NWT CUMULATIVE IMPACT MONITORING PROGRAM

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About the NWT Cumulative Impact Monitoring Program (NWT CIMP) and the Collaborative Barren-Ground Caribou Initiative (CBGCI)

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NWT CIMP is a monitoring and research program administered by the Government of the Northwest Territories, Department of Environment and Climate Change. The program supports environmental decision-making by generating cumulative impact and environmental trend information. It is NWT CIMP's role to fill information gaps to better understand cumulative impacts for effective decision-making.

The NWT CIMP Steering Committee made up of regional Indigenous, territorial and federal governments guide the program. The Mackenzie Valley Land and Water Board and the Mackenzie Valley Environmental Impact Review Board provide advice to this committee as observers.

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

1. NWT CIMP works with key decision-makers, the Steering Committee and other partners to determine monitoring priorities;
2. NWT CIMP conducts, coordinates and funds monitoring, research and analysis.
3. NWT CIMP communicates results to decision-makers and communities.

The program currently focuses on three priority valued components: **caribou**, **water** and **fish**. This presentation introduces NWT CIMP, the type of information generated, how this information can be used and where to find it.

Project results of NWT CIMP-funded projects are available on the NWT Discovery Portal www.nwtdiscoveryportal.enr.gov.nt.ca, the Mackenzie Datastream, our website, https://www.gov.nt.ca/ecc/en/services/nwt-cumulative-impact-monitoring-program-nwt-cimp, or by contacting nwtcimp@gov.nt.ca.

The Collaborative Barren-ground Caribou Initiative (CBGCI) was initiated in 2022, with funding provided from 2023-2026, to help address what is driving the changes in caribou abundance and what the future holds.

Migratory barren-ground caribou are very important in the NWT, both culturally and ecologically. These herds are known to alternate between periods of high and low population numbers on a time scale of decades. In the last 20 years, most herds found partially or entirely in the NWT have gone through large declines. This includes the 99% decline of the Bathurst barren-ground herd between 1986 and 2021. In contrast, the Porcupine herd reached an all-time population high in 2017.

Territorial government monitoring has documented many declines. However, understanding the main drivers of population trends remain incomplete. Despite various studies, government agencies, Indigenous governments and Indigenous organizations, co-management partners and communities have many unanswered questions about what is driving the changes in caribou abundance and what the future holds.

To help address these knowledge gaps, Polar Knowledge Canada (POLAR) and the Government of the Northwest Territories Department of Environment and Climate Change (GNWT ECC) worked together to offer the CBGCI, a special one-time funding opportunity. This opportunity funded 7 projects over three years. Participants in the CBGCI are working together to publish a special report on the drivers of caribou herd abundance and trends throughout the annual lifecycle to support decision-making in the NWT and beyond which will be available on NWT CIMP's website.

Ekwǫ̀ Nàxoèhdee K'è: Being Caribou Guardians with 'Boots on the Ground' (CIMP94-BG)

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The Tłı̨chǫ people have relied on *Kokètì ekwǫ̀* (Bathurst caribou) since time immemorial, but a harvest ban since 2015 reduced peoples' interaction with the caribou and the land. To advance traditional knowledge research, Tłı̨chǫ Government developed the *Ekwǫ̀ Nàxoèhdee K'è* (Boots on the Ground) guardian program to monitor the *Kokètì ekwǫ̀*; a herd experiencing the most dramatic decline. Using traditional ways of traveling the land, by boat and on foot, to key geographical features known as *ekwǫ̀ nǫʔokè* (water crossings) and what'àà (eskers), where elders anticipate *ekwǫ̀* herds' arrival, the guardian team sit in position, as traditional hunters did, waiting, and watching *ekwǫ*. The Tłı̨chǫ created the guardian program based on the concept of "*We Watch Everything*", a Tłı̨chǫ concept, focused on monitoring key indicators: health of caribou and the land; predators, climate change and industrial disturbance; and based on using traditional hunting methods as wildlife monitoring methods, and traditional hunting areas as monitoring locations. The program has operated since 2016 and expanded to three barrenland camps for summer caribou monitoring and one mobile camp during winter.

Since inception of the program in 2016, we observed cumulative effects of climate change and human pressures impacting caribou. Being caribou guardians with our boots on the ground, Tłı̨chǫ are traveling back to ancestral harvesting locations and reconnecting to our cultural places and *ekwǫ̀*. Thus, being caribou guardians allows Tłı̨chǫ to "go back to the original source to remember" the stories, language, knowledge, and cultural ways of life that connects us to *ekwǫ̀*.

