Columbia, Vancouver BC, Canada

[3] NRCan, Edmonton AB, Canada

The production of reliable eddy covariance (EC) data presents many challenges, such as site and instrumentation selection, manipulating and post-processing large datasets, and implementing quality control. We present our approach for EC data post-processing (i.e., 30-60 min frequency data) which includes QA/QC, gap-filling, and CO2 flux partitioning, using a data-cleaning pipeline scripted mainly in Matlab and R. The pipeline methodology incorporates resources and algorithms based on FLUXNET and other regional networks, as well as the REddyProc R-package. The intended result is to standardize datasets and allow reproducibility, while errors are minimized enhancing reliability and expanding usability of the data. Overall, this will enable standardized EC data within CanPeat and make this data available on Ameriflux. The pipeline code is freely available via a Git repository: https://github.com/CANFLUX/Biomet.net.

How do Seismic Line Disturbances Affect Snow Accumulation in Boreal Forests?

Maryam Bayatvarkeshi[1*], Maria Strack[1], Scott Ketcheson[2], Melanie Dickie[3] and Robert Serrouya[3]

[1]Department of Geography and Environmental Management, University of Waterloo, Waterloo, Ontario; *mbayatva@uwaterrlo.ca

[2]Faculty of Science and Technology, Athabasca River Basin Research Institute, Athabasca University, Athabasca, Alberta

[3]Wildlife Science Centre, Biodiversity Pathways, University of British Columbia, Kelowna, British Columbia, Canada

Despite several investigations on seismic line implications, the effect of seismic lines on wintertime conditions remains less understood. This study used time lapse photography to investigate whether snowpack conditions were affected by the presence of seismic lines by investigating average and maximum snow depth, timing of maximum snow depth, and timing of snow-free conditions. We deployed 50 pairs of cameras across two study sites in northern Alberta with different characteristics including orientations, width, and ecosite type. The depth of snow captured from the photos between 2017 and 2021 was analyzed. The average snow depth on the line was 12% higher than offline, but the difference was not statistically significant; however, the maximum depth of snow on the line was significantly 10% greater than offline. The maximum depth of snow on the line was reached five days later than offline and snow-free conditions occurred one day after offline. However, the snow melting duration online was five days shorter than that offline, indicating a faster melting process on the seismic lines. To assess the specific seismic line effect, we calculated the difference in snow depth between online and offline for each camera pair. These differences were primarily influenced by the width and orientation of the seismic lines, with wider lines and north-south-oriented lines showing greater variations. Since snowpack conditions significantly impact soil thermal and hydrological dynamics, these findings highlight the need for further research on winter conditions, particularly through field-based measurements of snow properties across various seismic line locations.

A Systematic Review of Decision Support Tools for Wetlands and Peatlands Conservation and Restoration

Jullian Sone[1*] and Roy Brouwer[1,2]

[1]Department of Economics, University of Waterloo, Waterloo, ON, Canada; *jsouzasone@uwaterloo.ca

[2] The Water Institute, University of Waterloo, Waterloo, ON, Canada

Peatlands are wetlands with partially decomposed organic matter and store about 600 Gt of C despite occupying only 3% of Earth's land area. Their high carbon stocks per unit area make them critical for climate regulation. However, global peatland areas have decreased due to land use conversion, especially in the tropics. Disturbed peatlands no longer sequester C and become sources of carbon. Sustainable peatland management is essential as a nature-based solution to mitigate climate change by maintaining peat's carbon sink capacity.

The willingness to implement management actions towards nature-based climate solutions increasingly requires that decision-making processes are informed by comparing the costs and benefits of management actions. Coupling and combining physical and monetary metrics for peatland ecosystem services and biodiversity is of paramount importance for gauging human-peatland interplay and trade-offs. Associated costs and benefits are stakeholder and context dependent and surrounded by high levels of uncertainty imposed by current and future environmental (e.g., climate change), economic market (e.g., price fluctuations), and policy and regulation (e.g., land protection) conditions.

This study aims to assess how policymakers and stakeholders make use and are informed by decision support systems (DSS) to manage peatlands worldwide, and how data and information is collected and combined to inform a meaningful and impactful discussion and decision making on alternative courses of action and their effect on peatlands' ecosystem services delivery. To this end, we carry out a systematic literature review following the PRISMA guidelines. Our findings reveal state-of-art approaches to best practices, their advantages and disadvantages, role and uptake in decision making and applicability. Our study sheds light on conditions and practices that have been successful in supporting decision making towards sustainable peatlands' management, accounting for trade-offs between economic land development and their conservation and restoration. We identify key knowledge gaps to improve future decision tools.

Addressing Seasonal Data Gaps in Peatland Carbon Cycling: A Study of Remote Sensing and Modeled Carbon Dioxide Fluxes

Katie Hettinga[1*], Fereidoun Rezanezhad[1], Bhaleka D. Persaud[1], Stephanie Slowinski[1], Maria Strack[2], Haojie Liu[3], Bernd Lennartz[3], Elyn Humphreys[4], Jianghua Wu[5], June Skeeter[6], Sara H. Knox[7], Haley Alcock[8], Oliver Sonnentag[8,9], Matteo Detto[10], Ali Reza Shahvaran[11], Mir Amir Mohammad Reshadi[11], and Philippe Van Cappellen[1]

[1]Ecohydrology Research Group, Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, Canada; *k2hettin@uwaterloo.ca

[2]Department of Geography and Environmental Management, University of Waterloo, Waterloo, Canada

[3]Faculty of Agricultural and Environmental Sciences, University of Rostock, Rostock, Germany

[4]Department of Geography & Environmental Studies, Carleton University, Ottawa, Canada

[5]School of Science and the Environment, Memorial University of Newfoundland, Corner Brook, Canada

[6]Geologic Survey of Canada, Natural Resource Canada, Vancouver, Canada; Department of Geography, University of British Columbia, Vancouver, Canada

[7]Department of Geography, University of British Columbia, Vancouver, Canada; Department of Geography, McGill University, Montréal, Canada

[8]Département de géographie, Université de Montréal, Montréal, Canada

[9]Department of Geography and Environmental Studies, Wilfrid Laurier University, Waterloo, Canada

[10]Department of Ecology and Evolutionary Biology, Princeton University, Princeton, USA

[11]Ecohydrology Research Group, Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, Canada

Peatlands hold up to one third of the global organic carbon (C) stock, mainly in the boreal region, which is especially vulnerable to climate warming. Warming is projected to intensify in the non-growing season (NGS), yet current measurement techniques for the net ecosystem exchange (NEE) of carbon dioxide (CO_2) in peatlands are limited by scale, remoteness of sites, harsh winter conditions, and power availability. To address these challenges, we explored the reliability of a remotely sensed and modeled data product (Soil Moisture Active Passive Level 4 C NEE or SMAP-NEE) as an alternative means of assessing fluxes in these environments. We analyzed nine years (2015-2023) of this data product alongside a subset of year-round eddy covariance NEE (EC-NEE) measurements from five Canadian peatland sites. We found that SMAP-NEE reported a stronger growing season (GS) sink and a weaker NGS source compared to EC-NEE measurements. These discrepancies highlight the need for improved model validation of this data product in peatlands

before it can be used effectively to estimate fluxes in these environments. Building on these findings, we have assembled an expanded dataset of EC-NEE from ten peatland sites across Canada, along with satellite-measured environmental variables, to identify key seasonal drivers and trends of CO_2 fluxes using machine learning techniques. This work will advance our understanding of how peatlands in different regions respond to seasonal changes, informing predictions of their future carbon balance under climate warming.

