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Cold Regions Research Centre Days Conference 2023 Full Schedule

Thursday November 23, 2023

One Minute Video

Burn Severity Map, Scotty Creek Research Station
Taylor Hayhurst – Wilfrid Laurier University
Supervisor: William Quinton

Scotty Creek Research Station is located in Northwest Territories within one of the most rapidly warming regions on the planet, and what were once permafrost-dominated landscapes have gradually thawed out, introducing more zones of talik formation, and discontinuous and sporadic permafrost. The warming climate in cold regions continues to break temperature records across Northwest Territories, which has increased the frequency of wildfire occurrences, heavily contributing degradation of subsurface features across the province. Looking at trends of data acquired from the Government of Northwest Territories, the number of wildfires per year is increasing whereas the average hectares burned per year is decreasing. The creation of a burn severity map is a priority going forward, in collaboration with NR-Can, Forestry Canada, and ECCC. The end goal of this map is to be able to combine and overlay other biophysical features to observe their relationship in context to burn data.

Petri Matthew Varsa – University of Waterloo
Supervisor: Gladimir V.G.Baranoski

3-Minute Thesis (3MT)

Permafrost thaw induced changes to surface water – groundwater connectivity
Eric Leonard – Wilfrid Laurier University
Supervisor: William Quinton

This research aims to understand the changes driving an increase in streamflow across basins in the Taiga Plains Ecozone underlain by discontinuous permafrost. The primary focus is on if the observed increases in streamflow in the Trout River and La Martre River, NWT are driven by permafrost thaw through new or reactivated groundwater pathways. Objectives include the assessment of permafrost thaw's influence on near-surface groundwater activation in both wetland and upland terrains, along with assessing how permafrost thaw at each terrain type may impact hydrologic flow paths and connectivity to the stream network. Through hydrological characterization of soils, units of preferential water flow have been identified. Employing electrical resistivity tomography, depths to seasonal frost, permafrost, and talik

layers have been distinguished. Furthermore, stable isotope and major ion analyses of water samples have shown distinct signatures of surface water and groundwater, shedding light on the heightened interconnections between these systems.

Wildfire impacts on physical and chemical properties of sub-arctic peat soils
Joshua Meyer – Wilfrid Laurier University
Supervisor: William Quinton

The Scotty Creek basin is a peatland dominated region of discontinuous permafrost, located in the Taiga plains ecoregion of the Northwest Territories. As with many areas of the North, Scotty Creek is experiencing rapid change with the advance of climate change. In the summer and fall of 2022 a rapidly moving wildfire swept across the basin, creating a large and varied burn scar. My thesis project, which began in the summer of 2023, seeks to quantify the physical and chemical impacts of varying burn severities on the peat soils found within the basin. Specific properties to be studied include porosity, bulk density, permeability, water retention, thermal conductivity, solute transport, and DOC leaching.

The water balance of a collapse scar wetland within thawing discontinuous permafrost; Scotty Creek, Northwest Territories
Iain Thomson – Wilfrid Laurier University
Supervisor: William Quinton

Mean annual air temperatures are increasing rapidly in Northwestern Canada, which is among the most rapidly warming regions on Earth. Consequently, permafrost thaw is proceeding at a rate not found in the historical record, with rates especially high in the peatland-dominated southern margin of discontinuous permafrost. As permafrost thaws, ground surface subsides. This process has transformed forest to wetland over much of this region. This landcover change has driven hydrological changes, including rising mean annual basin discharge. Such increases are far in excess of what can be accounted for by changes in precipitation and were shown to be driven by the expansion of runoff contributing areas, as permafrost “barriers” are removed with thaw. To better understand how permafrost thaw impacts flow and storage processes of peat plateau-wetland complexes, a detailed water balance was undertaken during the growing season (April – August) of 2022 for a collapse-scar bog and surrounding drainage area.

Microplastics in Arctic Freshwater Lakes and Ponds
Kelly Evans – Trent University
Supervisor: Julian Aherne

Microplastics (plastic particles < 5 mm) are ubiquitous in all environments, including remote Arctic regions. However, studies have yet to investigate the characteristics and abundance of microplastics in Canadian Arctic freshwaters. To address this knowledge gap, we filtered 8 L of lake water onto glass-fiber papers using a hand pump from 20 lakes and ponds surrounding Iqaluit, Baffin Island, Nunavut. We further sampled Hylocomium splendens, a common moss species used to biologically monitor atmospheric pollutants to discern atmospheric transport as

the source for microplastics. Subsequently, moss samples were digested using 30% Hydrogen peroxide and Fenton's reagent and filtered onto glass-fiber paper. Lake water and moss samples were visually analyzed for microplastics under a stereomicroscope, and a hot-needle test was performed on suspected plastic particles; a particle was quantified as plastic if it melted. To our knowledge, this project is the first to assess microplastics in Canadian Arctic freshwater catchments.

Exploring Great Bear Lake: Pioneering 3-D Hydrodynamic Modeling for Climate Solutions
Kirin Lorente – Wilfrid Laurier University
Supervisor: Homa Kheyrollah Pour

Great Bear Lake (GBL) is the largest polar lake in the world and plays a crucial role in maintaining high albedo during ice and snow cover periods. However, GBL is experiencing the effects of climate change and without a comprehensive understanding of GBL it is impossible to effectively identify and mitigate these impacts. Therefore, a 3-dimensional numeric model of GBL, is utilized to investigate the hydrodynamic and ice dynamic processes present. The Aquatic Ecosystem Model (AEM3D) will consider, temperature, circulation, water quality, ice thickness, and ice phenology, and the relationships between these components and the atmosphere. The model will be calibrated with remote sensing data and verified through on-site data. The results from the model will be the first comprehensive study of GBL in over a decade, will establish a baseline condition of GBL, and will help identify climate-driven patterns and shifts within the GBL basin.