Collaborative Forecasting Landscape Change and Population Dynamics of Barren-ground Caribou (CIMP207-BG)

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Barren-ground caribou (*Rangifer tarandus groenlandicus*), an ecologically and culturally important species, have been in decline and are threatened in the Northwest Territories. To explore possible drivers of caribou declines and evaluate management strategies, we worked with project partners to adapt the ALCES simulation model for five central barren-ground caribou (CBGC) herds (i.e., Bathurst, Bluenose-East, Bluenose-West, Tuktoyaktuk Peninsula, and Cape Bathurst).

The model – CBGC ALCES – is designed to be a decision-support tool for Renewable Resource Boards, Indigenous governments and Indigenous organizations, as well as the Government of the Northwest Territories (GNWT) to simulate cumulative effects of climate change, wildfire, human development, and management practices on habitat quality and population dynamics of these herds.

CBGC ALCES applies five linked seasonal population models to spatially represent habitat and mortality risks that occur within an annual timestep. The spatial population models are linked to landscape simulations so that habitat, fecundity, and mortality risk respond to human development footprint, wildfire, and climate change.

CBGC ALCES is designed so that users do not require a computer modeling background. Users can import spatial layers identifying planned human development scenarios, which are then combined with existing footprints and future wildfire and climate dynamics to simulate caribou habitat and mortality risk over multiple decades. Users may change inputs for fecundity, natural mortality, and harvest. The computationally intensive simulations are completed online, and outputs are presented using a map-based scenario results viewer. Simulations are shareable among users, and outputs can be downloaded as spatial layers and spreadsheets to facilitate collaboration and analysis.

Indigenous knowledge summaries enable comparison of simulation model behaviour with observations of caribou population change and serves as a platform for further discussion and interpretation with knowledge holders and management authorities.

More information on the tool is available at https://cbgc.alces-flow.com, and a public version of the data viewer is available at https://cbgc.alces-flow.com/public/web/notebooks/voila/render/results_viewer.ipynb.

The project is funded by the Collaborative Barren-ground Caribou Initiative, a partnership between the Northwest Territories Cumulative Impact Monitoring Program (NWT CIMP) and Polar Knowledge Canada, and GNWT's Department of Environment and Climate Change. This initiative is addressing barren-ground caribou population decline through improved understanding of the drivers of population trends.

Contaminants, Caribou Epigenetics, and Genomic Health (CIMP240-BG)

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This project investigates how environmental contaminants might affect the health of caribou at the genetic level. The research focuses on five herds across northern Canada: Beverly, Bluenose East, Porcupine, Qamanirjuaq, and Tuktoyaktuk Peninsula. By combining contaminant testing with genetic analysis, we aim to understand how pollution may influence population health and resilience, ultimately informing better protection and management strategies for these important animals.

Between 2023 and 2025, we obtained liver and kidney samples from 108 caribou across the five herds. Local hunters gathered all samples, with some participating in workshops that helped build community capacity for this type of research. The samples were tested for a range of contaminants including mercury, arsenic, lead, and PFAS (sometimes called "forever chemicals"). We also collected lichen samples from four of the herd ranges to explore whether caribou might be picking up contaminants through their diet and whether any previously unidentified pollutants were present.

The contaminant analysis revealed that each herd has its own distinct chemical profile, meaning caribou from the same herd tend to have similar contaminant patterns that differ from other herds. This likely reflects differences in their environments and food sources. Interestingly, the genetic analysis showed that essential nutrients like potassium, phosphorus, iron, and sodium have a stronger influence on gene function than the contaminants do. In other words, a caribou's diet and natural environment appear to matter more for how their genes work than exposure to pollutants.

That said, some genes were affected by contaminant exposure. These genes are typically involved in regulating other genes, immune function, or cellular communication. This suggests that contaminants act more as general stressors rather than causing specific, predictable health problems. The lichen analysis showed that most contaminants found in the lichen were also present in the caribou, with evidence that some may become more concentrated as they move up the food chain.

Despite recent population declines, all five herds still maintain moderate to healthy levels of genetic diversity. However, the Bluenose East herd shows signs of moderate inbreeding, which can expose harmful genetic defects over time and make a population more vulnerable to future challenges. Census data confirms this herd has declined significantly. While other herds have also experienced declines, they appear to maintain enough population size or exchange enough individuals with neighboring herds to avoid inbreeding problems. The small Tuktoyaktuk Peninsula herd, for example, may have benefited from past crossbreeding with feral reindeer and ongoing mixing with the Bluenose-West and Cape Bathurst herds during winter.

We are still working to verify the identity of some previously unidentified compounds found during their exploratory analysis and will report those findings once confirmed. Final results will be shared with communities before March 2026 through plain-language summaries, technical reports, and community visits.