Peat Extraction and Storage: How Management Practices Modulate Greenhouse Gas Outputs in Extracted Peatlands

Steffy Velosa[1*], Ian B. Strachan[2] and Nigel T. Roulet[1]

[1] McGill University; *steffy.velosa@mail.mcgill.ca

[2] Queen's University

[3] McGill University

Our study examines the impacts of different management practices associated with peat extraction on greenhouse gas (GHG) emissions. Fieldwork was conducted at two actively harvested peatland sites in Rivière-du-Loup, Quebec, from May to November 2022, each employing distinct management strategies. Using closed chambers and a portable gas analyzer, we measured carbon dioxide (CO_2) and methane (CH_4) to assess the effects of heavy machinery on the uppermost peat layer during field preparation for extraction. We also quantified emissions from stockpiles of harvested peat stored on-site, comparing those covered with an impermeable reflective tarp to those left uncovered.

Our results show that CO_2 emission rates did not differ significantly between the four phases of extraction: harrowed, drying, conditioned, and vacuum-harvested. CH_4 emissions, while lower overall than those from undisturbed peatlands, were notably increased during the harrowed, conditioned, and vacuum-harvested phases compared to the drying phase. The increase in CH_4 was attributed to a disturbance effect caused by heavy machinery, regardless of varying surface peat conditions, with CH_4 peaking immediately post-disturbance before stabilizing over time.

Uncovered stockpile fluxes varied seasonally and were significantly higher at the top of stockpiles than at the bottom. Uncovered stockpiles exhibited low CH_4 emissions but above average CO_2 emissions compared to extracted peat fields. Conversely, CO_2 emissions through the tarp of covered stockpiles were ten times lower than those from uncovered piles. However, more CH_4 (0.6 g CH_4-C m^{-3}) and CO_2 (61.1 g CO_2-C m^{-3}) were stored within covered stockpiles, compared to uncovered ones (CH_4 < 0.005 g CH_4-C m^{-3}; CO_2: 6.7 g CO_2-C m^{-3}). Since fluxes measured over holes in the tarp indicated the release of stored CO2, we assumed—though we could not measure it—that the stored gases would be released as the cover was removed and the peat was taken away for processing. Although stockpiles represented less than 1% of the total study area, they accounted for 1-2% of overall site emissions when including surface fluxes and emissions released during stockpile removal.

Ramsar Convention: Main Outcomes of Past Triennium (2022-2025) and Emerging Issues for Next (2026-2028) Triennium

Line Rochefort[1,2*]

[1] Director of the Peatland Ecology Research Group, Université Laval, Quebéc, QC, Canada

[2]North America STRP Regional Expert, Ramsar Convention on Wetlands, Canada: *line.rochefort@fsaa.ulaval.ca

As the North American regional focal point of the Scientific and Technical Review Panel (STRP) I will briefly present the outcomes of the past triennium such as for example the Briefing Note No. 14: Small Wetlands: Their Critical Importance and Strategies for Effective Conservation. For the coming 2026-2028 triennium, the STRP has identified several emerging scientific and technical priorities that require due consideration and action. These priorities include the improved monitoring and reporting of the ecological character of Wetlands of International Importance, advancements in wetland mapping and inventory tools, assessing the impacts of harmful algal blooms and fires, and the next Global Wetland Outlook. An overview of how the resolutions of the 2025 COP15 of the International Convention of wetlands are built and presented to Conference of Parties will be presented.

Science Based Peatland Management - The Premier Tech Example

Frédéric Caron[1*], Valérie Lavoie[1] and Neil Kuly[2]

[1]Premier Tech Growers and Consumers, Rivière-du-Loup, QC, Canada, *carf@premiertech.com

[2]Premier Tech Growers and Consumers, Athabasca, AB, Canada

Premier Tech (PT) is the story of one team, and of how we have constantly reinvented our business approach and challenged existing paradigms to deliver on our commitments. It all started in 1923, with PT's long-term vision already empowering us to master our destiny. In 1933, peat harvesting operations began in North America. Our commitment to securing access to raw materials remains core to who we are. In 1968, PT drew from the Cornell University research to develop and launch PRO-MIX®, transforming an entire industry. In the late '70s, way before it became a subject of discussion, PT began using peat extender with bark and compost. In 1983, PT initiated research on natural active ingredients, founding the Premier Research Center and giving rise to the innovation culture as well as the Innovation, Research & Development (IR&D) model, a cornerstone of our success. In 1990, PT began diversifying beyond horticulture, leveraging the knowledge and know-how of its IR&D teams to develop new industrial applications for its primary resource, such as industrial automation and passive biofiltration using organic media.

In 1992, the implementation of sustainable peatland management and ecosystems protection initiatives, in collaboration with PERG, has grown into a key lasting commitment. In 2010, PT obtained the Veriflora Certified Peatland Products certification, a natural outcome of PT's longstanding resource conservation leaderships. These two commitments are key to operation planning improvements from bog opening design to ecological restoration. The main changes will be presented to you.

As a leader in responsible peatland management, PT relied on its innovation culture to develop an Acrotelm-Harvesting Method (ACM) for vegetated undrained bogs. Since 2017, has PT delved into the valorization of sphagnum fiber to contribute to a more sustainable economy, leading PT to file the first in a series of patents on the Method and Devices for Removing the Acrotelm of Peatlands in 2019. The main principles and development steps of this patent will be presented to you.

Enhancing Renewable *Sphagnum* Biomass Productivity through Phenolic Addition in the 'Acrotelm-Harvesting Method': A GHG Assessment

Éléonor Bergeron de Pani[1*], Line Rochefort[1] and Christian Dunn[2]

[1]Peatland Ecology Research Group (PERG), Center for Northern Studies (CEN), Centre de recherche et d'innovation sur les végétaux (CRIV), Université Laval, Quebec City, Canada; *eleonor.bergeron-de-pani.1@ulaval.ca

[2]School of Natural Sciences, Bangor University, Bangor, Wales, UK

Aligned with its commitment to continuously enhance responsible peatland management practices, Premier Tech is developing the 'Acrotelm-Harvesting Method' (ACM), which targets the less decomposed acrotelm layer to potentially preserve surface vegetation and carbon stocks without draining the peatland. Based on the "enzymic latch" mechanism, the accumulation of phenolic compounds in peat is expected to lower the decomposition of organic material by inhibiting enzyme activity. Thus, this study investigates whether acrotelm regrowth following harvesting can be enhanced by increasing *Sphagnum* productivity through the addition of phenolic-rich products.

A field experiment was conducted in summer of 2023 at the Pointe-Lebel peatland in Quebec (49°8'N, -68°13'W), to test the following phenolic-rich products: wood residue biochar, wood residue biochar in combination with calcium lignosulfonate (an acid derived from lignin) and black spruce woodchips combined with the same acid. The treatments were added to the underlying peat layer before the surface vegetation was placed back during the harvesting process. The impact of the treatments on acrotelm regrowth potential was assessed through the measure of carbon fluxes and *Sphagnum* productivity. This presentation will showcase the preliminary results of the GHG emissions, one year after the application of the treatments, as of summer 2024.