Characterizing the influence of wildfire on contaminant enrichment at ponds within the Whooping Crane Nesting Region (Wood Buffalo National Park)
Amy Lacey – University of Waterloo
Supervisor: Roland Hall

The Whooping Crane Nesting Region (WCNR) is part of a remote wetland landscape at the Alberta-NWT border region of Canada. Here lies the breeding grounds in North America for the only naturally reproducing whooping crane (Grus americana), a critically endangered species whose small population size and wetland habitat requirements make them especially vulnerable to climate change. Wildfires raged in the region throughout the summer of 2023, distributing smoke and associated hazardous substances which may pose risks to whooping crane. Many hazardous substances have low solubility in water (e.g., metals, mercury, polycyclic aromatic hydrocarbons [PAHs]) and thus adhere to sediment that deposits along the bottom of aquatic ecosystems. This can result in a dangerous accumulation of metals and contaminants that may affect the whooping crane and other aquatic species. This study aims to establish a natural range of variability of metals of concern in the WCNR to determine the impact of recent forest fires on contaminant levels using surface sediment samples from 60 lakes.

Chronic Sublethal Toxicity of Neodymium to Fathead Minnows (Pimpephales promelas)
Jane Morgan – Wilfrid Laurier University
Supervisor: Jim McGeer

Globally, there is an increasing demand for rare earth elements (REEs) to produce green technologies and they are a priority on the Canadian critical minerals list. There is limited knowledge on potential environmental effects of REEs. My MSc studies are a collaboration with Canada's first rare earth element mine and the overall objective is to produce ecotoxicological data that will inform water quality guidelines. This study will assess the effects of water chemistry on neodymium (Nd) bioavailability, tissue bioaccumulation, and effects on fish swimming performance. Chronic sublethal exposure experiments will be conducted with fathead minnows in water chemistries relevant to Nechalacho. Following exposure, fish will individually be placed in a Blazka-type swim tunnel for respirometry measurements of metabolic rate followed by tissue sampling for Nd bioaccumulation. Water and tissue samples will be measured by inductively coupled plasma emissions spectroscopy. Findings will contribute to foundational knowledge of REE toxicity.

Multigenerational toxicity and metabolomics of Pb from fishing gear to the freshwater snail Planorbella pilsbryi
Sabrina St-Hilaire – Wilfrid Laurier University
Supervisor: Erin Leonard

Lead is a highly toxic element with no known biological function. It is estimated that over 460 tonnes of lead fishing gear enters Canada's waterways annually, posing a health risk to aquatic organisms. Despite their importance in aquatic environments as a food source, freshwater snails (Planorbella pilsbryi) lack representation in risk management assessments and species distribution lists. Although the toxicity of lead from various other sources is well established, the toxicity of lead from fishing gear remains unknown. Multigenerational toxicity testing and metabolomics will allow for a greater understanding of the mechanistic toxicity of lead from fishing gear, and how growth, development, and reproduction are impacted. This project will contribute relevant data to risk management assessors on the risk of lead fishing gear towards the Canadian Fisheries Act, and provide baseline data for future risk management efforts restricting the use of lead fishing gear in Canada.

Assessing the impacts of metals on the oxygen regulation in fathead minnows
Natalie Nykamp – Wilfrid Laurier University
Supervisor: Erin Leonard

Eutrophication from nutrient pollution can result in oxygen depleted waters leading to overall stress of aquatic ecosystems. Fish have adapted strategies to cope with these hypoxic waters such as increasing their ventilation rates, known as the hypoxic ventilatory response (HVR), as well as behavioural changes to combat the demands of low oxygen. Metals have become an increasing concern in aquatic environments because of anthropogenic inputs as well as their persistence in the aquatic ecosystem. This study examines the effects of neodymium (Nd), lead

(Pb), and nickel (Ni) on the oxygen regulation in fathead minnows *(Pimephales promelas).* The fish are exposed to the metal for 48 hours prior to observation, and the ventilation rates and behaviours of the fish are assessed in comparison to control groups. Results show that Nd and Ni have a significant effect on the fish's oxygen regulation, while Pb exposure is showing no significant effect.

Alleviating The Northern Crisis: Envisioning an Indigenous-Led Enterprise
Laura Rodriguez – Wilfrid Laurier University
Supervisor: Andrew Spring

For Indigenous Peoples, the land is a source of cultural and spiritual well-being that has divine and traditional connections to people's way of life and identities. Unfortunately, the global food system, colonial powers, and environmental dispossession are impacting northern Indigenous lands and food systems, leading communities to become food insecure. However, communities are still thriving in the face of adversity. In the Northwest Territories, members of Kakisa, in the lands of Ka'a'gee Tu First Nations (KTFN), are growing food through vegetable gardens and greenhouses with the support of researchers. Indigenous stakeholders in Brazil are sharing Indigenous agroforestry knowledge with residents of Kakisa, equipping them with the skills to grow food within the KRFN forest. These mitigation systems have reintegrated people back into the land and increased access to traditional food. Now, community members are envisioning what an Indigenous-led store looks like to continue to mitigate growing challenges. Through one-on-one interviews with 9 community members, interviewees revealed that they do not want to only focus on operating a store as their primary economic service in case it fails. They also want an enterprise that creates a space to share food, build relationships, and empower women, while improving the communities' economic opportunities.

Estimating Nutrition North Canada subsidy pass-through rates in Northwest Territories
Narayan Subramoniam – Wilfrid Laurier University
Supervisor: Andrew Spring, David Wheatley

Nutrition North Canada (NNC) is a multi-pronged food policy program across northern Canadian provinces and territories. NNC aims to improve access to food, increase food literacy, and reduce food prices through a retail subsidy. We study the pass-through rate of the NNC retail subsidy in Northwest Territories (NWT) and compare it against a similar analysis conducted for Nunavut. We find that the pass-through rate is, at most, 56% in NWT which is significantly less than Nunavut's pass-through rate. The proposed causes behind these differences are in road networks, population distributions, modelling limitations, and retailer misbehaviour. We highlight the issues of estimating the pass-through rate across a mix of retailer calculated profit-margins and show that previous regression analysis on the topic overestimates the pass-through rate by exactly the profit margin.