Investigating the Cumulative Impacts of Disturbance to Barren-ground Caribou on the Tibbitt to Contwoyto Winter Road- A Guardian-led Initiative (CIMP243-BG)

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Caribou are at the heart of North Slave Métis culture and community and serve as a spiritual anchor and cornerstone of cultural identity. However, there has been a dramatic decline in caribou numbers in the Northwest Territories, particularly of the Bathurst herd in recent years. Though there are many factors (climate change, habitat loss/ habitat encroachment and availability of food sources during migration), North Slave Métis Alliance (NSMA) members point to anthropogenic disturbance, including heavy traffic, sensory disturbance from mines and associated winter roads and overharvesting along the Tibbitt to Contwoyto winter road (TCWR) as the primary causes of the Bathurst herd's decline. In response, NSMA began the Guardianship Winter Road Monitoring Program. NSMA maintains a semi-permanent camp on the ice road, approximately 400km north of Yellowknife where Guardians stay for up to a week to conduct on-the-ground TCWR patrols and collect information on caribou numbers, body condition, harvest (through gut pile observations), disturbances and environmental conditions. Since 2024, Guardians have also deployed game cameras and autonomous recording units (ARUs) along the road to capture critical data on the caribou's interactions with the road.

Here, we present results from the 2025 winter road season. We created a Bayesian harvest model based on caribou gut piles monitoring. In 2025, guardians documented 70 independent gut piles with an average size of 20 (90% credible interval 16-26) caribou per gut pile. We estimate that a minimum of 2814 (2610-3150) barren ground caribou were gutted directly alongside the TCWR, though this is an underestimate of total harvest levels on the winter range. Although most hunters do not waste meat, there was wastage, where only the backstraps or quarters were taken at 10% (4.5-19%) of gut piles. NSMA Guardians were extremely disheartened to see disrespectful harvesting along the road. In addition, we modeled predictions of daily anthrophony activity across the spatial area for each point on a given day, based on our real observations from ARU data and covariate values including windspeed, lake ice depth and distance to road. We found that the effect of lake ice depth is insignificant, we expect to hear less anthrophony in windy conditions, and we expect to hear more anthrophony closer to roads. All of this information is helping the NSMA to quantify the impacts of winter roads on barren ground caribou herds. This program supports NSMA's commitment to safeguarding their traditional territory, integrating Indigenous knowledge into decision-making and reconnecting people to the land, their culture and their traditions.

Comparative Analysis of Factors Affecting Caribou Survival Patterns (CIMP241-BG)

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Available at: https://nwtdiscoveryportal.enr.gov.nt.ca/geoportaldocuments/2025-2026%20-%20Comparative%20Analysis%20of%20Factors%20Affecting%20Caribou%20Survival%20Patterns%20-%20NWT%20CIMP%20Results%20Workshop%20Presentation%20-%20Dec%202025%20-%20CIMP241.pdf

Adult survival is a central driver of barren-ground caribou population trends. While caribou are declining globally, neighboring herds can have very different patterns. For example, the Bathurst population has been steadily falling since the early 2000s, while the nearby Bluenose East herd is showing signs of recovery. We used movement and survival data collected by the Government of the Northwest Territories to explore patterns and causes of adult caribou mortality.

Going into this project, we wanted to explore seasonal patterns of survival and how these have changed over time. We also wanted to investigate how movement behaviours and weather conditions relate to survival. Through our collaborative relationship with the North Slave Métis Alliance, we held group conversations where members shared their expertise and helped shape our research questions. Community insights, along with our research interests, drove us to examine not just when caribou die, but how environmental changes, human access, health, and changing seasonal conditions might be shifting mortality patterns. In this presentation, we will present some of our results on annual trends, seasonal patterns, weather, and roads.

We analyzed data from 1,619 caribou (1,187 females and 432 males) across six herds from 1996 to 2023. Our results revealed several key patterns. First, herds don't survive or decline in sync - each herd showed its own unique pattern of ups and downs. While some neighboring herds had similar survival trends, others did not, suggesting local factors play an important role. We found that overall, most deaths occur in spring and late summer, but this wasn't always the case. In recent years, we've seen a shift toward more deaths in late winter and early spring. Weather played an important role: winter snow depth, winter temperatures, and spring precipitation all affected winter and spring survival, while summer temperatures impacted summer and fall survival. Interestingly, we didn't find evidence that harsh winter conditions led to delayed mortality later in the year. Finally, we detected an effect of road proximity on survival when using a 20km buffer around roads, though this effect disappeared with a more conservative 10km buffer.