Plant Succession following Partial Acrotelm Harvest in a Peatland

Olivier Gingras[1*], Mélina Guêné-Nanchen[1] and Line Rochefort[1]

[1]Peatland Ecology Research Group (PERG), Center for Northern Studies (CEN), Centre de recherche et d'innovation sur les végétaux (CRIV), Université Laval, Quebec City, Canada; *olivier.gingras.3@ulaval.ca

Harvesting a part of the acrotelm in a peatland, just below the photosynthetic layer, is an innovative approach where the harvested material consists of minimally decomposed *Sphagnum* moss fibers. This method has the potential to cause minimal disturbances to peatland functions: the surface vegetation is largely maintained and, no drainage is required. However, the ecological footprint of this method still needs to be assessed. For instance, in the harvested furrows, the root system of vascular plants can be significantly disturbed. The objective of this study is to evaluate plant succession in defined plant communities following the harvest of the acrotelm. The composition and structure of the vegetation were evaluated using 30 circular quadrats randomly distributed within each plant community in the Pointe-Lebel peatland (Quebec). Three plant communities were described: hummocks, lawns and hollows, representing 30%, 50% and 20% of the peatland, respectively. Three surveys were conducted: pre-harvesting, one year and two years post-harvesting. In the hummocks and hollows, there was an increase in dead material cover because of plant mortality. Specifically, on hummocks, trees and shrub cover were seven times lower two years post-harvesting. In hollows, lichen cover was reduced by half after two years, possibly due to their brittleness when dry, or in contrary, due to their inability to grow in open water. In lawns, *Sphagnum* moss cover only decreased by 12% two years after harvesting. The lawn community is the most resilient of the three to the harvesting method. Moreover, two species showed a very low decrease in cover after harvesting: *Sphagnum rubellum* and *S. fuscum*; another species even showed an increase post-harvesting: *Eriophorum vaginatum*. The vegetation recovery following the harvest of the acrotelm is more comparable to the recovery observed after harvesting reintroduction material in donor sites during peatland restoration, rather than the plant recovery following peat extraction. If used in open peatlands with prominent distribution of *Sphagnum* lawns, this method could be used to harvest *Sphagnum* fiber cyclically. However, the impact of cyclical harvesting of the acrotelm on plant community structure and diversity needs to be assessed.

Quantifying Hydrological Conditions in a Peatland Managed with the Acrotelm-Harvesting Method: A Case Study Approach

Venkata Prateeksha Vadali[1*], Ian B. Strachan[1] and Maria Strack[2]

[1]Department of Geography and Planning, Queen's University, Kingston, ON, Canada; *v.vadali@queensu.ca

[2]Department of Geography and Environmental Management, University of Waterloo, Waterloo, ON, Canada

Peatlands naturally function as carbon sinks and are globally important reserves of carbon. Currently, horticultural peat extraction in Canada requires partial draining of the peatland and the removal of the overlying vegetation. This disturbance results in the exposure of catotelm peat (which is denser) increasing the water table depth and variability of soil moisture. Premier Tech Horticulture has developed the "acrotelm-harvesting" method (ACM). This technique allows for the harvesting of 10 cm of peat from below the vegetated surface by lifting and replacing the vegetation and does not require peatland drainage. While the ACM represents a less invasive extraction technique, it has yet to be assessed for the resulting impacts to peatland ecological and hydrological functioning. As vegetation remains largely intact and hydrological changes are minimal, it is likely that this method could result in smaller carbon losses. The ACM was implemented at an ombrotrophic bog near Pointe-Lebel, Quebec (49º8'N, 68º13'W) between 2021-2024. Our study design contains two unharvested control sections along with four sections representing, -harvesting conducted in each year of 2021, 2022, 2023, and 2024. In this presentation, we explore the hydrological dynamics for the entire study site (harvested and unharvested sections) with a greater focus on the section harvested in 2024 (H24). A network of 18 wells and piezometer nests was installed across the study site with loggers measuring water table depth (WTD) every hour. In H24, piezometer nests in the path of the machinery were removed in advance to not interfere with the operations and were re-installed after the completion of harvest. Saturated hydraulic conductivity (K_{sat}) was measured at each piezometer and specific yield (Sy) was estimated using the rise and run method for every rain event-well combination. Post-harvesting WTD values was found to have been 15 cm closer to the surface. The removal of peat results in the surface now being deeper into the peat profile. This caused a reversal of observed K_{sat} values between 25 and 50 cm depth post-harvest. Sy values were lowered post-harvesting corresponding with exposure to a more decomposed peat layer near the surface and causing a flashier WTD response to precipitation. This case study of H24 provides evidence for ACM altering the hydrological dynamics and facilitating increased lateral water movement in the top 25 cm of the peat profile via increased K_{sat} and lowered Sy values. This has implications for dissolved organic carbon (DOC) dynamics and its movement out of the study site.

Hydrological Gradient as a Driver of Vegetation Distribution and Biomass in a Newly Rewetted Fen in Elma Manitoba

Chinonso Chris-Emenyonu Millicent[1]* and Maria Strack[1]

[1]Department of Geography and Environmental Management, University of Waterloo, Waterloo, Ontario, Canada; *cchrisem@uwaterloo.ca

The goals of peatland restoration following peat extraction include returning hydrological conditions and plant community to those observed in reference peatlands. The plant community is one of the primary drivers of C cycling in peatlands. Understanding how vegetation composition and biomass vary along a hydrological gradient post-restoration can help inform restoration planning and hydrological targets for plant community establishment and return of carbon accumulation function. The main goal of this study was to determine the role of hydrological gradient in explaining patterns of plant cover and biomass in a rewetted fen in Elma, Southeastern Manitoba. We measured vegetation cover and biomass and determined the gross primary productivity (GPP) along a gradient of hydrological conditions developed following rewetting. We had a total of 10 sampling plots for GPP and a total of 60 quadrats for plant surveys and biomass estimation. Carbon dioxide measurements were made using the closed chamber method, twice per week from June to August with vegetation surveys and biomass collection completed in August. Results from the vegetation survey showed that vascular plants dominated the site with few bryophytes. Plant cover was greatest in areas of moderate wetness, followed by wet and then dry conditions. Graminoids dominated in moderate to wet conditions, while forbs and shrubs were more prevalent in moderate to dry sites. Litter accumulation was also measured and showed an interesting trend as both the moderate and wet had similar values while there was a decrease in litter in the dry areas. Biomass and GPP followed a similar pattern to plant cover with greater biomass and higher rates of productivity at the moderate and wet locations compared to dry. The results have shown that hydrological gradient plays a major role in peatland vegetation recovery and carbon sequestration, making it important to manage water levels and ensure effective rewetting to support plant establishment and biomass accumulation at rewetted peatlands.

Exploring Alternatives to Straw Mulching for Facilitating *Sphagnum* Establishment in Peatland Restoration: A Mesocosm Experiment

Tomotsugu Yazaki[1,2*], Mélina Guêné-Nanchen[2], Kathy Pouliot[2], Line Rochefort[2]

[1] Université Laval/Meiji University(Japan); *yazakitm@meiji.ac.jp

[2]Peatland Ecology Research Group (PERG), Center for Northern Studies (CEN), Centre de recherche et d'innovation sur les végétaux (CRIV), Université Laval, Quebec City, Canada

The Moss layer transfer technique (MLTT), developed by the Peatland Ecology Research Group (PERG), has been applied for the restoration of *Sphagnum*-dominated peatlands in North America. During the restoration process, it is crucial to protect the moss diaspores from desiccation to ensure their successful establishment, given the hostile conditions on residual peat deposits after extraction. Conventionally, wheat straw has been used as a mulch material to protect the reintroduced mosses. However, wheat straw is in high demand for horticulture, urban greening, and livestock and varies in availability from region to region. Utilizing mulch materials sourced directly from peatlands could enhance the sustainability of peatland restoration.

