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Cover Photograph

Mega slump located in the Stony Creek watershed west of Fort McPherson, NWT;
Steve Kokelj

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Recent Changes in Vegetation Productivity Across the Bathurst Caribou Range as Measured from Satellite Imagery and Field Sampling

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The productivity of tundra and boreal forest vegetation has undergone rapid change in recent decades. Increases in vegetation productivity ("greening") are occurring mainly on the tundra and have frequently been attributed to an increase in shrubs, while decreases ("browning") are often attributed to drought-related plant stress and have been observed primarily in the boreal forest. The purpose of this project is to map and analyze these types of changes across the entire range of the Bathurst caribou herd, and to identify linkages between these changes and significant shifts in herd distribution and habitat use during the same period.

We used MODIS data from NASA's Terra and Aqua satellites to monitor changes in vegetation productivity since year 2000; a period that coincides with a massive decline in the herd's size. Areas that have experienced forest fires in the last 50 years were removed from the analysis in an attempt to identify areas where climate may be the primary driver of change. We found substantially more greening than browning trends after the effect of fire had been removed. Specifically, significant greening occurred in 16% of the annual range (approximately 23,000 km^2), while significant browning occurred in only 1% of the range. The herd's calving grounds experienced less significant change, with 10% (approximately 1800 km^2) greening and less than 1% browning, while late summer range experienced the most change.

In 2018 we conducted five weeks of fieldwork near treeline in the vicinity of MacKay Lake in the middle of the herd's range. We visited 10 sites that have undergone significant greening according to the satellite imagery, and 10 sites that have not changed. At each site we obtained stem samples from 60 shrubs. These samples are currently being processed in the lab so that annual rings can be counted and measured. This will allow us to determine the extent to which changes indicated from the satellite imagery are related to shrub establishment and mortality or changes in growth.

Impacts of Wildfire Extent and Severity on Caribou Habitat: from woodland to barren ground

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One of the reasons caribou may avoid recently burned forests is thought to be due to lack of food. Ground-dwelling lichens are an important food source for both barren ground and boreal caribou and these are easily killed by wildfires. Understanding how quickly habitat and food resources recover after wildfires will help us better understand caribou distribution. A priority action identified in the GNWT document "Caribou Forever" is to "manage habitat in relation to forest fires and land use activities", which recognises the importance of fire and vegetation dynamics for caribou habitat. This is not as simple as we might expect because burned forests don't necessarily come back as they were before the fire. For example, black spruce forests with lots of lichens sometimes regenerate to deciduous forest where lichen does not grow, or to tundra-like vegetation. Knowing the conditions where forests regenerate away from lichen-favourable habitat helps us better understand how future fires may impact caribou distributions. This is particularly important now because even though fires are natural events in boreal forests, fire activity is expected to increase in the NWT, becoming more frequent and more severe. Accordingly, the impact of fire on caribou habitat remains a central outstanding research question, which is the focus of the research program we will talk about today.

The purpose of this presentation is to provide an overview of the progress made toward understanding lichen recovery after fires in different forest types. We will report on a network of 460 permanent sample plots established throughout Dehcho and Tłįcho lands that burned at different times, including prior to 1965 when NWT fire records began through to 2014. The goal of the plots in the 2014 fires was to improve our understanding of vegetation changes following the largest fire season on record in the NWT. The purpose of the plots in older burns is to improve our understanding of rates of caribou lichen recovery post fire. The results from this four-year project have direct implications for forest and wildlife management in the face of changing boreal fire regimes.

How will fish in Gwich'in and Inuvialuit lakes respond to climate change?

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The aim of this project is to collect baseline data on water quality and fish communities in small- to medium-sized lakes located along the Dempster and Inuvik-Tuktoyaktuk highways. Using this baseline data along with climate-change models, we will try to predict how water quality and fish communities may change in response to a warming climate.

In the first two years of this project we have conducted fish and water quality surveys on 36 lakes. For each lake, we measured water quality parameters such as pH, dissolved oxygen, conductivity, turbidity (cloudiness), and nutrient levels (phosphorus and nitrogen). In addition, we made maps of the bottom of each lake (bathymetric maps) using depth sounders and computer software. Fish communities were surveyed using gill nets following a standardized protocol. Captured fish were measured for length and weight, and if a specimen was deceased, a tissue sample was taken for the measurement of mercury levels.