Our work has produced practical outcomes for caribou management in the Northwest Territories. By compiling survival data across multiple herds, we're helping the Government of the Northwest Territories standardize their monitoring efforts across the region. This comprehensive dataset will feed directly into population models that managers use to make decisions about caribou conservation and to evaluate how management actions, like predator control programs, impact caribou outcomes.

Tracking Change Together: Advancing Community-Based Monitoring for Caribou (CIMP239-BG)

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Barren-ground caribou are central to food, culture, and identity across the North. For the Bluenose-East herd, this is especially true for people in Délı̨nę, Wekweètì, and Kugluktuk. At the same time, community members are seeing many pressures on caribou and changes on the land, including changes in snow and ice, vegetation and insects, industrial development, other human disturbances, predators, and other stressors. People have been saying for years that “things are changing,” but there are still gaps in how this knowledge is recorded, compared across years, and brought into formal decisions about caribou management.

In this project, we are bringing together Indigenous Knowledge, community-based monitoring, and existing scientific information to build stronger, Indigenous-led ways of tracking the health of the Bluenose East herd and its environment. Through interviews and conversations with harvesters, Elders, and local organizations in all three communities, we are documenting the signs people use to understand caribou health, how caribou health has changed over time, how environmental conditions are changing, how harvest practices and where caribou are seen are shifting, and how these changes are connected in people’s experience on the land. We are working together to highlight the observations and signals that are most practical and meaningful to follow from year to year.

We are also strengthening community-based wildlife health surveillance through both caribou sampling kits and opportunistic samples from our wider network, building a more consistent picture of caribou health that can be brought back to communities. Through this, we are observing emerging health concerns, such as a recent parasite outbreak, and shifts in health determinants, such as exposure to infectious agents and declines in important nutrients. We are tracking changes in health processes, especially body condition, and relating these patterns to health outcomes such as survival. Using this information, we are beginning to piece together benchmarks and trends that describe what "healthy," "needs attention," and "concerning" look like for the Bluenose East herd in ways that make sense to both communities and managers.

We are aiming for a simple, shared set of indicators and "warning levels" that communities and co-management partners can use to understand when caribou and their environment are doing well, when there is concern, and when stronger actions may be needed. This approach is helping to strengthen Indigenous-led monitoring, and give decision-makers clearer, earlier signals of change for the Bluenose East caribou herd.

Investigating Pestivirus Infections in Barren-ground and Dolphin Union Caribou: Strain Identification and Diagnostic Test Refinement (CIMP239-BG)

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This project aimed to develop a better understanding of the species of viruses that infect barren ground caribou. It is of interest to determine if viruses influence the caribou population health and numbers. Caribou are exposed to pestiviruses, recently immune responses (antibodies) towards these viruses were detected in samples from caribou in Canada. The challenge with the study of viruses in wildlife is the lack of diagnostic tests and limited opportunities to detect and sample infected animals. Fortunately, we had access to fresh and archived blood and tissue samples that could be used to evaluate new diagnostic tests and to detect the presence of pestiviruses.

This study had two main goals: (1) to investigate whether pestivirus genetic material was present in caribou tissues, and (2) to create improved diagnostic tests detecting the immune response towards pestiviruses, specifically for caribou. To test for active viral infections, 132 tissue samples, spleens, lymph nodes, and placental tissues, were screened using an assay which can detect genetic material of all pestiviruses currently known (RT-PCR). However, none of the samples tested positive, meaning we were unable to find an infected sample. Unfortunately, we could not confirm the specific pestivirus species infecting caribou.

Commercial diagnostic tests are not optimized for caribou and current pestivirus immune assays do not reveal the identity of the species that has infected the animal. The second part of the project focused on improving detection of the immune response (antibodies) towards specific pestiviruses strains. A caribou-specific antibody assay (ELISA) using a virus protein (E2) was used. This protein can be found at the surface of the virus particle and is therefore well detected by the immune system of an animal that is infected. The pestivirus we used is 'border disease virus' (BDV strain 1, 2, 3 and 8). These BDV strains are known to infect a large variety of wildlife species. In this way we could evaluate if any of these BDV strains was circulating in caribou.

When using caribou blood-on-filter paper samples, the test could strongly detect immune responses to BDV1 which suggests that caribou may have been exposed to BDV1 itself, or a virus that resembles BDV1.