To select suitable alternative mulch materials for initial *Sphagnum* establishment, an outdoor mesocosm experiment was conducted at Université Laval botanical garden (Quebéc). *Sphagnum* carpet growth and hydrometeorological conditions were assessed under different mulch treatments, including no application (control), wheat straw (positive control), cattail straw mulch, residual root material from peat extraction, low and high densities of Ericaceae branches, and low and high densities of black spruce branches. Mesocosms were prepared by filling them with rewetted peat, and *Sphagnum* diaspores were applied at a 1:10 ratio. The growth of *Sphagnum* carpet thickness and associated hydrometeorological conditions were monitored over the first year.

This presentation will discuss the impact of alternative mulch materials and their associated hydrometeorological conditions influencing *Sphagnum* carpet establishment during the initial year of restoration.

Work in Progress: Sun Gro's Approach to Peatland Restoration in Alberta

Laura Hjartarson[1*] and Warren Walker[1]

[1] Sun Gro Horticulture Canada Ltd.; *Laura.Hjartarson@sungro.com

Sun Gro Horticulture (Sun Gro) has an extensive history of peatland restoration following peat extraction with its commencement co-occurring with the development of peatland restoration techniques in Canada in the 1990s. With peat extraction operations across Canada, Sun Gro is driven to be a leader in responsible peatland management and has restored over 1,000 hectares of post-extraction peatlands using the scientifically backed Moss Layer Transfer Technique (MLTT). The primary goal of peatland restoration following peat extraction is to establish a self-sustaining peat-accumulating ecosystem. To establish the functions found in natural peatlands, the MLTT focuses on the reintroduction of peatland vegetation and the return of hydrologic regimes conducive to the establishment of peatland vegetation. Utilizing local plant propagules and following principles of natural succession, focusing on the key players of peat formation, bryophytes, the technique has shown to be successful. While the MLTT was pioneered on peatlands in eastern Canada, the technique has proven to be applicable to peatlands in Alberta as well. Taking advantage of Alberta's climatic conditions, Sun Gro has adapted the method to facilitate peatland restoration operations throughout the winter months. Frozen conditions with relatively low amounts of snowfall reduce challenging logistic considerations posed by wet conditions, which may reduce overall impact and improve efficiency. This presentation will provide an overview of Sun Gro's approach to peatland restoration during the winter, showcasing over a decade of peatland restoration projects implemented by Sun Gro across Alberta.

Cross Canada Peatland Methane Data Synthesis: Water Table - Soil Temperature Response Drives Emissions

Miranda L. Hunter[1*], Noah Boss[1], Marissa Davies[2], Maria Strack[1], and data contributors

[1]Department of Geography and Environmental Management, University of Waterloo, Waterloo, Canada; *mlhunter@uwaterloo.ca

[2] Canadian Forest Service, Northern Forestry Service

Peatlands are an important land cover in Canada, and act as a source of methane (CH_4), a powerful greenhouse gas. Predicting future emissions under a changing climate is difficult due to the confounding effects of both the expected increases in soil temperature, and the expected water table drawdown under increased vapour pressure deficits. Current modeling efforts, such as the Canadian Model for Peatlands (CaMP), are limited in part by a lack of CH_4 measurements, and an uncertainty in the environmental controls at different temporal scale across different peatland types. There is a need for a cross Canada data synthesis to better understand controls of CH_4 emissions from different peatlands in Canada.

This study therefore compiled instantaneous and seasonal plot scale CH_4 measurements from 24 peatland sites across Canada spanning six peatland classification types: bog, forested swamp, open poor fen, open rich fen, treed poor fen and treed rich fen. The objectives of this study were to i) investigate the importance of vegetation cover, water table depth (WTD), air temperature and soil temperature, and their interactions, on CH_4 fluxes from different peatland classes, and ii) project the fate of CH_4 emissions under a warming climate. This study found specific non-linear gaussian WTD - CH_4 relationships for each peatland type, with optimal CH_4 production occurring at WTDs at or near the surface. Significant interactions between WTD and air temperature suggests that future modelling work should consider a coupled water table and temperature response to improve CH_4 predictions. This work will further our understanding of environmental controls of CH_4 emissions from different peatland types in Canada, and support modelling efforts to better predict CH_4 emissions under future climate change scenarios.

The Role of Language in Scientific Knowledge Production and Dissemination: A Comparative Study of the Can-Peat and Congopeat Research Networks

Sandra Klemet-N'Guessan[1]* and Kelsey Leonard[1]

[1] Faculty of Environment, University of Waterloo, Environment 1, 200 University Avenue West, Waterloo, ON, Canada; *sklemetn@uwaterloo.ca

Linguistic diversity is a crucial, yet often overlooked, component of equitable and inclusive open science practices in the production and dissemination of scientific knowledge. This is especially important in the context of Indigenous Data Sovereignty, as Indigenous languages are critical to upholding Indigenous rights to govern the collection, ownership, and application of their data. While English has been the dominant language of science in the past decades, findings from the translatE project suggest that much of the evidence in environmental sciences is available in other languages. Honouring linguistic diversity is thus a prerequisite to ensuring both the accessibility of scientific knowledge to all and the accuracy of syntheses and reviews of scientific knowledge for informed environmental decision-making. This project investigates the role of language in data collection, management, and dissemination within environmental research, focusing on two peatland research networks, Can-Peat in Canada and CongoPeat in the Congo Basin as case studies. To achieve this, we evaluate the strategies used for data collection, management, and dissemination within these networks, employing a mixed-methods approach that combines quantitative and qualitative analysis of data gathered from key informant interviews and surveys, and a review of language use in existing publications, reports, and website content, as well as media coverage associated with each research network. This study will outline lessons learned from the two networks to inform linguistic practices in future environmental research. This study will also integrate ethical and equitable open science guidelines as well as Indigenous Data Sovereignty throughout the research process, thereby demonstrating how to effectively implement the wise practices in environmental research emphasized in the study.