Out of the 36 lakes visited, 25 contained fish. The most common fish species in these lakes included Whitefish, Northern Pike (Jackfish), and Cisco. Our analyses showed that we could predict fish presence or absence in these lakes based on mean water depth, July water temperatures, dissolved organic materials present in the water, and conductivity. Mean depth, lake surface area, dissolved oxygen levels, conductivity, and July water temperatures were important for determining the types of fish present and their abundances. Our dataset is not yet big enough to attempt forecasting changes in fish communities; however, lake temperatures, conductivity, dissolved organic materials, and dissolved oxygen levels are expected to change as the climate warms, suggesting that there could be shifts in fish communities in response to the changing environment.

Overview of ENR's Climate Change Hazard Mapping Initiative

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The temperature in Canada's north is changing much faster than the global average, with winter temperatures expected to increase by 12°C by the 2090's. Impacts are already affecting people's health and safety, as well as infrastructure. Observed impacts include thawing permafrost, increases in drought and forest fires, flooding, changing ice conditions, and coastal erosion.

Recognizing that climate change represents serious and urgent challenges for the NWT, the GNWT released the 2030 NWT Climate Change Strategic Framework (Strategic Framework) on May 1, 2018. This document outlines how the territory plans to respond to challenges and opportunities associated with a changing climate, moving towards an economy that is less dependent on fossil fuels and doing its part to contribute to national and international efforts to address climate change. The 2019-2023 draft Action Plan is the implementation piece of the Strategic Framework that will address the concerns and interests of NWT residents with a long-term, comprehensive and coordinated response to climate change. It is the first of two five-year action plans to implement the Strategic Framework.

The Climate Change Hazard Mapping Program is an example of an initiative under the Strategic Framework. The purpose of this initiative is to develop climate change hazard maps and supporting resources to assist communities or other departments and organizations in their climate change adaptation efforts. As an example, vertical ground movement maps have been developed as a pilot test for a few communities. Precise measurements of ground elevation in and around communities are recorded by satellites over numerous years, and these changes in ground elevation over time are displayed on maps. Vertical ground movement maps can show areas where the ground is rising or falling, due to geological processes such as freeze-thaw cycles and permafrost melting. These maps can identify areas where shifting ground due to these processes may be a concern. Beneficial use of these maps include identifying areas where current or planned community infrastructure may be in jeopardy, helping to inform waste management plans, or monitoring certain features at mine sites associated with closure and reclamation requirements.

“We Watch Everything” - a Boots on the Ground Approach to Caribou Monitoring

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Boots on the ground is a caribou monitoring program based on the traditional knowledge (TK) of Tłı̨chǫ and Inuit harvesters and elders. The program is a collaboration between the Tłı̨chǫ Government, Government of Northwest Territories-Environment and Natural Resources (GNWT-ENR), Dominion Diamond Mines ULC (DD), and the Wek’èezhìi Renewable Resource Board (WRRB). The objectives are to monitor the conditions of Bathurst caribou herd on the summer range focusing on key indicators: (1) habitat; (2) caribou; (3) predators, and (4) industrial development. Boots on the Ground has developed the methodologies “We Watch Everything” and “Do as Hunters Do”. These methods are based on Tłı̨chǫ and Inuit traditional methods for monitoring our land and combines observations of biological nature with cultural knowledge of indigenous harvesters. “We Watch Everything” use indigenous ontology, language and perspectives on nature as the pillars of the framework. The “Do as Hunters Do” field data collection process unfolds through a set of techniques and concepts that are specifically related to the landscapes of Contwoyto Lake, as using hunting locations for observations and traditional hunting techniques for caribou monitoring. In addition, the use of participatory anthropological methods documents the harvesters’ qualitative descriptions, which allows us to further understand the interconnected elements of barren ground caribou habitat.

For three years, the program has monitored cow- calf ratio and health conditions of Bathurst caribou and their habitat. Overall, Bathurst caribou on the summer range displayed signs of being healthy, although a number of injuries are observed each year. The program examined the cumulative effects of industrial development, predators and climate change. Several signs of climate change were identified, as earlier spring melt, disappearance of summer snow, and appearance of a new predator specie, the bald eagle, on the post-calving and summer range. Increasing temperatures and the melting of summer snow altered caribou behaviour and exposed them to additional risks. Instead of moving to sun-shaded high hills with snow, herds tend to move in large circles to create wind, and seek to lakeshores and water to cool down their body temperatures. Industrial developments, roads, and human disturbance built on *tataa* (caribou land crossings), or on important corridors, forces caribou to select alternate terrain for migration. Local wolves are aware of and use the industrial and natural land features to their advantage in the hunt. In recent years, caribou remained on the barrenlands for most of the year; a shift in range that provides a steady supply of prey for local wolf populations. Parallel, the decrease of harvesters from the landscape around Contwoyto Lake has profound impacts on predator/prey relationships between caribou, wolves, and humans. Using our traditional knowledge framework, our monitoring attested how change on caribou’s summer range takes many forms, some of which would not be recognizable without a holistic approach, and based on these results, specific management recommendations regarding caribou habitat are developed.