Although no viral genomes were identified through RT-PCR, the diagnostic antibody test BDV ELISA developed in this project provides valuable new information on past pestivirus exposure in northern caribou. The detection of BDV1-reactive antibodies suggests that a BDV1-like virus may be circulating, while we have indications that multiple pestivirus lineages may be present. This work contributes a new diagnostic tool and fills an important gap in caribou health research, supporting ongoing monitoring efforts and helping communities and researchers better understand factors that may influence caribou populations. To support broader knowledge sharing, an illustrated guide was created to make the results of this research easier to understand and more accessible to diverse audiences.

Our team continues the search for viruses that infect caribou to better understand the interaction between the caribou host, the virus and its environment.

Using Animal-borne Sensors and Acoustic Recording Units to Monitor Caribou Behavior, Insect Harassment and Sound Disturbance (CIMP242-BG)

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Available at: https://nwtdiscoveryportal.enr.gov.nt.ca/geoportaldocuments/2025-2026%20-%20Using%20Animal-borne%20Sensors%20and%20Acoustic%20Recording%20Units%20to%20Monitor%20Caribou%20Behaviour%2C%20Insect%20Harassment%20and%20Sound%20Disturbance%20-%20NWT%20CIMP%20Results%20Workshop%20Presentation%20-%20Dec%202025%20-%20CIMP242.pdf

We monitored the impacts of natural and unnatural disturbances on caribou using acoustic monitoring. Changes in caribou behaviour can be caused by natural and unnatural disturbances that they can hear, and we might be able to record. We specifically set out to monitor human-made sound disturbance (e.g. traffic or mining activity) and insect harassment. By recording sounds of human activity and insect harassment from the land and from the GPS collars of caribou, we were able to directly observe and monitor these disturbances and how caribou respond.

First, we processed acoustic data from stationary acoustic recorders installed across the Bathurst calving grounds that recorded data from May through August in 2021. This dataset was shared with us by the Kugluktuk Angoniatit Association, the Government of Nunavut and the Government of the Northwest Territories. We evaluated at what temperature, windspeed and soil moisture combinations the insect activity was greatest and developed a method for predicting insect activity (and potential insect harassment) across the landscape. We used this tool to map insect relief areas within the Bathurst herd's summer range from year to year and to identify consistent areas of critical insect relief habitat. These maps provide important context for land-use planners evaluating potential routes for the Arctic Economic & Security Corridor, as an all-season road may impact caribou's ability to access insect relief areas.

Second, we attached 'audiologgers' to existing GPS collars that GNWT-ECC was deploying on barren-ground caribou. These devices record sound and fine-scale movement, and generate data that can help us monitor caribou behaviour. Most notably, these devices can detect real-time responses to disturbance, whereas traditional GPS collars only provide a location fix every 8 hours. We observed a few instances of caribou responding to human disturbances in our datasets, while also collecting baseline information on caribou activity patterns of foraging, rest and rumination in spring and summer. We recorded several calving events—some of which were not detectable from GPS data alone—and saw dramatic increases in activity with insect harassment. This tool is useful for discerning what caribou are actual doing when they approach human infrastructure, and how behavioural changes impact their typical activity patterns. It has also provided intimate details of maternal care, since we are able to hear when caribou are nursing their calves and calling to their calves and can measure how the frequency of nursing bouts changes as cow-calf pairs encounter different disturbances.

Together, our acoustic methods will provide a more comprehensive understanding of how caribou interact with and manage the natural and unnatural disturbances that they hear. This can be used to inform land-use planning and mitigation strategies that foster better coexistence between humans and caribou.

Aquatic ecosystems in the Rádeyįlįkóé (Fort Good Hope) Area as Indicators of Environmental Change: A Community-based Monitoring Project (CIMP215)

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Climate change and associated landscape-level changes are placing severe pressures on northern aquatic resources. In particular, accelerated degradation of permafrost has led to the drainage or expansion of permafrost lakes and ponds that vary in their nature and characteristics. In parallel, wildfire frequency has increased, causing additional pressure on water resources. Across the Sahtú Settlement Area, effects of permafrost thaw and wildfire on aquatic resources are already being observed. It remains unclear, however, how aquatic ecosystems will respond to these environmental changes. As part of a community-based initiative, we performed sampling with the K'ahsho Got'ine Foundation Guardians within Ts'ude Niline Tu'eyeta protected area, in the vicinity of Rádeyı̨lı̨kóé (Fort Good Hope). Ts'ude Niline Tu'eyeta was officially recognized as a protected area in 2019, corresponding to the start of the monitoring project. The protected area is part of the ancestral territory of K'ahsho Got'ine communities and holds cultural importance to the community that perpetuates various activities in the area, such as fishing and trapping. Thanks to its numerous waterbodies, the area also provides key habitats for migratory birds, and is home to the mountain caribou.