Mapping Anthropogenic Disturbances on Canadian Peatlands using Semantic Segmentation of Satellite Imagery

Sanghyeon Song[1]*, Oliver Sonnentag[2], Mary Kang[1], Matthew Fortier[2], Mélisande Teng[3] and Michelle Lin[3]

[1]Department of Civil Engineering, McGill University, Montréal, QC; *sanghyeon.song@mail.mcgill.ca

[2]Département de Géographie & Centre d'Études Nordiques, Université de Montréal, Montréal, QC

[3]Mila - Quebec Artificial Intelligence Institute, Montréal, QC

Peatlands account for 12% of Canada's land area and store approximately a quarter of the global peatland soil carbon. However, Canadian peatlands have increasingly experienced the impact of disturbances from human activities. While undisturbed peatlands act as net carbon sinks, anthropogenic disturbances can transform them into net carbon sources. Developing maps of peatland disturbances caused by human activities is essential for effective monitoring and management of peatlands, ensuring peatlands continue to serve as carbon sinks. Although various geospatial datasets that represent different types of anthropogenic disturbances across Canada exist, they vary in scale, coverage, attributes, periods, and mapping methods. Consequently, comprehensive and up-to-date national maps of anthropogenic disturbances on peatlands remain limited. This study aims to produce current and historical maps of anthropogenic disturbances on peatlands in Canada from Landsat satellite imagery using deep learning methods. Landsat-5, 7, and 8 imageries will be used as the base satellite imagery for mapping anthropogenic disturbances as they have been providing full coverage of Canadian peatland regions at 30-m spatial resolution since 1984. By applying deep learning models for semantic segmentation of satellite imagery, polygonal and linear features generated by anthropogenic activities in peatlands can be identified by disturbance types (e.g., forest cut blocks, roads, oil and gas facilities, agricultural lands, etc.). A dataset labelled by types of anthropogenic disturbance will be prepared, and then a semi-supervised model will be trained using the labelled dataset. The model will be tested on a separate validation dataset to ensure the model's robustness. Historical anthropogenic disturbances can be mapped using the same method on the decades-long satellite imagery archive provided by the Landsat series, allowing us to track how human disturbances changed Canadian peatlands. Additionally, uncertainty analyses will be conducted to evaluate differences in the peatland areas and the extent of disturbance-affected regions by comparing different peatland maps. Through this study, it will be possible to establish a comprehensive national-scale spatial and temporal data repository documenting the anthropogenic disturbances in Canadian peatlands and to analyze changes in peatland disturbances over time by comparing historical disturbance maps.

Greenhouse Gas Balance of Thermokarst Fens and Bogs in the Discontinuous Permafrost Zone during Extreme Drought Years

Kasha Kempton[1]* and David Olefeldt[1]

[1] University of Alberta; *kkempton@ualberta.ca

The greenhouse gas (GHG) balance of northern peatlands is being influenced by the combined effects of rapid permafrost thaw and increasing frequency and severity of droughts. Our soil chamber flux measurements revealed that thermokarst fens in the discontinuous permafrost zone of boreal western Canada (Lutose, Alberta) acted as stronger net sources of carbon dioxide (CO_2) and consistently emitted more methane (CH_4) than thermokarst bogs during two extreme-drought years. Peatlands in the discontinuous permafrost zone store large amounts of soil carbon, but thawing permafrost results in changes to hydrology and vegetation, which have the potential to substantially impact their greenhouse gas balance. As permafrost thaws, thermokarst bogs and fens develop and expand, further modifying GHG dynamics. Although thermokarst fens account for approximately 30% of peatlands in the discontinuous zone, they have received little attention, and there is limited understanding of how the GHG balance varies along the trophic gradient from poor fens to extreme-rich fens.

This study explored the spatial and temporal variability of greenhouse gas fluxes across four sites, including a thermokarst bog, poor fen, rich fen, and an extreme-rich fen. Trophic status of each site was classified based on pH, electrical conductivity (EC), vegetation, and concentrations of magnesium (Mg) and calcium (Ca). Fluxes were measured over two growing seasons and one winter (June 2023 to October 2024). Controls on greenhouse gas fluxes are currently being explored using data on vegetation composition, water chemistry, hydrology, and climatic conditions. Preliminary results show that CH_4 emissions generally increased along the trophic gradient, with the exception of the extreme-rich fen, where high sulfate concentrations suppressed emissions. Non-growing season CH_4 emissions were also a significant contributor to annual emissions across all sites.

Overall, our findings indicate that trophic status plays an important role in determining the greenhouse gas balance of thermokarst bogs and fens following permafrost thaw. Understanding the drivers of the carbon dioxide balance and methane emissions in these ecosystems during extreme drought years is essential for refining models of peatland carbon dynamics and predicting their future role in the global carbon cycle as climate change continues.

Quantifying and Comparing CO_2 and CH_4 Fluxes in Southern Ontario Swamps

Megan Schmidt[1]* and Maria Strack[1]

[1]Department of Geography and Environmental Management, University of Waterloo; *meg.schmidt@uwaterloo.ca

Swamps are forested wetlands that account for approximately 8% of the terrestrial area of Canada and up to 87% of total wetland spatial extent in southern Ontario. Trees in swamps store large amounts of carbon and have the potential to store significant amounts in soils that range from mineral to meters-deep peat. Despite their prevalence and potential as natural climate solutioins, swamps are under-represented in carbon accounting and modeling due to difficult access and unclear classification relative to other wetland types. Currently, most data on swamps comes from subtropical and tropical sites rather than the temperate and boreal regions found in Canada.

Twelve swamps were selected across southern Ontario, Canada to quantify and compare the net exchange of CO_2 and CH_4 between soil and the atmosphere. We considered differences between sites due to the physical and biological characteristics of hydrogeomorphic settings and canopy types that drive interactions and the resulting fluxes.

Dry soil conditions during the growing season resulted in net CO_2 efflux across the sites. There were significant differences between sites and canopy types but not between hydrogeomorphic settings, indicating there are more site-specific controls and conditions to be identified. Water table and soil temperature were found to have a significant impact on net CO_2, with fluxes generally decreasing as moisture increased and increasing with rising temperature.

Methane emissions varied across hydrogeomorphic settings and canopy types, with many sites acting as a net sink for CH_4 over the year. Water table was a significant factor in CH_4 flux as efflux generally increased as water tables rose nearer the surface. Conversely, CH_4 decreased as soils warmed, with the exception of two sites, in which CH_4 flux increased with soil temperature.

Overall, variation in carbon stocks and fluxes may be better explained by site-specific conditions, suggesting that carbon in swamps cannot be accurately estimated using hydrogeomorphic setting and canopy type only.

Ecosystem-Scale GHG Exchange Following the Acrotelm-Harvesting Method (ACM)

Katherine Bot[1]*, Ian B. Strachan[2] and Maria Strack[3]

[1] School of Environmental Studies, Queen's University, Canada; *katherine.bot@queensu.ca

[2] Department of Geography and Planning, Queen's University

[3] Department of Geography and Environmental Management, University of Waterloo

Current horticultural peat production practices involve the removal of vegetation and partial drainage of peatlands, resulting in changes to greenhouse gas (GHG) emissions. The Acrotelm-Harvesting Method (ACM) was developed to minimize these impacts by preserving ecosystem function and integrating restoration efforts. It is anticipated that the ACM reduces GHG emissions during and after harvesting compared to conventional methods. However, the ACM still necessitates the passage of machinery over the peatland, potentially disturbing surface vegetation and altering the carbon dynamics. This study provides the first comprehensive assessment of the ACM's impact on ecosystem-scale GHG fluxes. At a bog near Pointe-Lebel, QC, paired eddy covariance (EC) towers in a section harvested in 2021 (H21) and an unharvested (UNH) section provided temporally continuous, spatially integrated flux measurements for the 2024 growing season. Results indicate that H21 exhibited some vegetation (shrubs) damage and altered surface topography, including the compaction of hummocks, which led to overall wetter conditions. These changes reduced carbon dioxide (CO_2) uptake through photosynthesis and increased methane (CH_4) emissions as the removal of sphagnum lowered the surface closer to the water table. Despite these shifts, H21 remained a net carbon sink three years post-harvest, though its capacity was reduced compared to the unharvested section. These findings contribute to a better understanding of the ACM's environmental impact and its potential as a sustainable peatland management strategy, which is essential for addressing climate change.

