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Akaitcho

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Julian Kanigan

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Update on GNWT-ENR's Environmental Site Assessments and Monitoring Projects at Various NWT Contaminated and Operating Sites

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The Department of Environment and Natural Resources (ENR), Government of the Northwest Territories (GNWT) is currently carrying out environmental site assessments and environmental monitoring projects at various contaminated and operating sites across the Northwest Territories.

The GNWT has carried out assessments on sites within the North and South Slave Regions such as; Ptarmigan Mine, Tom Mine, Tin Mine, Burwash Mine, Crestaurum Mine, Rodstrom Mine, Pine Point Rail Bed and the Fort Resolution Underground Pipeline.

The purpose of this presentation is to provide an update and next steps on the assessment and monitoring work being conducted in the North and South Slave Regions.

The Yellowknife Bay Aquatic Ecosystem 75 years After Gold Production Began: Arsenic, Antimony and Metals in Water, Sediment and Fish

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Yellowknife Bay on Great Slave Lake is a water body of cultural, subsistence and recreational importance for the Yellowknives Dene First Nation and residents of Yellowknife. The bay has been impacted by releases of pollution from gold mining since the start of ore production in the late 1930s. The metalloids arsenic and antimony as well as metals were deposited in the bay through effluent and tailings releases, and air emissions from ore roasting. Local concerns remain over the long-term fate of legacy mining pollution. A study from 2013 to 2015 investigated the movement and environmental fate of metal(loid)s released into Yellowknife Bay, with a focus on water and sediment quality, and bioaccumulation in the food web.

Dated sediment cores, which can provide a historical record of pollution, showed significant enrichment of antimony, arsenic, copper, lead, manganese, mercury, silver and zinc in sediments corresponding with the timing of early mining operations in the area. Mining pollution extended approximately 30 km south of Giant Mine and into the main body of Great Slave Lake. The most intensive enrichment of metal(loid)s in sediments occurred at the north end of Yellowknife Bay within 5 km of Giant Mine. In Yellowknife Bay nearest to Giant Mine, levels of antimony and metals have declined near the sediment surface but remain above pre-mining levels. At farther sites, concentrations of elements in surface sediments have declined to background.

While sediments in Yellowknife Bay indicate recovery from legacy pollution of less-mobile metals (e.g., copper, lead), arsenic remains highly concentrated in younger surface sediment with solid-phase peaks of 800-4500 ppm in the top 5 cm. Levels and speciation of dissolved arsenic in sediment porewaters were related to oxygen conditions, with maximum concentrations found near the oxic-anoxic boundary. The arsenic peaks in near-surface sediment likely resulted from dissolution and upward migration of dissolved arsenic from arsenic-rich sediments in deeper layers.

Summer concentrations of arsenic in surface waters were relatively low (<4 µg/L) in Yellowknife Bay, although levels were several-fold higher at Back Bay compared to the mouth of Yellowknife Bay and main body of Great Slave Lake. Surface water arsenic was predominantly in the dissolved fraction as arsenate (As^{+5}) although arsenite (As^{+3}) was also present. Water concentrations of total arsenic declined to approximately 1 µg/L or less at a distance of 10 km south from Giant Mine, at the mouth of Yellowknife Bay.

Over 200 fishes, representing seven species, were collected in Yellowknife Bay and near Wool Bay on Great Slave Lake for arsenic and metals analysis of tissues. Arsenic concentrations in fish muscle were well below the Canadian Food Inspection Agency guideline of 3.5 ppm wet weight. The low arsenic in fish muscle can be explained by low arsenic in surface waters and the physiological behaviour of this element in fish.

Yellowknife Bay is showing positive signs of recovery with long-term declines of arsenic in water and metals in surface sediment. However, further study is recommended to better understand the potential for arsenic release from sediment, which remains a large and potentially leaky reservoir of legacy arsenic.

Monitoring of Remediated Federal Contaminated Sites in the NWT

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Indigenous and Northern Affairs Canada (INAC) is focused on accelerating the remediation of contaminated sites in the North to protect the health and safety of Indigenous people, Northerners, and the integrity of the environment. Once a contaminated site has been remediated, INAC continues to monitor those sites to ensure that all remedial actions continue to meet their intended purposes; that is, once a site is remediated, INAC ensures it remains safe for people and the environment.

In the North and South Slave regions, INAC Contaminants and Remediation Division (CARD) has remediated Colomac Mine, Discovery Mine, Hidden Lake Mine, Great Slave Lake area sites and North Inca Mine. Monitoring continues at Colomac Mine, Discovery Mine and Great Slave Lake area sites. Monitoring has been completed at Hidden Lake Mine and North Inca Mine; INAC is now investigating the possibility of transferring these remediated sites to the Government of the Northwest Territories. Additionally, CARD recently received results from a Traditional Knowledge and Users' Survey of the Pine Point Rail Bed.