Between 2019 and 2025, we sampled more than 50 lakes that vary in their geomorphic setting, permafrost conditions, and exposure to perturbation (for instance, wildfire history) in the protected area and its vicinity in order to examine the diversity of their chemical and biological characteristics. Specifically, we characterized water chemistry, such as nutrients, major ions, and dissolved metals, and the bacterial communities by DNA sequencing. Preliminary results showed that distinct bacterial assemblages were identified among the different lakes, reflecting the local environmental conditions. Bacterial communities changed over time, while water chemistry was rather stable, showing the ability to use bacterial communities as sentinels responding to fine changes. Additionally, sediment cores were collected during 2023 and 2024 to monitor long-term changes in lakes and landscape history.

This project has been directly addressing concerns and needs about changes in aquatic ecosystems expressed by community members in Rádeyı̨lı̨kóé and has helped ensure the capacity of the KGF Guardians to conduct long-term monitoring. The data collected will serve as a solid baseline to understand and evaluate future changes in the area.

Ecotoxicology and Monitoring of Cumulative Effects on the Slave River (CIMP232)

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The cumulative effects from upstream activities (e.g., Oil Sands mining, pulp and paper mills, coal mining, hydroelectric dams, municipal development) and local activities (Fort Smith sewage lagoon effluent and surface water runoff from the landfill, airport and historic contaminated materials at Bell Rock), lead community members to have water quality concerns. There are ongoing programs that monitor water quality in the Slave River at Fort Smith, however, there are some knowledge gaps important to community members, and there is a desire to grow capacity for the Fort Smith Métis Council (FSMC) to lead this work.

The questions we set out the answer with this CIMP project are (1) are there signs of water quality impairment in late fall, early spring, and under-ice; and (2) are sewage discharge and surface water runoff from the landfill high enough to impact Slave River water quality?

This presentation focuses on question 2 and the local concerns around Fort Smith, NT.

Slave River surface water grab samples were collected at reference sites, which were below the Rapids of the Drowned or at the Fort Smith water treatment plant (untreated river water), and immediately downstream (within 3 m) of the test sites, which were the sewage lagoon outflow, runway (airport) spring, eagle spring, and runoff from the landfill and Bell Rock. Samples were collected monthly during open water conditions and sent to Taiga laboratories for analysis of total and dissolved metals, nutrients, major ions, microbiologicals, and physical parameters.

Results were compared to historic data collected at Fort Smith and/or the water treatment plant and assessed for seasonality and influence of changes in Slave River flow. Overall, the majority of parameters are highly seasonal and flow-dependent where the common pattern is for most parameters to increase during the spring thaw when water levels increase and decrease as water levels go down afterwards into the summer, fall, and winter. Parameters that increase with flow are related to the surficial geology and reflect the landscape in general, where total metals and total nutrients have a strong connection with flow. Some parameters, such as chloride, sodium and dissolved strontium decrease as flow increases, which suggests groundwater is an important source of these elements and they become diluted with the addition of snow melt and surface runoff in the spring.

Secondly, results were reviewed for evidence of local elevations in parameters reflecting site-specific concerns such as from the sewage lagoon (nutrients, microbiology), airport (major ions, nutrients), eagle spring (major ions, nutrients), landfill (metals, turbidity), and Bell Rock (uranium and other metals, major ions, turbidity). Results at these sites followed the same seasonal patterns as historical data, which allowed for sites to be compared directly to the reference site below the Rapids of the Drowned. Overall, differences are small between sites and below the Rapids of the Drowned for these suites of parameters (total and dissolved metals, nutrients, major ions, physicals, and microbiologicals). Next steps include assessment of these data with respect to upstream concerns.

Impacts of Aerator Installation on the Chemical and Biological Recovery of Frame Lake (CIMP237)

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Municipal development and land use changes have led to the degradation of aquatic habitats in urban areas across Canada. In recent decades there has been a push to rehabilitate previously impacted lakes so that they may support healthy aquatic ecosystems. Frame Lake is located within the City of Yellowknife and has been impacted by decades of land use changes within its catchment and the deposition of municipal waste and mining emissions. The lake currently cannot support fish, because the lake becomes depleted of oxygen over winter. Diavik Diamond Mine installed an aerator during the summer of 2024 with the intention of maintaining sufficient dissolved oxygen levels to support fish. While the primary intention of the aerator is to support winter fish habitat, there are potential secondary benefits to maintaining oxygen within the water column under ice, including promoting the chemical and biological recovery of lakes from arsenic pollution.