Plant Community GHG exchanges in Post-recovery Acrotelm Harvest Method Peatlands

Declan Roche[1]*, Ian B. Strachan[2] and Maria Strack[3]

[1]School of Environmental Studies, Queen's University; *20dwr2@queensu.ca

[2]Department of Geography and Planning, Queen's University

[3]Department of Geography and Environmental Management, University of Waterloo

Traditionally harvested peatlands lose their carbon sink functions as a result of the removal of vegetation and the drainage of water. Active restoration can turn these bogs back into sinks fifteen years post-harvest. The Acrotelm Harvest Method (ACM) is an innovative new harvesting method in which the top layer of the peatland is cut and raised, harvesting undecomposed sphagnum fibres and then lowered back down once completed. This method aims to restore peatlands on a shorter timescale, post-harvest. This study investigated the recovery of a 2021 ACM-harvested site in Pointe Lebel, Quebec and compared its net ecosystem exchange, ecosystem respiration, gross ecosystem productivity, and methane fluxes with an adjacent unharvested control site. Three microforms were categorized: hummocks, hollows, and lawns, and placed with three replicates in each site. Gas exchange data was collected via non-steady-state chamber measurements from each microform plot in the two sites from May-August 2024 and July 2022 and 2023. Each replicate had its water table depth and soil temperature measured in tandem with a given flux. Preliminary results suggest that the ACM recovering site (H21) was a net CO_2 sink over the 2024 summer, with no statistical differences seen between the two sites in terms of ecosystem respiration and gross ecosystem productivity. Methane in the recovering site was considerably higher than its unharvested counterpart in two of the three microforms due to being closer to the water table. results of this analysis will aid the industry in advancing peat harvesting and stresses how this method could potentially have widespread benefits across the field.

Greenhouse Gas Emissions from a 20-Year-Old Restored Peatland

Amélie Delesalle[1]*, Ian B. Strachan[2] and Maria Strack[3]

[1]School of Environmental Studies, Queen's University; *21ad27@queensu.ca

[2]Department of Geography and Planning, Queen's University

[3]Department of Geography and Environmental Management, University of Waterloo

Peatlands are ecosystems with unique hydrological and ecological properties that serve as critical carbon reservoirs, helping facilitate the reduction of greenhouse gases (GHG). In Canada, the peat industry uses vacuum harvesting to extract peat for horticultural use. This disturbs the natural ecosystem, increasing CO_2 and decreasing CH_4 emissions due to complete removal of surface vegetation and lowering of the water table. Following years of extraction, if these peatlands are not properly restored, GHG emissions will increase, negatively impacting the climate. The moss layer transfer technique (MLTT) is the primary method for restoring peatlands in Canada. The MLTT allows peatlands to regain their natural ecosystem function and to reaccumulate peat. This is done by revegetation of key species including sphagnum moss, and rewetting of the peatland through the blockage of drainage ditches. This study investigated a peatland in Pointe-Lebel, Quebec restored in 2004 using MLTT following vacuum extraction. A non-steady-state chamber method was used to measure CO_2 and CH_4 exchanges of three plant communities: moss, shrub, and cotton grass, each with three replicates. Wells at each collar provided the water table depth; a controlling variable for GHG fluxes. A vegetation survey was conducted at peak plant productivity to characterize the proportions of the plant communities and to allow chamber measurements of GHG to be scaled by the contribution of each plant community. If successful, a restored peatland will be a net sink of carbon. Preliminary data analysis indicates a net CO_2 sink during the summer of 2024 for cotton grass and shrub communities, but a net source for moss. No statistically significant difference was seen for ecosystem respiration, and gross ecosystem productivity revealed significant differences between moss and the other communities. Results also suggest that the site is a small source of CH_4. These results will aid in advancing research on peatlands, stressing the importance of taking the proper steps towards restoration.

The Role of Vegetation in Reducing Carbon Emissions from a Peat Stockpile in Northern Alberta

Veronica Santia[1]* and Maria Strack[1]

[1]Department of Geography and Environmental Management, University of Waterloo, Waterloo, Ontario; *vsantia@uwaterloo.ca

The Oil Sands Region (OSR) in Alberta, within Canada's boreal forest, is a combination of three recognized oil deposits. The boreal forest in the OSR can reach peatland coverage of over 50%. Peatlands are natural carbon (C) sinks through a net uptake of atmospheric carbon dioxide (CO_2). Peat removal for mining operations and the subsequent stockpiling of the peat under aerated conditions promotes organic matter decomposition, potentially emitting significant amounts of C into the atmosphere. Peat stockpiles in the oil sands can stand for decades, often with industry-planted vegetation on the surface, leaving the actual decomposition rates largely unknown. This research aims to improve our accounting of wetland soil C losses for national emissions reporting by evaluating the C emissions on the stockpile at an in-situ oil sands lease across different vegetation treatments, locations (elevation or depression), elevations, and soil moisture contents. To evaluate C emissions, C fluxes were measured weekly using the closed chamber technique for both CO_2 and methane (CH_4) exchange. Paired plots, with and without vegetation, along a vertical transect were set up to allow for a comparison of soil respiration and net C exchange. Biomass was collected to determine the total addition of new organic matter. The net C exchange of the stockpile treatments will be estimated as the difference between soil respiration and C accumulation in biomass. Preliminary results suggest significantly higher ecosystem respiration at intact collars compared to bare peat, likely due to the increase in organic matter. No statistical significance was found in the relationship between stockpile location and ecosystem respiration, gross ecosystem production, and net ecosystem exchange, but CH_4 emissions were significantly related to stockpile location. Aboveground biomass stores 172.8 g C m^2, while belowground biomass stores 455.2 g C m^2. Large peat stockpiles on oil sand leases have substantial implications for GHG emissions and accurate emission reporting. This data will be utilized for annual estimates of peat stockpile-related C losses, which can add to our limited knowledge of national scale estimates of C losses in wetlands that result from oil sands operations.

Vegetation and Carbon-Cycling Responses to Access Roads in Boreal Peatlands

Carissa MacKenzie[1]* and Maria Strack[1]

[1]Department of Geography and Environmental Management, University of Waterloo, Waterloo, Ontario; *carissa.mackenzie@uwaterloo.ca

Mining and recreational access roads can alter hydrologic connectivity in boreal peatlands, but the ecosystem-wide effects and response times are poorly understood. My project explores how gravel roads affect plant community structure and ecosystem function, across a gradient of hydrologic impairment and peatland type, to observe the overall influence on carbon cycling and storage. Preliminary findings suggest that in two bog sites, access roads are impeding water upstream causing shifts in plant species composition observable over 400 m away and less total biomass being produced. Downstream effects at both sites are evident in decreased shrub biomass up to 200 m away, likely a result of enhanced overstory growth from lowered water tables and subsequent shading of the understory. Shifts in species composition downstream were less extreme than those observed upstream, and the greatest effects appear limited to within 75 m from the road. Vegetation community shifts on both sides are likely enhanced at active roads through gravel dust deposition, observable deep in the moss layers over 30 m away from the road. Nutrient inflow from road runoff and gravel dust in both bogs can be seen with the presence of more nutrient-adapted *Sphagnum* species and the proliferation of graminoids adjacent the road. In a rich fen, results suggest that higher water levels upstream are causing shifts in carbon cycling patterns within 5 years post-construction. The significant increase in understory gross primary productivity upstream (measured via carbon dioxide fluxes) may indicate overstory canopy die-back as a result of flooding stress. Methane flux patterns also indicate sinking of the road, with the weight of the gravel and vehicle traffic compressing the peat, leading to increased flooding at 20 m on both sides. Next steps include expanded vegetation surveys, extracellular enzyme tests and geospatial analyses to quantify ecosystem changes at numerous roads across the boreal region. My final results will pinpoint key factors predicting carbon storage in road-altered peatland ecosystems, which can be used for better construction designs, simplified monitoring strategies and effective restoration methods.