Infrastructure Development and Community Food Security in the Inuvialuit Settlement Region: The Impact of the Inuvik-Tuktoyaktuk Highway
Camille Slack – University of Ottawa
Supervisor: Sonia Wesche

While some research exists on rural road development impacts within the global Indigenous context, the impact of new roads on Arctic Indigenous communities remains largely unknown. My research aims to address this gap through a collaborative case study with Tuktoyaktuk (pop. 937), a hamlet in the Inuvialuit Settlement Region (ISR) that gained all- season road access with the 2017 opening of the Inuvik-Tuktoyaktuk Highway (ITH). Building on preliminary findings from community focus groups and interviews conducted by an Inuvialuit youth, alongside feedback from community consultation and secondary interviews conducted last winter, my research examines local perspectives on the impacts of the ITH, including key trends connected to food access, harvesting, travel and community wellbeing.

Community-developed research expectations in the Lhù'àän Mân region, southwest Yukon: Exploring researcher perspectives
Savannah Müller – University of Ottawa
Supervisor: Sonia Wesche

The Lhù'àän Mân (Kluane Lake) region in southwest Yukon – the traditional territory of Kluane First Nation (KFN) – has experienced significant research activity in the past half century. However, research activity has often been externally driven and inaccessible to the local communities. In response, KFN is developing a set of research expectations to guide all types of research within their territory. Using a participatory approach, this study aimed to engage with Kluane-based academic researchers using a series of semi-structured interviews. The objectives of this study are to: (O1) explore how researchers are engaging with the Kluane communities, (O2) explore how researchers would approach engaging with emerging research expectations, and (O3) identify potential challenges and opportunities to improving researcher engagement with community-developed research guidelines. This study was directed by partners at KFN's government and seeks to support the broader community-led project, which supports equitable and collaborative research processes in the Kluane region.

Assessing the supraglacial hydrological changes of surging glaciers in the St. Elias Mountains, Yukon
Jaime Dubé – University of Ottawa
Supervisor: Luke Copland

Glacier surges are dramatic changes in a glacier's dynamics, which occur cyclically over multi-year to decadal periods. Surge-type glaciers go through 2 main phases: the quiescent phase, during which the glacier is almost stagnant, and the active/surge phase, marked by intense increases in velocity. Surges in Yukon-Alaska appear to be primarily caused by subglacial water pressure buildup, with this water being mainly fed from melt flowing into supraglacial channels on the glacier surface. My work aims to analyze of the evolution of the supraglacial hydrology

of Lowell Glacier, Yukon, during a recent surge cycle. Sentinel-2 imagery is used to delineate surface meltwater distribution and its changes over time using semi-automated methods in a GIS. This is undertaken in comparison glacier velocity data to quantify its connection to surface hydrological conditions during the surge, allowing us to better understand the impacts of future surges on the local watershed.

Thermokarst Mapping Collective
Will Bender – Wilfrid Laurier University
Supervisor: William Quinton

The purpose of the Thermokarst Mapping Collective is to build an observation-based inventory of the features that are sensitive to permafrost thaw or are actively undergoing permafrost thaw (thermokarst) within the Northwest Territories and some area from adjoining watersheds. Using satellite imagery in a GIS mapping software, the territory is split into grid cells of 7.5km by 7.5km. Mappers identify and record thermokarst features in each cell which creates a spatial dataset. The mapping is substantiated from ground truthing and oblique imagery. The finished dataset product is intended to be used by northern industry, government policy makers, and land users to better understand geographical patterns of climate driven impacts in the NWT.

Exploring Lake Hydrology in Permafrost Zones: A Comparative Analysis Using GeoTop, CSLM, and SWOT Satellite Observations
Arnab Singh – Wilfrid Laurier University
Supervisor: Philip Marsh, Roderik Melnik

Freshwater lakes and reservoirs comprises nearly 74% of surface water. The Surface Water and Ocean Topography (SWOT) satellite provides data on the surface elevation of the lakes and will be available every 4-6 days in our northern study region from November 2023. In this study, we will be using GeoTop and Canadian Small Lake Model (CSLM) to simulate the water elevation level for select lakes at lake-sparse Trail Valley Creek and lake-dense Hans Creek to match those with the data from SWOT. Expansion of simulation to consider the network of lakes at the sites to see how the channel and sub-channel flow influences water elevation level is a critical component of the study. Since much of these lakes lie in continuous permafrost zones, we will be linking elevation level fluctuation to permafrost thaw, ice melt and groundwater flow through change in water storage, lake ice formulation, and talik evolution.

Fired Up: Evaluating the frequency of post-fire ecological state change through time
Brian Newton – Wilfrid Laurier University
Supervisor: Jennifer Baltzer

Northern latitudes are experiencing rates of warming that are four times greater than the global average. This has resulted in more frequent and severe wildfire events which in turn have reduced the resilience of the boreal forest to wildfire disturbance. Instances of compositional shifts between major forest stand classes have been observed following recent wildfire events, however little is known about the changing frequency of these shifts during

recent decades of rapid climate change. I will be using pre-fire historic aerial photos and post-fire satellite imagery of burn sites from the last 70 years to quantify the changing frequency of compositional shifts in the plateau-central region of the Yukon. I will then model these changes against macro landforms to gain more context behind these shifts. Transitions to new forest classes have major ecological consequences, their understanding will be critical for informed land management policies.

How Lichen Responds to Permafrost Thaw Across the Northwest Territories.
Katerina Coveny – Wilfrid Laurier University
Supervisor: Jennifer Baltzer

The arctic is facing the threats of climate change at an accelerated rate compared to the rest of the world, temperatures are increasing and with them, permafrost is thawing. The thawing of permafrost is known to increase above ground plant biomass, canopy cover, and waterlogging in soils. These changes are known to negatively impact slow growing lichen (Cladonia sp.) communities that are crucial for winter Woodland Caribou (Rangifer tarandus) forage. We will use 10 - 30 years of permafrost monitoring data from continuous, discontinuous, and sporadic permafrost distributions to understand the rate of permafrost thaw across the latitudinal extent of the Northwest Territories. Lichen biomass will be determined using lichen cover and height measurements taken in the field. Woodland caribou are an essential part of the boreal forest ecosystem and play an important cultural and economic role in many northern communities. Understanding how the current rate of permafrost thaw impacts lichen biomass will be crucial to support Woodland Caribou populations throughout the Northwest Territories.