The purpose of this presentation is to provide an overview of recently completed monitoring activities at the Colomac Mine, Discovery Mine, and the Great Slave Lake area sites, as well as to highlight successes and outline next steps for Remediated Sites Monitoring. Additionally, this presentation will offer a summary of the preliminary findings of the Pine Point Rail Bed Traditional Knowledge and Users' Survey.

Community and Scientist Monitoring of the Great Slave Lake Ecosystem

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Community members and scientists are very interested in knowing how the Great Slave Lake ecosystem functions and how to protect its well-being. For example, community members have noticed differences in the appearance of the water and changes in the fish they are harvesting. Scientists are measuring changes in mercury concentrations in fish but, without knowing more about the environment in which the fish lives, are limited in how they can investigate what is causing changes. In this presentation, we present some of the highlights of community-based and scientific monitoring we have been conducting at Fort Resolution since 2010.

The community monitoring began in summer with measurements of water temperature, muddiness (how clear the water is) and color at three locations in Resolution Bay. Slave River flow and winds stirring up the lake bottom make the water muddy and microscopic plants (algae) can made the water green or brownish. This study continued through the year by monitors working with water treatment plant operators to put their water quality measurements into a data base that could be examined for seasonal patterns and differences between years; water plant operators make a series of measurements of the intake water to know how to treat it to meet drinking water standards. Over two years, additional measurements were made of the water including the concentrations of metals, chemicals needed for algae to grow and of the algae. Since then, with skills gained, monitors conducted a special study of the discharge waters at the water treatment plant and measured additional aspects of Resolution Bay waters including metals and plant nutrients. Two special studies were conducted to record which fish were being caught in the domestic fishery and how catches changed through the winter with fish movements and location of the nets.

The water studies are providing information on how the water, algae (which can form scums), and taste may change with the season, Slave River flow, winds mixing up the sediments, temperature and plant nutrients such as phosphorus and nitrogen. These records can be used by the community to document change and can be shared with researchers so that they can understand what is going on in the Great Slave Lake ecosystem and work to implement protective action if needed. The monitoring of the domestic fishery is useful by documenting fish catch. It can show how fish move in and out of an area, if these patterns are changing (e.g., lake trout becoming more common in Resolution Bay waters) and new species appearing. In addition, the airport at Fort Resolution routinely makes weather measurements which are recorded and can be used to document change in climate. With all the monitoring going in Fort Resolution, community monitors are in a very good position to record and record change.

Impact of Wildfire on Northern Stream Ecosystems

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High-latitude regions are currently undergoing rapid ecosystem change due to increasing temperatures and modified precipitation regimes. Since 2012, the Northwest Territories (Canada) has been experiencing severe drought and wildfire seasons. In 2014 alone, fires within the Northwest Territories consumed over 3.4 million hectares of forested land; 1.4 times larger than the national yearly average for Canada. Wildfire is one of the most important agents influencing age structure and composition of the forest stand, as such, it is a critical factor in ecosystem dynamics. The impacts of wildfire on terrestrial systems garner more attention compared to aquatic habitats. This is especially true when considering aquatic ecosystems located in the boreal forest biome, where the impacts of fires on stream ecology and chemistry is relatively understudied. Freshwater ecosystems, such as lakes and streams, are highly relied upon by northern communities for their cultural significance and economic and environmental goods and services they produce, including country foods.

This study examines the impact of recent wildfire on freshwater streams within the North Slave, South Slave, and Dehcho regions of the Northwest Territories through analysis of their water chemistry and benthic macroinvertebrate assemblages. Benthic macroinvertebrates, or the organisms living within/on the bottom of these streams, were sampled following methods outlined by the Canadian Aquatic Biomonitoring Network (CABIN). Biological indices (ex. Relative abundance and richness) were calculated and compared to determine relationships regarding diversity and abundance. Results of this study suggest that recent wildfires cause at minimum short-term impacts in water quality, such as increased turbidity and total suspended solids (TSS). In addition, results indicate slight changes in invertebrate communities of burned streams compared to unburned streams, including increased richness and abundance of collector-gatherer taxa.

NWT Cumulative Impact Monitoring Program Results in the North and South Slave Regions, NT

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The mandate of the Northwest Territories Cumulative Impact Monitoring Program (NWT CIMP) is to analyze scientific and traditional knowledge to monitor the cumulative environmental impacts of land and water use in the NWT. Cumulative impacts are changes to the environment caused by human actions or a combination of human actions and natural factors through time and space. This abstract provides a brief description of NWT CIMP and summarizes NWT CIMP-supported monitoring results from 2002-2017 in the North and South Slave regions.