For this study, we addressed four research questions: 1) how will the installation of an aerator influence the distribution of dissolved oxygen under ice; 2) how will the introduction of oxygen over winter alter the movement of arsenic from contaminated lake sediments into the water; 3) how will aeration influence phytoplankton and zooplankton community composition; and 4) how will increased oxygen affect the bioaccumulation of arsenic in phytoplankton and zooplankton. To answer these questions, we conducted extensive surveys of water quality, phytoplankton, and zooplankton communities at Frame Lake and two reference lakes over the last three years. Water quality instruments were deployed on each lake to collect continuous oxygen measurements, and on Frame Lake we also periodically measured oxygen along transects away from the aerator. Zooplankton and phytoplankton were collected throughout the winter months and descriptors of community diversity were calculated, including species richness and Shannon diversity.

At the present time we only have results from one winter after the aerator was installed, but data collection will continue through the 2025-2026 season. Results to date show that operation of the aerator has not improved oxygen levels in Frame Lake substantially, with the lake reaching anoxia (no oxygen) again during winter 2023-2024. Since oxygen levels did not change during the first winter of operation, we were unable to definitively evaluate the effects of aeration on arsenic movement from sediments, on the composition of phytoplankton or zooplankton, and on the arsenic levels in those groups. However, using our dataset across all seasons we found that increased oxygen levels in the water column resulted in less arsenic movement out of sediments. In addition, zooplankton species richness and diversity were positively correlated with oxygen levels. Taken together, these results suggest that we should expect improvements in water quality and the diversity of zooplankton communities if aeration improves oxygen levels. Although aeration has not achieved the desired results so far, the funding from CIMP has allowed us to develop a comprehensive biological, chemical, and geochemical baseline characterization of Frame Lake. This has improved our knowledge of seasonal zooplankton community dynamics, water chemistry, and contaminant cycling in shallow subarctic lakes.

Lake Ice Processes - Fundamental for Assessing Ice Road Climate Risks and Vulnerability Under Current and Future Warming (CIMP238)

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Across Canada, approximately 10,000 km of winter roads are constructed every year, much of which cross ice-covered lakes, known as ice roads. Ice roads are more than just roads for northerners. They represent freedom, economic strength, resilience, health, and security. Climate change has dramatically impacted Canada's northern ice roads. Ice roads have become less reliable, risking public safety, infrastructure, and the economy. Although it is known that climate change is making ice roads less reliable, it is unknown how extreme and variable weather is changing how lake ice forms, grows, and melts. This knowledge is key to safely operating and managing ice roads. With future climate change predicted to increase the intensity and frequency of these events, there is an urgent need to understand how severe weather influences ice roads. In this project, we use a combination of frequent field measurements and modelling to determine how future severe and variable weather will influence lake ice and ice road safety in NWT over the 21st century. Over this 3-year project (2023-2026), field data are collected along various ice roads in NWT using innovative and state-of-the-art technologies. This data used to develop a practical and user-friendly model which will predict Canadian lake ice and ice road safety into the future. Working with Indigenous and government partners in NWT, our model will provide practical guidance on the viability of Canada's ice roads under future climate change risks. This guidance will be key in helping to develop future local and regional ice road safety guidelines for enhancing the resilience of northern communities, economies, and infrastructure.

Cumulative Impacts of Landscape Characteristics, and Natural and Human Disturbances on Lake Water Quality and Benthic Macroinvertebrate Community Structure in the Yamba River Watershed

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Remote northern watersheds often lack baseline environmental data due to their inaccessibility, limited infrastructure, and high monitoring costs. As climate pressures intensify and industrial development expands, establishing baseline conditions and understanding the natural range of variation in water quality and biological communities is essential for effective environmental management. To address these knowledge gaps, the Cumulative Impact Monitoring Program (CIMP) initiated a study in the Yamba River watershed, a sub-basin of the Upper Coppermine River basin located approximately 300 km northeast of Yellowknife, Northwest Territories. This region is of emerging interest because of its proximity to existing diamond mines and the proposed Arctic Economic Security Corridor.

Between 2020 and 2023, we sampled water chemistry and benthic macroinvertebrate (BMI) communities from 70 lakes to examine how natural landscape characteristics and natural and human disturbances cumulatively influence lake water quality and BMI abundance and species richness. Benthic macroinvertebrates were collected using a standardized near-shore kick method and identified to the lowest feasible taxonomic level. Watershed-scale environmental variables were compiled using GIS and included human disturbance metrics (i.e. road density and disturbance footprint), natural disturbance indicators (i.e. wetting and drying indices, greening and browning indices, and surface water change), landscape composition (e.g. geology, exposed land, shrub, wetland, rock cover), and lake characteristic metrics such as the flushing index, used as a proxy for lake water replacement rate.