Boreal plant ability to acquire novel nitrogen from permafrost thaw
Keira McManus – Wilfrid Laurier University
Supervisor: Jennifer Baltzer, Chantel Markle, Caitlyn Lyons

Climate change is increasing the severity of permafrost thaw in the boreal forest. Previous research has shown that when permafrost thaws, the frozen inaccessible resources found within permafrost are released and become available for plant uptake. In this research project a stable isotope experiment is used to explore the variation in boreal plant ability to uptake these newly thawed nutrients. This experiment took place in Scotty Creek, NWT and specifically looks at plant uptake of novel nitrogen. The results from this research will help determine the response of boreal plants to thawing permafrost and inform predictions for the future of the boreal forest.

Impacts of beaver activity on stream food webs and mercury bioaccumulation in tundra streams.
Mathew Mervyn – Wilfrid Laurier Universty
Supervisor: Joseph Culp, Jordan Musetta-Lambert

North American beavers (Castor canadensis) are expanding their northern range due to various environmental effects of climate change. Beavers alter hydrological patterns, biogeochemistry,

instream habitat, and food webs by building dams across streams and rivers. The ecological effects of beavers on the surrounding environment are well-studied in boreal regions, but poorly understood in the Arctic. Of particular concern to northern Indigenous communities is the potential for beaver activity to increase mercury bioaccumulation because the bioavailable neurotoxin, methylmercury (MeHg) can be magnified via bottom-up trophic level pathways. My research aims to characterize how beaver dams affect food webs in tundra-dominated streams. In addition, I am examining how beaver impoundments influence the availability of Hg and MeHg in streams and the potential for uptake in freshwater food webs.

12 Minute Talks
Animal Movement and Distribution

Eyes on ʔetthën: Caribou and camera traps in the Land of the Ancestors
Eric Jolin – Wilfrid Laurier University
Supervisor: Frances Stewart

Thaidene Nëné Indigenous protected area (TDN), an ecologically intact protected area straddling the treeline of the Northwest Territories, is experiencing severe declines in barren-ground caribou and concurrent range expansions of muskox and moose. Traditional knowledge holders note behavioural responses between ungulates, but how they spatially segregate is unknown. The primary objective of my proposed research is to quantify caribou habitat use response to landscape characteristics, and species co-occurrences, across a boreal-tundra ecotone. I will use species detection data from camera traps to develop caribou distribution models, to determine the effects of environmental covariates, heterospecific ungulates, and their shared predators. If caribou shift their habitat use within a heterogenous multi-ungulate system, then occurrence should be correlated with different environmental predictors than other ungulates. TDN will serve as an ideal case study to better understand the effects of climate change on large mammals in a rapidly changing northern environment.

Implications of Beaver Dams on the Hydrology of Arctic Watersheds
Jackson Seto – Wilfrid Laurier University
Supervisor: Philip Marsh

The warming Arctic has led to shrub expansion and tundra greening across much of the Arctic. These changes in vegetation have allowed the tundra to become habitable for beaver populations and expand throughout large areas in the tundra-taiga transition zone. Beavers are ecosystem engineers and can influence hydrology, through the impoundment of ponds, lakes and rivers. It is expected that this, leads to changes in water storage and discharge. However, few studies have been performed in the Canadian Arctic, thus the details of the extent of which beavers influence the hydrology of Arctic Canada is limited. In this study we will investigate the impacts of beavers on the hydrology of the western Canadian Arctic, by comparing two hydrologically different watersheds north of Inuvik. This research aims to quantify the impact of

beaver activity on water storage and discharge, and assess the influences on streamflow, lake surface area, and storage volume.

Project Proposal: Dolly Varden Char in the Changing Arctic – Stable Isotopes and Trophic Ecology
Jordan Jason-Byerley – Wilfrid Laurier University
Supervisor: Heidi Swanson

Dolly Varden are partially anadromous, meaning not all individuals undertake annual sea-run migrations. Climate change is resulting in declines in sea-ice and increases in sea surface temperature, which may result in fish moving further offshore to access more suitable habitats and forage availability. This project will propose using Dolly Varden tissue specimens collected in the North Western Canadian Arctic over the previous decade that will then analyzed for carbon, nitrogen and sulfur stable isotopes. These stable isotopes lend insight into fish diet and habitat use and how that has changed over time.

Movement and space use patterns of sympatric Arctic char (Salvelinus alpinus) and Dolly Varden (Salvelinus malma) in the Canadian Arctic
Simon DePasquale – Wilfrid Laurier University
Supervisor: Heidi Swanson

In Kugluktuk, Nunavut, Canada subsistence fishers have observed major population declines in anadromous char in recent years. In the Coppermine River near Kugluktuk, climate change may be differentially impacting Arctic char (Salvelinus alpinus) and Dolly Varden (Salvelinus malma) and causing a shift in community composition. To better understand why overall char numbers are declining and how changes in community composition may be related to this decline, I will use acoustic and radio telemetry to identify and differentiate the movements and space use patterns of Arctic char and Dolly Varden in the Coppermine River and its surrounding marine environment. By researching the movement ecology of char in the Coppermine River, my thesis will help guide species specific restoration measures and improve the food security of Kugluktuk.

12 Minute Talks
Arctic Lake Hydrology & Water Quality

The Future of Thermokarst Lakes: Comparing Lake Model Performance around Trail Valley Creek
Alexander Fogal – Wilfrid Laurier University
Supervisor: Phil Marsh

The Arctic and Boreal regions have the highest areal lake-cover on the planet, with a wide variance of size and depth, ranging from seasonal wetlands to large, deep lakes, like Great Bear Lake in the Northwest Territories. These regions also have a high density of ice-rich permafrost,

the degradation and thawing of which can cause the formation or enlargement of lakes, but also the shrinking and draining of these same lakes. Such permafrost-controlled lakes are termed thermokarst lakes, and are complicated entities: their hydrological processes and role in regional hydrology is poorly constrained. These lakes are also complicated to model, with further difficulties such as data sparsity affecting model output quality. Herein, multiple lake models will be compared for how they perform when applied to thermokarst lakes in the vicinity of the Trail Valley Creek research station. Model output will be validated using field observations and in situ meteorological data.