Seismic Lines are Associated with Enhanced Ground Layer Evapotranspiration Losses in Peatlands

Maryam Bayatvarkeshi[1]*, Maria Strack[1], Scott Ketcheson[2], Percy Korsah[1], Megan Schmidt[1] and Nazia Tabassum[1]

[1]Department of Geography and Environmental Management, University of Waterloo, Waterloo, Ontario; *mbayatva@uwaterrlo.ca

[2]Faculty of Science and Technology, Athabasca River Basin Research Institute, Athabasca University, Athabasca, Alberta

Evapotranspiration (ET), encompassing water loss through ground evaporation and plant transpiration, is a significant component of the water balance in boreal peatlands. In the western boreal region, seismic lines created for petroleum exploration have disrupted local hydro-climatic conditions in ecosystems, including peatlands. Understanding the impact of these disturbances on hydrological processes is critical, particularly in the sub-humid climate of northern Alberta, Canada. This study evaluates how seismic lines influence ET from the understory using weighing lysimeters and chamber techniques to measure actual ET (AET) and calculating potential ET (PET) using the Penman and Priestley-Taylor methods. We observed that understory AET on seismic lines was 59% and 14% higher than in adjacent areas (herein referred to as offline), as measured by lysimeters and chambers, respectively. Key factors driving these differences were soil temperature, photosynthetically active radiation, wind speed, and vegetation composition. PET on seismic lines was also 51% higher, with a Priestley-Taylor coefficient (α) of 0.73 compared to 0.61 off the lines. Including estimates of tree transpiration, total AET from seismic lines was 31% higher than in undisturbed areas. Given the widespread presence of seismic lines, these changes in ET significantly impact water fluxes and alter the regional water budget, with potential implications at the watershed scale.

Evaluating the Impact of the 'Acrotelm-Harvesting Method' on *Sphagnum* Regrowth Potential in a Boreal Peatland

Éléonor Bergeron-de Pani[1]*, Mélina Guêné-Nanchen[1] and Line Rochefort[1]

[1]Peatland Ecology Research Group (PERG), Center for Northern Studies (CEN), Centre de recherche et d'innovation sur les végétaux (CRIV), Université Laval, Quebec City, Canada; *eleonor.bergeron-de-pani.1@ulaval.ca

Aligned with its commitment to continuously enhance responsible peatland management practices, Premier Tech is developing the 'Acrotelm-Harvesting Method' (ACM), which targets the less decomposed acrotelm layer to potentially preserve surface vegetation, and carbon stocks without draining the peatland. This study assesses the impacts of the ACM on the regrowth potential of *Sphagnum*, by comparing *Sphagnum* productivity and decomposition post-harvesting. The study is conducted at the Pointe-Lebel peatland in Quebec (49°8'N, -68°13'W), where one unharvested control sector and various ACM-harvested sectors, evaluated at different years (1, 2, and 3-yrs post-harvesting), are studied. Experimental units were set up in the three main plant communities: hummocks, lawns, and hollows. Each plant community is represented by three repetitions per sector.

Firstly, decomposition rates were similar between ACM-harvested and the unharvested control sectors across all plant communities, showing no detrimental impact of the ACM on *Sphagnum* regrowth potential. Secondly, ACM positively impacted *Sphagnum* productivity in contrast to the unharvested control sector in hummock and lawn communities, which contribute to 10 % and 80 % of the landscape respectively. As for the hollows, which represent 10 % of the landscape, *Sphagnum* productivity was initially null in the ACM-harvested sectors due to the apparition of bare peat. It recovered two years post-harvest, but not to a similar level as the unharvested hollows. Despite these limitations, the method remains promising to produce *Sphagnum* fiber, as *Sphagnum* regrowth potential is boosted in the most abundant communities. Furthermore, the harvesting techniques of ACM are continually improved to reduce the appearance of bare peat areas. This study will continue over the next two years to monitor long-term sector responses and assess the cyclical potential of this method.

The Influence of Regenerating Forests on Peatland Catchment Hydrology in Sudbury, Ontario

Anna Cushon[1]*, Colin McCarter[2] and Pete Whittington[1]

[1]Department of Geography and Environment, Brandon University; *cushona32@brandonu.ca

[2] Nipissing University

Peatlands are extremely effective global carbon sinks which is largely controlled by their hydrology. The terrain and vegetation of the uplands surrounding certain peatlands can hydrologically influence the runoff and water chemistry that contributes to them and subsequently their carbon sequestration potential. Peatlands in Sudbury Ontario, were severely damaged through years of harmful mining practices that introduced toxic metal contaminants and sulfur dioxide to the surrounding environment. Since the 1970s there has been an effort to regreen Sudbury through upland forest restoration. Nearly 50% of the area has been successfully regreened with the hope of meeting the goal of net zero emissions by 2050. However, if all the peatlands were healthy and functioning, they could store the same amount of carbon in two years than all the regreened forests in the Sudbury area have in the last 50 years. To restore these peatlands, an understanding of the fluxes and flows of water into them, as well as the water table position is crucial. The damaged peatlands in Sudbury are largely fens, receiving water from precipitation as well as the surrounding uplands. Runoff arriving to the peatlands has been influenced by the regreening of the uplands, notably the addition of lime to the surface. To examine the amount of runoff from upland sites of different levels of restoration, runoff will be measured and observed using v-notched weirs, eaves troughing in soil pits, wells, and piezometers. Forest vegetation surveys will also be conducted to quantify changes in vegetation. It is expected that actively restored sites will have greater amounts of vegetation and soil depth and therefore will have less runoff in comparison to the naturally restored sites. This information can be used to determine if modifications to upland regreening efforts are necessary to enhance overall C sequestration potential. This knowledge will be critical to achieve net zero C within the region, and more broadly in Canada.