NWT Cumulative Impact Monitoring Program (NWT CIMP): Impact on Resource Decision-Making

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NWT CIMP is a monitoring and research program that is administered by the Government of the Northwest Territories, Department of Environment and Natural Resources. It has an annual budget of approximately $1.5 million and a staff of 6. It produces some of the best, most credible science and traditional knowledge in the territory.

The purpose of the program is to support environmental decision-making by generating baseline, cumulative impact and environmental trend information. As you know, many other agencies share responsibility for environmental monitoring in the NWT. It is NWT CIMP's role to fill information gaps that prevent an understanding of cumulative impacts.

NWT CIMP is part of the Mackenzie Valley co-management system, being an obligation of settled land claims in the Northwest Territories and Part 6 of the Mackenzie Valley Resource Management Act. NWT CIMP operates in the Inuvialuit Settlement Region through a memorandum of understanding with the Inuvialuit Regional Corporation.

The program is advised by a Steering Committee of regional Indigenous governments and organizations. Land and Water Boards and the Review Board provide advice to this committee as observers. ENR and the Steering Committee endorsed the current 5-year Action Plan in 2016 and it is focused on meeting the needs of co-management boards.

NWT CIMP has three key activity areas related to monitoring and research:

1) The program works with key decision-makers, the Steering Committee and others to determine monitoring priorities
2) NWT CIMP staff coordinate monitoring, research and analysis. We also provide funding to others to conduct relevant research and monitoring. Approximately 30 projects are funded per year, and about 10 of those are in their final year
3) NWT CIMP staff communicate results to decision-makers and communities

The program currently has three priority valued components that were chosen by a broad group of decision-makers in 2011 and reconfirmed by the Steering Committee in the new action plan. These priorities are caribou, water and fish.

The focus of this presentation will be to give participants a better understanding of NWT CIMP information and its use in decision-making. It will focus on topics that co-management boards have identified as a high priority, with specific examples of how projects have been or could be used in board decisions.

Community-Based TK Monitoring – Monitoring for Better Decision-Making: Phase 3

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This research asks, what is Traditional Knowledge (TK) Community-based monitoring (CBM) according to Łutsel K'e Dene Fırst Natıon, and how does it serve as a pathway for meaningful inclusion of Indigenous knowledge into resource management decisions? We explore this question through 1) assessing how Łutsel K'e's CBM programs currently include TK, 2) identifying challenges and recommendations, and 3) conducting a review of relevant literature and speaking with other indigenous CBM program organizers and participants in the North. This research looks to the experiences of indigenous monitoring practitioners and managers to understand how CBM works to support the transfer of local traditional knowledge in community-level land governance and decision-making, as well as provide outputs to external, typically science-based third parties and governments. This research will produce a CBM toolkit for Łutsel K'e and other indigenous communities, and contribute to supporting the improvement of CBM methodology and strategy for better inclusion of indigenous knowledge in resource decisions.

This program builds off of the NWT CIMP 185 Project *Community-Based TK Monitoring – Monitoring for Better Decision-Making: Phase 1 & 2* which explored the legacy of challenges surrounding the integration and consideration of Indigenous traditional knowledge in living systems management and major project envıronmental assessments ın the Northwest Territories and beyond. *Phase 1 & 2* yielded recommendations for decision-makers and TK researchers alike to improve the inclusion of TK in resource management and understanding cumulative effects.

Building a cumulative impact monitoring network: Standardizing the reporting, archiving and dissemination of permafrost ground temperature and geohazard information

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Permafrost is the product of cold climate and affects terrain across the entire Northwest Territories. It consists of frozen earth materials and can be thought of as the cement that holds northern landscapes together. The state of permafrost is linked with climate and rapid warming throughout the NWT is causing permafrost to thaw. Permafrost thaw is affecting northern ecosystems and it is the main driver of changes to northern aquatic ecosystems. Permafrost also provides the foundation for our communities, including building and roads. As climate warms and permafrost thaw increases it becomes critical to organize permafrost monitoring information and mapping to track change and inform decision making. This presentation discusses the need for ongoing efforts to organize and compile information on the permafrost temperatures, ground ice conditions and maps that track landscape change.