Beyond Oxygenation: The impact of aerator installation on the chemical and biological recovery of Frame Lake, Yellowknife
Madeline Patenall – Wilfrid Laurier University
Supervisors: Derek Gray, Mike Palmer

Nutrient and contaminant inputs have had detrimental effects on aquatic habitats worldwide. An example is Frame Lake, located in the heart of Yellowknife, NT. Urbanization and mining have caused nutrients and arsenic-bearing emissions to be deposited in the lake, resulting in eutrophication, metal(loid) contamination, and reduced recreational value. Installing a deep water (hypolimnetic) aerator has been proposed as a remediation strategy for Frame Lake. The specific objectives of this work include: 1) investigating the impact of hypolimnetic aeration on the cycling of arsenic and nutrients between lake sediments and the water column and 2) assessing how aeration influences the lower food web. Baseline data has been collected, and sampling of surface waters, sediment porewater, and organisms of the lower food web will continue once the aerator is installed. Findings will have implications for the rehabilitation of Frame Lake and the multitude of lakes afflicted by eutrophication and arsenic contamination worldwide.

Examining Seasonal Variability Of Water Quality and Zooplankton Communities in Yellowknife, Northwest Territories
Nicole Andreola – Wilfrid Laurier University
Supervisor: Derek Gray

Frame Lake, located in Yellowknife, Northwest Territories, used to be an attractive swimming and recreational spot for locals. After urbanization in the watershed and the resulting eutrophication of the lake, the water quality has declined. The lake used to contain fish, but these were likely lost due to the decrease in oxygen levels associated with eutrophication, especially over winter when ice prevents gas exchange with the atmosphere. One possible solution to this problem is to install a hypolimnetic aerator to allow oxygen levels to increase below the ice during the winter. Aeration introduces oxygen to the water, and some studies suggest that it can help to break down accumulated organic matter on the lake bottom, reducing oxygen demand from the sediments. Currently, a rehabilitation project is underway to install an aerator next year. My project aims to study the effects of this aerator on water quality and zooplankton communities.

Hydrological controls on pond water balance and water levels in the Whooping Crane Nesting Region, Wood Buffalo National Park
Laura K. Neary – University of Waterloo
Supervisor: Roland Hall, Brent Wolfe

The summer breeding range of the endangered whooping crane lies within a remote pond-rich region of Wood Buffalo National Park (WBNP) where they build nests and raise their young along the shores of shallow ponds and wetlands. Low water levels are known to increase predation and high-water levels reduce chick survival because of flooding. Knowledge of factors that contribute to water-level variation is necessary to anticipate how vulnerable or resilient these ponds may be to climate change. In 2021, we launched a collaborative research program to characterize hydrological conditions of ponds across the Sass and Klewi subregions. Sampling methods include seasonal measurements of water isotope composition and water chemistry and deployment of depth loggers at 63 well-dispersed ponds that span a range of size and colour. Contrasting hydrological conditions in 2021 and 2022 reveal the sensitivity of ponds to shifting meteorological conditions, particularly snowmelt, rainfall and evaporation.

12 Minute Talks
Northern Environmental Research and Indigenous Knowledge Integration

Seasonal freeze-thaw cycles alter concentration-discharge relationships of weathering ions and Dissolved Organic Carbon in permafrost underlain mountain catchments.
Arsh Grewal – McMaster University
Supervisor: Sean K. Carey

In permafrost underlain systems, seasonal thaw of the active layer has a considerable impact on flow path activation and stream chemistry. In this study, we utilize grab sampling of major ions and dissolved organic carbon (DOC) across eight permafrost underlain headwater mountain catchments located in Yukon Territory, Canada. Our primary objective is to assess the role of seasonality and catchment characteristics on concentration-discharge (CQ) relationships. We use CQ relationship to infer different sources and pathways of water flows and how this acts to influence stream chemistry. Additionally, we utilize continuous specific conductance (SpC) and discharge data to calculate event-scale metrics at four catchments. Results from grab sampling shows significant dilution of weathering derived ions and flushing of DOC during the summer periods at all sites. Residuals for CQ relationships of weathering derived ions (DOC) were generally lower (higher) during spring and higher (lower) during fall. Indicating seasonally changing flow paths.

The influence of snowfall on lake-ice freeze-up processes
Arash Rafat – Wilfrid Laurier University
Supervisor: Homa Kheyrollah Pour

Lake ice in the Yellowknife region is heavily relied for transportation via ice roads, crossings, and winter trails- many of which traverse small lakes. Despite the reliance on these ice covers, few in-situ data exist on how these ice covers form, in part from the inability to safely stand on thin (early autumn) or rotten ice (spring). To combat this, we have design and constructed a year-round Floating Research Station in Yellowknife, Northwest Territories. The station consists of an automated ice sensor called the Snow and Ice Mass Balance Apparatus (SIMBA), which provides estimates of ice thicknesses and snow depths every 15 minutes. Using the Station, we investigate the response of lake ice processes to extreme snowfall in Yellowknife between October-December 2022. With climate change projected to change snowfall patterns in northern regions, results of this study have significance on the safety of communities who rely on lake ice in the early winter period.