Modeling Daring Lake Fen Using CLASSIC

Adriana Caswell[1]*, Elyn Humphreys[1] and Salvatore Curasi[2]

[1]Geography and Environmental Studies, Carleton University, Ottawa, ON, Canada; *adrianacaswell@cmail.carleton.ca

[2]Climate Processes Section, Climate Research Division, Environment and Climate Change Canada, Victoria, BC, Canada

As climate change is expected to alter carbon and water dynamics in peatlands, it is increasingly important that peatland carbon, energy, and water fluxes are understood and captured in models so that feedbacks can be more accurately predicted. In this study I evaluate the peatland functionality of the Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC) by modeling site-level carbon, energy, and water fluxes and stores for an Arctic sedge fen. Model results were compared against observation-based data obtained from an eddy covariance flux tower located at the site and manual measurements. This study models the site for seven years from 2011 to 2017 using the peatlands module and shrub parameters. I ran two simulations with varying moss depths (0.01 m and 0.04 m) to provide insight into the influence of moss depth on modeled fluxes. Moss depth noticeably influences modeled fluxes with 0.01 m depth resulting in better agreement with observed data. The model simulates heat fluxes, net radiation, and below-ground carbon well. However, gross primary production was underpredicted which impacted the above-ground carbon, leaf area index, net ecosystem production, and ecosystem respiration predictions. Soil temperature and active layer depth predictions were found to be low. The model predicted seasonal fluctuations in water table depth and volumetric water content but ultimately underestimated soil water storage and its seasonal dynamics. Future research will examine how modifications to sedge peat thermal properties and plant productivity parameters (e.g. maximum rate of the CO2 fixing enzyme Rubisco, V_{cmax}) can improve model simulations.

Mining Atmospheric CO_2: Peatland Restoration in a Smelter Damaged Ecosystem

Akwasi Kwarteng Oduro[1]* and Pete Whittington[1]

[1]Department of Geography and Environment, Brandon University; *887.oduro@gmail.com

Peatlands are critical ecosystems that contribute significantly to global carbon sequestration, storing more carbon than all the world's forests combined. With approximately 20% of the world's wetlands located in Canada, 90% of which are peatlands, their preservation and restoration are crucial to mitigating climate change and maintaining ecological balance.

In Sudbury, Ontario, legacy industrial activities and atmospheric pollution have severely degraded the local peatland ecosystems. Research reveals that hundreds of years' worth of peat have been oxidized back into the atmosphere, contributing to increased carbon emissions. Despite this, restoration efforts for metallic and atmospherically polluted peatlands remain underexplored, creating a significant gap in the existing literature.

To address this gap, we modified the traditional moss layer transfer technique into three distinct treatments and applied them in replicate across six experimental plots. A comprehensive water balance was conducted measuring precipitation, interception, evapotranspiration, soil moisture, and groundwater fluxes. Preliminary results do not show a significant difference between the treatments, and that water was never limiting in any treatment. This suggests that the balance between the upward movement of the contaminants and the growth rate of the moss (and not site wide hydrology), will be the most important factor facing the restoration. Investigations into the transport rates (saturated and unsaturated fluxes) of the containments are also underway.

This study offers critical insights into restoring industrially degraded peatlands and emphasizes the potential of tailored restoration strategies to rehabilitate these vital carbon-storing ecosystems.

Assessing Ecotone Ecohydrological Function in Fen Restoration

Gladys Kibera[1]* and Pete Whittington[1]

[1]Department of Geography and Environment, Brandon University; *kiberagm69@brandonu.ca

Peatlands are a critical component in global climate regulation, water storage, and biodiversity conservation. However, peat extraction severely disrupts these functions, particularly fens and bogs, removing their ability to maintain essential ecohydrological functions. Ecotones, transitional zones between distinct ecosystems offering an ecohydrological gradient, are being increasingly recognised for their potential to enhance resilience and recovery in degraded peatlands.

This study evaluates the ecohydrological functions of ecotones in fen restoration, addressing gaps in understanding their contribution to water table stabilisation and vegetation recovery. While prior research has outlined restoration techniques for bogs, the Elma site was a restoration to a fen. Fens have more complicated hydrology than bogs; hence, an ecotone would help with such problems as it would help increase the flow of water and nutrients from the surrounding natural peatland to the fen restoration site.

This study was conducted at two sites in Eastern Manitoba: Elma North and Elma West. Key metrics, including water table depth, soil moisture content, evapotranspiration, and vegetation establishment, were monitored to assess the effectiveness of creating ecotones in the fen restoration process.

Impacts of Seismic Lines on Peatland Carbon Cycling In Boreal Alberta

Percy Korsah[1]* and Maria Strack[1]

[1]Department of Geography and Environmental Management, University of Waterloo, Waterloo, Ontario, Canada; *pekorsah@uwaterloo.ca

A vast network of linear disturbances, such as seismic lines and roads, used for exploration of oil and gas deposits in boreal peatlands, could impact long-term peatland carbon (C) storage by altering ecohydrological conditions. Prior studies reported changes to hydrology, microclimatic conditions, and vegetation communities. Yet, the cumulative impact of these changes on peatland functions, that is, microbial functional activity, peat accumulation rates and carbon dioxide (CO_2) and CH_4 exchange is not very well understood. We therefore measured in-situ and in-vitro soil respiration, NPP and litter decomposition, and CH_4 emissions on eight seismic lines across one fen and two bog peatland sites affected by seismic exploration in northern Alberta and compared the results to adjacent natural areas. Soil respiration was slightly lower on seismic lines than from natural peatlands, likely due to minimal contributions of tree root respiration on the lines. Ground layer NPP was higher on the lines, but this did not offset the loss of overstory NPP. The litter decomposition rate was similar on and off the seismic line, but a shift in plant community composition towards species with more easily decomposable litter, particularly at the fen site, resulted in greater loss of litter overall. The potential peat accumulation rate was therefore lower on the seismic lines. This implies that recovery of an overstory in these wooded peatlands is necessary to achieve pre-disturbance C accumulation rates.

Findings from this study provide important baseline information about how seismic line disturbances alter C cycling in peatlands and could assist in designing restoration efforts aimed at returning forest cover.

Q10 Results for Alberta's Boreal Swamps in the Slave Lake and Peace River Areas

Justin Yu[1]*, Maria Strack[1], Scott Davidson[2] and Bin Xu[3]

[1]Department of Geography and Environmental Management, University of Waterloo; *j423yu@uwaterloo.ca

[2] University of Plymouth

[3] Northern Alberta Institute of Technology

Peatlands and wetlands across the world are important ecological areas as they have a very large capacity to take carbon dioxide (CO_2) from the atmosphere and store them in the ground while only covering a small fraction of global land area. Wetlands such as boreal swamps in Alberta, Canada are at a high risk of being disturbed by human activities such as mining and road development. These disturbances alter their ability to be carbon sinks and take CO_2 from the air, and instead causes them to become carbon sources, releasing more CO_2 than they take in. It is therefore integral to have effective models, maps and criteria's to be able to effectively manage and protect these vital ecosystems in the face of a rapidly changing climate. However, boreal swamps have not been well studied in these regions and are lacking foundational data to inform reclamation and land management decisions. As part of a project to create a foundational dataset for the different swamp types found in the boreal region of Alberta, a preliminary set of sampling was done in August 2024 at a handful of sites to incubation experiment to determine potential ecosystem respiration (ER) and Q10 values for coniferous, tamarack, mixedwood and thicket swamp types. ER rates were higher in the treed swamp types compared to thicket swamps with mean ER rates of 847 mg C m^{-2} d^{-1}, 1293 mg C m^{-2} d^{-1}, 1408 mg C m^{-2} d^{-1} for coniferous, tamarack and mixedwood swamps respectively compared to 329 mg C m^{-2} d^{-1} for thicket swamps. Mean Q10 values were similar between thicket and tamarack swamp types at 1.22 and 1.27 respectively but were higher in the mixedwood and coniferous swamps at 2.89 and 3.30. Overall, determining potential ER and Q10's for swamps in the boreal regions of Alberta are important for addressing the data gaps that exist for these wetland types and to inform further research.