Multiple regression models were used to assess the predictors of three key water quality parameters (dissolved phosphorus, total organic carbon (TOC), and hardness) and two BMI parameters (abundance and richness). Water chemistry was primarily driven by natural landscape parameters. Dissolved phosphorus was associated with wetness, greening, exposed land, and water coverage ($R^2 = 0.40$). TOC was strongly influenced by greening, wetlands, exposed land, rock cover, and water coverage ($R^2 = 0.60$). Hardness was shaped by underlying geology, wetlands, exposed land, rock cover, and shrub dominance ($R^2 = 0.44$). Anthropogenic disturbance metrics did not significantly influence water chemistry.

In contrast, BMI communities responded to both landscape characteristics and lake-specific features. BMI abundance was significantly associated with landscape browning, wetness, underlying geology and habitat type ($R^2 = 0.33$). Road density also emerged as a significant predictor; however, because only a small portion of sampled catchments contained roads, this result should be interpreted cautiously until validated with broader sampling across a wider road-density gradient. Species richness was influenced primarily by flushing index, exposed land, and habitat type, although unexplained ecological variability remained high ($R^2 = 0.26$).
Overall, natural landscape properties were the dominant drivers of water quality and benthic community structure in the Yamba River watershed, while human disturbance signals were limited and preliminary. These findings provide valuable baseline information to support ongoing monitoring and future development assessments in the region.

Cyanobacteria Blooms in Great Slave Lake: Observations from Traditional, Local, and Scientific Knowledge

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Northwest Territories residents depend on clean fresh water for drinking, harvesting, recreation, and cultural activities. Cyanobacteria (sometimes called blue-green algae) are microscopic, plant-like organisms that occur naturally in fresh water including lakes, rivers and ponds. Individually, they are too small to see without a microscope but under certain conditions, they can multiply quickly and form large groups called "blooms." These blooms can change the colour and clarity of water and often from a surface scum. Some types of algal blooms can harm the environment or produce toxins that are harmful to people, pets, and wildlife. Conventionally, algal blooms have been associated with warm and nutrient-rich lakes, not northern water bodies. The deep, clear subarctic waters of Great Slave Lake (also known as Tinde'e, Tucho, and Tu Nedhé) have long been considered too cold, with algal biomass too low to support blooms.

By combining Traditional, local, and scientific knowledge sources, we document new and increasing cyanobacteria blooms in Great Slave Lake and other inland lakes over time. Tracking and documenting these changes is important for understanding the ways climate change and other cumulative impacts are affecting Great Slave Lake. Unlike southern jurisdictions, where cyanobacterial blooms are tracked and publicly reported by the provinces, blooms are an emerging issue in the Northwest Territories and there is no formal surveillance program. Here, land user observations have been particularly important and provide invaluable insights and observations of ecosystem change over time.

We found no cyanobacteria blooms occurred in Great Slave Lake before 1989. The first suspected blooms were first small and observed near point-source sewage effluent in an isolated area of the North Arm. Over the last 15 years, new blooms have spread in size, density, and locations and have been observed as far as the East Arm in 2024 and 2025. These dense floating blooms were usually observed along shorelines in late summer and were short-lived. *Dolichospermum* is the dominant cyanobacteria genus. Our initial testing did not detect any potent liver toxin (microcystin), which can be produced by some blooms. However, new testing has confirmed that Great Slave Lake blooms process the capacity (genes) to produce microcystins and other toxins. Further research is needed to understand what conditions might trigger toxin production in our northern water bodies. As a precaution, residents should assume toxins may be present in any future bloom and avoid collecting drinking water or swimming near affected areas.

By analyzing information across knowledge systems, we establish a foundation for collaborative research and monitoring in our rapidly changing northern water bodies. This approach could be used as a template for bridging different knowledge systems in northern environmental change research. Additional research, surveillance and monitoring the cumulative cyanotoxin profile with continued collaboration with Traditional, local, and scientific knowledge holders.

Regulating Projects Near Water in the North

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The Fish and Fish Habitat Protection Program (FFHPP) of Fisheries and Oceans Canada (DFO) is responsible for reviewing all projects in or near water that may cause the death of fish, or the harmful alteration, destruction or disruption of fish habitat. This includes a variety of projects, such as mining, port development, highway construction, and hydroelectrical facilities impacting lakes, rivers, streams, creeks, wetlands, nearshore, and riparian habitat. Across the Arctic region - Nunavut, Northwest Territories, and the north slope of Yukon - FFHPP works closely with developers and indigenous groups on ways to avoid, mitigate, and, when necessary, offset harmful impacts to fish and fish habitat.