Advancing socio-political actualization of Dene Stewardship: Co-development of an Indigenous-led GIS-Based Cumulative Impact Monitoring Framework with Sambaa K'e First Nation, NWT, Canada
Micheal McPhee – Wilfrid Laurier University
Supervisor: William Quinton, Miguel Sioui

Cumulative impacts across the Northwest Territories (NWT), Canada continue to exacerbate a myriad of challenges for Indigenous populations when traversing methodological approaches, multijurisdictional policies, and daunting research relationships within land management contexts. This thesis addressed how differing cultural systems, ecological change, and fractured multi-lateral partnerships will synergize into a cohesive strategy for Sambaa K'e First Nation (SKFN). Embracing Indigenous methodologies as a consistent guiding ethos, co-developed research questions with SKFN leadership yielded a participatory framework which facilitates cultural revitalization, environmental protection, and informed decision-making through standardized monitoring protocols for TK indicators, a consolidated database, and a framework for intergenerational knowledge exchange. Results indicate the need to develop protocols related to knowledge documentation, procurement, and dissemination, to ensure the sociopolitical actualization of SKFN's goals are not hindered by cumulative impacts to land, culture, and research relationships. This framework increases interdisciplinarity between on the ground action, multi-lateral partnerships, and governance.

Keynote

Chasing Quicksilver: 13 years of studying the Arctic mercury cycle
Christian Zdanowicz – Uppsala University (Sweden)

Dr. Zdanowicz studies the impacts of climate warming and atmospheric pollution in the Arctic. Over the past 13 years, he has investigated how atmospheric mercury circulates through the Arctic cryosphere, as well as how mercury cycling and climate change interact. His presentation will look back on what he's learned and on the questions that remain, drawing on research carried out in Nunavut, the Yukon, and NWT.

Friday November 24, 2023

12 Minute Talks

Remote Sensing in Northern Research

Characterizing importance of spring snowmelt on water balance of lakes in a northern freshwater delta using water isotope tracers and water-level loggers
Arisha Imran – University of Waterloo
Supervisor: Roland Hall, Brent Wolfe

Ice-jam flooding is a well-recognized hydrological process that maintains positive water balance of the abundant lakes in the Peace-Athabasca Delta, a Ramsar Wetland of International Importance in northern Alberta. Snowmelt input may also be a substantial contributor to lakes, but its role is less well characterized. Here we combine analyses of water isotope composition and water depth variation in flooded and non-flooded lakes in spring 2020 to quantify the contribution of snowmelt input to lake-level rise. Using a binary mixing model to estimate the relative input, results showed lakes in the northern less flood-prone Peace sector rose to a similar amount as lakes that received river floodwaters in the southern flood-prone Athabasca sector. Findings highlight the importance of snowmelt input to perched basins, especially amidst shifting climate regimes.

Influence of dry seasonal conditions on ground thaw and hydrology of a small Arctic watershed.
Brampton Dakin – Wilfrid Laurier University
Supervisor: Philip Marsh, David Rudolph

We conducted a study to test the high resolution, physics-based model GEOtop in the dramatically warming western Canadian Arctic. Field data for model testing was collected from May 25th to August 29th, 2021, at Siksik Creek, a sub-catchment of Trail Valley Creek, located 50km north-east of Inuvik, NWT. This data covered the entirety of the watershed which crossed a variety of terrain and vegetation types and included frost table depths; water table depths; and stratigraphy and soil thicknesses across mineral earth hummocks and their inter-hummock

zones. We used GEOtop to explore the processes controlling the hydrological cycle for this summer, how the movement of water impacted thaw depths in these landscapes, and the role hummocks and other terrain types play within this. We then considered how the summer of 2021 differed from a previous, wetter year where we had a similar field data set.

Non-growing season CO2 emissions may offset a substantial fraction of the growing season CO2 uptake in Canadian peatlands
Katie Hettinga – University of Waterloo
Supervisor: Fereidoun Rezanezhad, Philippe Van Cappellen

Canada's peatlands hold over half of the organic carbon (C) stock of Canadian soils and are considered a critical C sink. However, during the non-growing season (NGS) these ecosystems typically emit carbon dioxide (CO2) and how these NGS CO2 emissions compare to the growing season (GS) CO2 uptake remains uncertain. In this study, we focused on five peatland sites in Canada. We acquired seven years (2015-2021) of derived C data from NASA's Soil Moisture Active Passive (SMAP) Carbon Net Ecosystem Exchange (NEE) datasets. Our data analyses showed that NGS CO2 release represented between 25 and 1,120% of the GS CO2 uptake, but, that the derived C fluxes may be overestimated in northern peatlands. Our findings highlight the importance of considering the NGS when constructing annual budget estimates. Furthermore, while peatlands are likely sinks in the long term their annual sink status may be dynamic.

The Role of Lake Physical Variables and Atmospheric Forcings on the change in Algal Biass in North American Great Lakesom
Micheal Dallosch – University of Waterloo
Supervisor: Homa Kheyrollah Pour, Claude Duguay

Climate change is an anticipated driver of the rising trend in algal blooms where interactions between environmental variables are not well understood. Using a new remote sensing data product provided by the European Space Agencies (ESA), in combination with the ERA5-land hourly climate reanalysis product, a High Order Dynamic Gaussian Bayesian Network (HO-DGBN) was constructed for five North American Great Lakes to identify interactions between lake wide (daily to monthly) algal biomass and various atmospheric and lake physical variables. Monthly HO-DGBN models returned the lowest forecasting error (NRMSE = 0.16 – 0.55, median = 0.39), where water temperature, air temperature and surface net solar radiation (SNSR) were the most important variables. Temperature interactions were mixed, while SNSR was primarily positive and lake mixing depth negative. Precipitation and wind speed were found to be the least important. New remote sensing data products provide potential for improving our understanding of algal biomass dynamics.

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12 Minute Talks
Disturbance impacts on ecosystems in the NWT

Lichen it: Advancing lichen transplantation for post-fire caribou habitat restoration
Elise Brown-Dussault – Wilfrid Laurier University
Supervisor: Jennifer Baltzer

Rapid climate change in Canada's North is making boreal wildfires larger and more intense, leading to lasting impacts on local communities and ecosystems. Woodland caribou, in particular, are getting affected: caribou lichen, their main winter staple, tends to live in forests 80 years old or older. Shorter fire intervals mean that fewer forests are reaching that age and developing those lush lichen mats caribou rely on. This 80-year timeline is largely due to caribou lichen's extremely slow dispersal rate, which may get slower still as fires grow larger. Trials of caribou lichen transplantation from the last decade are showing promising results for accelerating caribou lichen recovery in burned forests. I will share early results from a caribou lichen transplantation trial in the DehCho Region of the NWT, where I seek to identify the best conditions for caribou lichen to be transplanted into for optimal recovery and establishment.