Tǫdzı, Habitat, and Health

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In Canada, *Tǫdzı* (boreal caribou) are listed as 'threatened' under the federal *Species at Risk Act*. They have a similar status in the Northwest Territories. Scientific and Indigenous research clearly shows that habitat loss, degradation, and fragmentation are the main causes of tǫdzı population decline. In the NWT, increasing forest fires, industrial development and associated infrastructure contribute to an increased loss of habitat. Across Canada, Indigenous people consider all tǫdzı habitat to be at risk.

As early as 1996, Tłı̨chǫ elders associated with the Whaèhdǫò Náowo Program recommended that the Tłı̨chǫ do research on forest fires in the boreal forest and document Tłı̨chǫ knowledge on tǫdzı. These elders thought this necessary because of their observations of flora and habitat change associated with industrial developments, and climate change impacts such as more frequent and intense forest fires. For the Tłı̨chǫ elders and harvesters, in depth knowledge of these habitat changes is essential to understanding how to maintain the relationship with tǫdzı while harvesting and using them. To gain Tłı̨chǫ knowledge, harvesters observe the relationships between all beings in the environment.

The original goal of the community of Whatì and the Wek'èezhìı Renewable Resources Board's project was to take a first step towards compiling Tłı̨chǫ elders' and harvesters' knowledge of tǫdzı and their habitat before and after a forest fire. Our research question was 'when do tǫdzı return to a place after a forest fire?'. However, the goal and research question morphed as the research team listened to the elders. The elders focused us to: i) observe and document their knowledge of habitat-types key to tǫdzı's ability to thrive within their range; and ii) document how to watch the land to determine the likelihood of animal occurrence and health.

Their goal is to watch all the tǫdzı land and share key details of the relationship between tǫdzı character and their range. Harvesters and elders who know tǫdzı understand their character and behaviour just as they understand the traits of all that dwell within Wek'èezhìı. They also understand when their land and the beings it contains, change. They know by observing, experiencing, harvesting, and using tǫdzı because tǫdzı were, and continue to be, an important being with which the Tłı̨chǫ thrive – both intellectually and physically.

The purpose of this presentation is to address the Tłı̨chǫ elder's knowledge that decision-makers must understand and recognize that tǫdzı need 100% of their habitat within their range to maintain a healthy population. Any management plan must be respectful of the relationships between tǫdzı and all that is part of their range, including Tłı̨chǫ Dene. From a Tłı̨chǫ perspective, one cannot consider the state of tǫdzı without considering other species that inhabit the area.

Using the past to inform the future: A paleoecological perspective of the impacts of drought and fire on lakes and forests.

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Arctic and sub-Arctic terrestrial and aquatic ecosystems are being affected by numerous ecological stressors. Climate change is prominent amongst these. A warming climate during the 20th century, which has occurred at rates and magnitudes in the North that exceed those in most other parts of the world, has led to cascading impacts. In Arctic and sub-Arctic regions of Canada, widespread climate warming is thought to be affecting disturbance regimes including those related to wildfire and drought. The 2014 fire season in the Northwest Territories (NWT) was notably severe with ~390 reported fires burning nearly 3.5 million hectares of forest cover. Warm and dry conditions also caused low lake levels and reduced stream flow. The main purpose of our research is to use paleorecords to study the cumulative impacts of warming temperatures, low moisture availability and wildfire on forest and aquatic ecosystems in the southern NWT.

Our first objective is to use tree ring and lake sediment isotope records to reconstruct stream flow and moisture availability (precipitation-evaporation), respectively. Our second objective is to determine the duration, intensity and frequency of fire during the past several 100s to 1000s of years. Our third objective is to determine the magnitude and direction of change in aquatic ecosystems in response to warming temperatures, drier conditions and fires. We will consider changes in aquatic communities (invertebrate in stream and algal in lakes), overall primary production and lake levels. A comparison of sites recently affected to those unaffected by wildfire provides an understanding of the connections between wildfire, community composition, and lake primary production in the context of climate warming.

Tree ring measurements from moisture-stressed sites in the Snare River catchment provide a record of stream flow for the last several centuries. The return period of the drought-like conditions of 2014 was estimated at ~100-200 years. We measured charcoal accumulation in lake sediments and determined that over the last 2000 years fire frequency decreased or remained stable. Findings also showed marked spatial variability in the number of fire events, which ranged from <5 to 13 over 2000 years. Benthic invertebrates in streams were collected following protocols of the Canadian Aquatic Biomonitoring Network (CABIN) to determine aquatic ecosystem health of recently burned compared to unburned sites. Increases in particulate organic matter resulting from fires led to structural differences in invertebrate communities, including higher richness and abundance of primary consumers and their predators. It is, however, unknown whether these observed changes persist, which would require continued long-term monitoring. In lakes we measured sedimentary chlorophyll *a* and its derivatives to determine a record of overall algal production. Algal production changed little in response to fire, but increased steadily beginning at the turn of the century. These increases are linked to warming temperatures. Analysis of depth measurements, catchment properties and isotope tracers indicate that shallow lakes with small catchments are the most responsive to warming. Results presented here are preliminary and we are continuing to determine the cumulative impacts of multiple stressors on ecosystems in the southern NWT.

Assessing Regulators' Information Needs to make Decisions regarding Cumulative Effects under the MVRMA

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There is an expectation that cumulative impacts to freshwater resources are not only monitored but also managed. The recent NWT Environmental Audit and CIMP's Action Plan identified the need to understand the cumulative impact priorities of decision makers and make sure that monitoring programs can deliver meaningful information to regulators. This project was initiated to understand regulators' information needs for making decisions about cumulative impacts to freshwater resources when assessing the impacts of development proposals under the MVRMA, and to identify some of the issues and challenges to be addressed to help improve practice.

Our project consisted of two parts. First, we examined how cumulative effects information about freshwater resources is used in environmental assessment decision making processes and the challenges to the effective use of information at the project scale. Results indicate some uncertainty about who is responsible for providing and interpreting cumulative effects information such that it is meaningful to decision makers, and limitations in the ability to make decisions about individual projects and impact management strategies based on cumulative effects information. Second, we examined the monitoring data that are collected across a suite of Type A water licenses, and from a sample of government programs, to determine whether existing data support cumulative effects understanding. Our analysis focused on the consistency of monitoring parameters, the compatibility of monitoring and reporting methods, whether the indicators monitored are capable of detecting cumulative change, and the accessibility and usability of monitoring data. Results indicate that monitoring is routinely prescribed and based on the needs of the specific water license, but there is considerable variability across water licenses, both in terms of what is monitored and how, and concerns about the usability and accessibility of monitoring data to support better understanding of cumulative effects.

Overall, our project identified a number of constraints – but also opportunities – for advancing monitoring programs to better support cumulative effects information needs when making project decisions. Our results reinforce the need for regional approaches and improvements in monitoring to track cumulative effects, and the need to ensure the data generated is useful to and applied within project-based decision-making. A strong foundation for cumulative effects decision making exists, and the challenges (and solutions) may be more about coordination, knowledge, and governance than science.

The mobility of arsenic in a small subarctic shield watershed impacted by mining pollution: What does this mean for the long-term fate of arsenic in the Yellowknife area?

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The early years of historical mining activities in the Yellowknife region resulted in the release of large amounts of arsenic, antimony, and metals to the surrounding area. Sixty years after the bulk of these emissions were deposited large amounts of arsenic and antimony remain in lake sediments and soils in the region, and surface waters of many small lakes continue to exhibit elevated concentrations of these metalloids. Understanding the chemical recovery of small lakes from mining pollution in the region requires the consideration of processes occurring within lakes and their surrounding catchment. Studies that integrate these processes provide important information on the long-term fate of arsenic in impacted subarctic environments.

This presentation will draw on results from year-round sampling in the watershed of a small shallow lake (1.1 km^2 and < 3 m maximum depth) to discuss the various pools and fluxes of arsenic in a subarctic environment impacted by 50 years of mining pollution. Inputs and outputs of arsenic from the lake were measured by combining bi-weekly chemical sampling and continuous flow measurements at the lake inflow and outflow. The flux of arsenic between lake sediments and the overlying water column was measured using a combination of porewater extraction techniques and experimental field incubations of lake sediments. The contribution of arsenic from surface runoff from the surrounding catchment was estimated in a small subcatchment by measuring discharge volume and chemistry from the catchment. Contemporary atmospheric loading of arsenic to the watershed was measured in summer and winter by collecting rain and snow for chemical analyses.