Hydrothermal Effects of a Highway on Streams in Continuous Permafrost
Tim Ensom – Wilfrid Laurier University
Supervisor: Philip Marsh, Steve Kokelj

In permafrost regions the construction of roads modifies the ground thermal regime and hydrology, with implications for infrastructure. Along the Inuvik-Tuktoyaktuk Highway, NWT, stream crossing structures have altered stream channel boundary conditions, initiating freeze dams that can restrict winter baseflow. Prolonged winter baseflow leads to elevated hydrostatic pressure at crossings, injection ice formation in channel banks, riparian terrain heave, recurrent winter aufeis development, and the development of ice plugs in culverts. Observed consequences include stream channel destabilization and scour of aggregate road embankments during freshet. We demonstrate that rapid freezing promoted by roads and structures drives complex interactions between water and infrastructure, and identify that unfrozen conduits beneath stream ice at crossings are essential for the avoidance of such problems. We highlight the importance of interdisciplinary perspectives and robust monitoring systems to inform engineering innovations in a changing permafrost and hydrological environment.

Forest recovery trajectories postfire in permafrost environments of the Northwest Territories, Canada
Caitlyn Lyons – Wilfrid Laurier University
Supervisor: Jennifer Baltzer

Wildfire activity is increasing across the boreal biome with implications for postfire forest regeneration. Wildfire is a known driver of permafrost thaw resulting in rapid active layer thickening in the years immediately following fire. Black spruce is the dominant tree species in boreal North America and in moist conditions with thick organic layers previous research has shown that despite increasing wildfire activity black spruce is able to self-replace postfire. However, these sites are also most likely to harbour permafrost where permafrost thaw could result in lagged shifts in regeneration trajectories. In the boreal forest of the Northwest Territories we found that black spruce densities were similar in permafrost and non-permafrost sites immediately following postfire however, 8 years postfire the permafrost sites demonstrated a decrease in black spruce densities compared to the permafrost free sites. A loss in black spruce resilience postfire in permafrost conditions will have implications for the future composition of the boreal forest.

Individual and Mixture effects of Nd, Pr, and Y: Bioaccumulation Studies
Celine Do – Wilfrid Laurier University
Supervisor: Jim McGeer

Neodymium (Nd), Praseodymium (Pr), and Yttrium (Y) are three rare earth elements (REEs) that occur in the mineral ore bastnaesite, the primary ore of Canada's first REE mine at Nechalacho, NWT. There is very little data available for individual REEs and even less available on mixtures. The objectives of this study were to investigate the interactions of Nd, Pr, and Y bioaccumulation in Daphnia magna, alone and as ternary mixtures. Daphnids were initially exposed to sublethal concentrations for 24-h under two test conditions: lab studies with an artificial medium (pH=6.8, no added bicarbonate, and a water hardness of 50 mg CaCO3/L) and field studies using environmentally relevant conditions found in Thor Lake, NWT (the first fish-bearing lake downstream of Nechalacho). This research is supported via an NSERC Alliance Grant with additional funding from Environment and Climate Change Canada, Stantec Inc. and Cheetah Resources.

12 Minute Talks
Northern Ecology and Wildlife Management

Exploring The Salinity Tolerance of Zooplankton Communities In The Great Plains
Abbeneet Kaur Binning – Wilfrid Laurier University
Supervisor: Derek Gray

Across decades, the Great Plains experience alternating periods of drought and wet conditions, resulting in fluctuating salinity levels for the region's lakes. Recent studies suggest that

increased salinity could have negative impacts on the diversity and abundance of zooplankton in prairie lakes, but few studies have examined salinity tolerances of species common to this region. The objectives of this study are to: 1) Determine the salinity tolerance of common zooplankton species from the Great Plains; and 2) Test for differences in tolerances of zooplankton in lakes with differing salinity levels. To obtain zooplankton for experiments, we sampled 11 lakes in Saskatchewan, sorted zooplankton into monospecific cultures, and are currently testing their salinity tolerance (EC50) in 48-h acute toxicity tests. When our experiments are complete, the dataset will allow us to evaluate if common zooplankton species might be able to adapt to changing salinity levels on the Great Plains.

Muskoxen on the move: Ecological implications of range expansion for a large northern ungulate
Nick Luymes – Wilfrid Laurier University
Supervisor: Frances Stewart

Rapid changes in species geographic ranges have become increasingly common, driven by species introductions, habitat loss, and climate change. Understanding how range shifts affect ecological dynamics is important for biodiversity conservation and the protection of critical habitats. This is particularly important for northern regions, where biodiversity is low and the effects of climate change are disproportionate. In the Northwest Territories, a species that provides an opportunity to study range shifts in real time is the muskox. Muskoxen were severely depleted due to overexploitation but have since been increasing on the mainland, expanding their range below treeline. We plan to use data from GPS-collared muskoxen to study movement behaviours, home ranges, and resource selection of muskoxen in taiga forests and compare with muskoxen in tundra environments. This research will enhance our understanding of how species adapt to new environments and inform conservation strategies for northern ecosystems impacted by climate change.

The Influence of Beaver Activity on Lake Water Storage and Streamflow of Arctic Tundra Lakes
Malcolm Brockett – Wilfrid Laurier University
Supervisor: Philip Marsh

Lakes in the western Canadian Arctic are changing as the climate rapidly warms and as beavers move into these tundra regions. However, the potential hydrological impacts of beavers in these regions is poorly understood. This research assesses the impact of a beaver dam on the water storage of a lake located approximately 50 km north of Inuvik, NT, during the 2022 summer season. This beaver dam increased lake water storage by approximately 4%, a change which is compared to the discharge of two nearby lakes to determine the impact of beaver dams on streamflow downstream of these lakes. Results suggest that discharge from each lake would be stopped by a dam of this size for approximately 1 month, and 8 days, respectively. This implies that in the period shortly after a dam is built, downstream streamflow may be reduced for a considerable period, with potential downstream impacts on stream ecosystems.

Comparing Camera Trap and Aerial Survey Data for Determining Muskox Calf:Cow Ratios in the Northwest Territories
Christine Dunbar – Wilfrid Laurier University
Supervisor: Frances Stewart

Muskoxen (Ovibos moschatus) were first introduced to North America over 30,000 years ago during the Pleistocene period. In the Northwest Territories (NWT) muskox have been recording higher annual growth rates in recent years, despite the presence of predators and anthropogenic factors. There are several different techniques that can be used to identify wildlife abundance and occurrence in the north. Camera traps and aerial surveys are methods that are commonly used in the NWT. However, both these methods have their disadvantages. This study is attempting to address the following objectives: O1) can we estimate calf:cow ratios accurately from camera trap data? O2) How does camera trap data compare to data from aerial surveys? O3) why do calf:cow ratios vary, and what are some drivers of this variation across latitudinal gradient in Canada's north?

12 Minute Talks
Northern Lakes: Challenges and Research Methodologies

Winter Bathymetry Mapping Through Lake Ice Using Ground-Penetrating Radar
Alicia Pouw – Wilfrid Laurier University
Supervisor: Homa Kheyrollah Pour

Lake bathymetry data is crucial for assessing water levels and determining lake morphometry, especially in Canada's Arctic and Sub-Arctic regions, where lakes cover up to 40% of the landscape. Understanding watershed hydrology and lake ecosystems in these high-latitude regions heavily relies on this data. Considering lakes in these regions are frozen for over six months annually, understanding fluctuations in water levels during ice-on season is critical for winter water management. Traditionally, bathymetry assessments rely on sonar instruments aboard a watercraft during the ice-off season. However, to map the lakebed during ice-on season, the application of Ground-Penetrating Radar (GPR) can be applied. In January 2022, ~3 km of GPR data was acquired on Ryan Lake, Northwest territories, which previously measured a maximum depth of ~90 m. Findings indicate GPR derived lake depths were accurate when compared to in-situ observations collected during ice-on ($R^2 = 0.99$, MAE = 0.47m) and ice-off ($R^2 = 0.99$, MAE = 1.17 m). This successful method eases collection of bathymetric data in remote northern regions, enhancing data availability crucial for water management.

Pits and Peaks: Lessons learned navigating northern fieldwork
Branden Walker – Wilfrid Laurier University
Supervisor: Phillip Marsh

The effects of a rapidly warming climate are amplified across Arctic regions, and there are many unknowns surrounding how this changing climate is influencing the physical environment,

vegetation and animals, feedbacks to the global climate, and northern communities. As researchers, our goal is to shed light on these unknowns using a combination of field work, remote sensing, and physically based modelling. Our quest for knowledge comes with many challenges unique to working in the Arctic. We are often tasked with relocating to remote locations whereby we conduct field experiments, collect data, and interact with local communities. Navigating the logistics of northern fieldwork can be challenging, and sometimes things don't always turn out as we had planned. With the complexity of Arctic science, it is critical that we work in teams with researchers from many disciplines and often from many universities, research institutes and from many countries. From triumphant moments to catastrophic failures, this talk explores the highs and lows of conducting fieldwork in cold regions based on personal experience in the western Canadian Arctic where Laurier operates the Trail Valley Creek Arctic Research Station.

The opportunity of lake ice remote sensing using the current and future global navigation satellite system reflectometry (gnss-r) missions
Yusof Ghiasi – University of Waterloo
Supervisor: Claude Duguay

While Global Navigation Satellite System Reflectometry (GNSS-R) missions like Cyclone GNSS (CYGNSS) have been used for remote sensing of lake ice, as an essential climate variable in northern regions, this study highlights three limitations that can be overcome by newer GNSS-R missions such as Spire, SMAP-R, and HydroGNSS. These missions offer polar coverage for monitoring Arctic lakes, employ modern coherence detection techniques to distinguish ice from open water (especially in HydroGNSS), and utilize digital elevation models for more precise tracking of specular points, improving the assessment of lake ice's impact on reflected GNSS signals.

Coupling Remote Sensing and Modelling to Monitor Ice Thickness and Phenology on Sub-Arctic Lakes
Gifty Attiah – Wilfrid Laurier University
Supervisor: Homa Kheyrollah Pour, Andrea Scott

Lake ice thickness (LIT) and phenology (LIP) are critical climate variables offering insights into climate change, regional weather, and its impacts on winter transportation in Northern regions. However, their continuous monitoring faces challenges due to in-situ limitations and remote sensing data gaps. A multi-method approach integrating remote sensing data with a spatially distributed thermodynamic lake ice model was adopted to address this. Lake surface temperature (LST) was generated for 535 North Slave Region lakes (1984-2021). This LST dataset and ECMWF-ERA5 data facilitated the model development to simulate the spatial distribution and trends of LIT and LIP. Preliminary findings revealed decreasing trends in ice cover duration and thickness around Yellowknife, as well as later freeze-up and earlier break-up events. The study contributes an open-source LST dataset and LIT/LIP information for community use and further lake research, with documented methods to ensure replicability and enhance understanding of climate change in Northern regions.

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Panel:
Lessons Learned: Transitioning from your Graduate Degree

Panelists:
Dr. Jordan Musetta-Lambert – Research Scientist at Environment and Climate Change Canada
Dr. Raquel Alfaro-Sánchez – Postdoctoral Researcher at University of Castilla La Mancha (Spain)
Dr. Lucy Poley – Geospatial Ecologist Wildlife Conservation Society Canada

The objective of the panel is to provide students with a learning opportunity to prepare for "life after the degree" by hearing from early career researchers who have successfully made the transition from student to employment. Panelists were chosen from a cross section of major employers.