Seasonality is an important feature of subarctic environments and early results from this study show that the mobility of arsenic varies across landscape compartments and is seasonally dependent. Lake sediments were a small source of arsenic to overlying waters during the open-water season when lake waters are well-oxygenated. These sediments became a substantial source of arsenic by mid-winter once anoxic conditions developed at the sediment boundary and water column arsenic concentrations increased almost three-fold compared with late summer measurements (September: 50 µg/L - April: 141 µg/L). Lake water arsenic concentrations decreased rapidly to less than 40 µg/L once snowmelt entered the lake but prior to the loss of ice cover and peak flow at the lake outlet. Terrestrial contributions of arsenic to the lake via surface runoff were isolated to the snowmelt period in early May and during record precipitation periods in June and July. Loading estimates during these periods indicate that substantial amounts of arsenic continue to be mobilized from the terrestrial to aquatic environment.

These observations highlight the importance of considering processes across seasons in evaluating the long-term fate of arsenic in shallow lakes in the region. The annual remobilization of sediment As into overlying waters under ice may be a significant process inhibiting the long-term chemical recovery of mine-impacted shallow lakes since it does not coincide with periods of high flow at lake outlets. Large winter increases in lake water arsenic also suggest that winter processes should be considered when evaluating exposure of aquatic life to legacy arsenic.

NWT-Wide Community-Based Water Quality Monitoring (CBM) Program

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During the development of *Northern Voices, Northern Waters: NWT Water Stewardship Strategy* (2010), NWT communities and Aboriginal governments highlighted the need to be more involved in and know more about water stewardship.

The NWT-wide Community-based Monitoring (CBM) program started in 2012 in response to community questions about water quality. The goal of the monitoring program is to have communities involved in water stewardship activities and to collect water quality monitoring information to help answer community questions about water quality. The program involves community members from 21 different communities in the NWT, staff from the Government of Northwest Territories-NWT's Department of Environment and Natural Resources (GNWT-ENR), and other water partners. The goal of the monitoring program is to give NWT residents the opportunity to do water monitoring and answer community questions about water quality.

The CBM Program is designed to allow community members to decide where to monitor water quality and to allow them to do the sampling themselves (community monitors). The GNWT-ENR and other water partners play coordinating and supporting roles within this program. These roles include 1) Providing ongoing training and support to the community monitors to collect water samples using standard methods. 2) Analyzing water quality data and providing results back to communities.

In 2017, GNWT-ENR hired independent consultants to look at all the water quality data collected by the CBM program. The consultants used standard methods to look for water quality trends (the general direction in which water quality is changing over time) across the NWT. They also looked at the data quality to see if sampling procedures used by the CBM program were giving the data needed to answer community questions, and they answered several community questions.

Differences in water quality across the NWT seem to be related to the speed of water flow and the type of rocks that the water is flowing through. Water quality in some regions is also being affected by climate change. Overall, the CBM program was found to be working very well with only a few adjustments recommended.

An investigation of variable fish mercury concentrations in Dehcho lakes

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Following on previous results from 2013-2015 that indicated considerable variability in fish mercury concentrations among lakes in the Dehcho region, we used a paired-lake study design to examine why lakes on the Horn Plateau (Big Island, Willow) have lower fish mercury concentrations than lakes in the Mackenzie lowlands (Ekali, Sanguez). We investigated whether there were differences between the regions (Horn Plateau and Mackenzie Lowlands) in size and characteristics of the catchments, invertebrate community composition, methyl mercury concentrations in invertebrates, and mercury concentrations in water and sediment that may explain mercury variability in fish. Results indicate that inflow waters to lakes have relatively high concentrations of methyl mercury (and high % methyl mercury). It thus appears that catchments are significant sources of methyl mercury to downstream lakes, which differs from the dominant paradigm of methylation occurring mostly in-lake. Because Ekali and Sanguez lakes have larger catchment: lake area ratios, we infer that these lakes are more influenced by their catchments than either Big Island or Willow lakes. Further, rates of mercury biomagnification through invertebrate communities were higher in the Mackenzie lowland lakes than in the Horn Plateau lakes.

We also found that methyl mercury concentrations were higher in littoral invertebrates than in profundal invertebrates, and higher in benthic invertebrates than in zooplankton. Analyses are continuing, but to date we conclude that: i) significant methylation of mercury is occurring in catchments; and, ii) catchment-derived methyl mercury is delivered primarily to littoral habitats where it accumulates in littoral benthic invertebrate food chains. Because Ekali and Sanguez are more influenced by their catchments than Willow and Big Island lakes, and likely have relatively more littoral habitat, mercury concentrations in predatory fish are higher. We make the further observation that beaver ponds and permafrost slumps lead to notably high mercury concentrations in downstream waters.