Monitoring cumulative impacts is an important part of environmental regulation and integrated system of environmental management in the NWT. The legal mandate for NWT CIMP comes from the Gwich'in, Sahtu and Tłı̨chǫ land claim agreements, and Part 6 of the *Mackenzie Valley Resource Management Act*. Aboriginal governments and organizations help to guide the program through the NWT CIMP Steering Committee. The Northwest Territory Métis Nation, Akaitcho Territory Government, and North Slave Métis Alliance represent the North and South Slave regions on the NWT CIMP Steering Committee. Decisions are made by consensus with input from both members and observers.

NWT CIMP is focused on cumulative impact monitoring that informs environmental decision-making. As such, the program emphasizes the monitoring priorities of co-management boards. In the North and South Slave Regions, this includes the Mackenzie Valley Environmental Impact Review Board and the Mackenzie Valley Land and Water Board. The program strives to include communities in as many aspects of cumulative impact monitoring as possible.

NWT CIMP has supported 39 individual projects specific to the North and South Slave regions since 2002. Many other supported projects are relevant to both the North and South Slave regions and other regions of the territory. Most projects have been related to water and fish, caribou, traditional knowledge and capacity building. Generally, projects have been short-term, lasting one or two years. However, with increased, stable funding in the last seven years, NWT CIMP has supported several longer-term monitoring projects.

Last year, NWT CIMP provided $337,000 to support 13 projects in the North and South Slave regions, 10 of which overlapped with other regions. Approximately 15% ($70,000) of this funding was provided directly to regional and community organizations. This year, five projects are being supported directly in the regions in addition to seven multi-region projects.

Project results for these and all NWT CIMP projects are available for download on the NWT Discovery Portal www.nwtdiscoveryportal.enr.gov.nt.ca or by contacting nwtcimp@gov.nt.ca.

The Recovery of Yellowknife Area Lakes From 50 Years of Mining Emissions: The Influence of Landscape Scale and Within-Lake Processes

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Lakes are a dominant feature of the landscape in the Yellowknife area and are an important part of the cultural and recreational fabric of the community. The early years of historical mining activities in the region resulted in the release of large amounts of arsenic, antimony, and metals to the surrounding area. Fifty years after the bulk of these emissions were deposited, surface waters of many small shallow lakes continue to exhibit elevated concentrations of contaminants, particularly arsenic. This talk will highlight recent research investigating the influence of landscape factors and within-lake processes on the chemical recovery of Yellowknife area lakes.

A recent survey of 98 lakes within a 30-km radius of Yellowknife was used to investigate the distribution of arsenic in surface waters across the landscape. Regionally, the concentration of arsenic in surface waters decreased with distance from the historical ore roasting operations, and concentrations were highest in lakes downwind (to the west) and proximal to the historical stacks. Four lakes within this hotspot area representing a range of physical and hydrological properties were sampled regularly for one year to investigate seasonal variation in the concentration and speciation of arsenic in surface waters. Arsenic concentrations increased considerably (93 to 182%) under ice throughout the winter for three of the four study lakes. Peak under ice concentrations of arsenic were accompanied by large increases in iron and manganese concentrations and were observed under low oxygen or completely anoxic conditions. These data suggest that two important winter processes may lead to under-ice increases in lake water arsenic concentrations, the exclusion of solutes from the development of overlying lake ice and/or the diffusion of metal(loid)s from sediment porewaters to lake waters.

These results demonstrate that impacts to Yellowknife area lakes from legacy mining pollution vary across the region and highlight the importance of understanding both landscape level and within-lake processes. It is particularly important that regulators and land managers consider the importance of winter processes in a region where lakes are ice covered for two-thirds of the year.

Traditional Knowledge in Resource Decisions and Community-Based Monitoring: Current Challenges and Recommendations

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Research and documentation of traditional knowledge (TK) is a social science exercise, a discipline that differs greatly from the natural sciences. The inclusion of TK in natural resource decisions can result in decisions that are better for humans and the environment, more responsive to unique interactions between the two, and more reflective of local concerns and scenarios. The Government of the Northwest Territories has unique obligations to include TK in all environmental management actions and decisions. Its policies and *Acts*, as well as frameworks for implementation, are intended to ensure that TK has meaningful influence on environmental decision making and empowers indigenous people in environmental governance.

This presentation focuses on the preliminary results of research into the current challenges and opportunities associated with incorporating traditional knowledge in resource decisions and understanding and managing cumulative effects in the Northwest Territories (NWT). This research examines: the needs and challenges related to incorporating TK as expressed by those involved in TK research, regulatory review, and resource management, and; the role TK currently plays in regulators' informed decision-making and in managing cumulative effects in the NWT. It will also describe emergent methods, challenges, and opportunities associated with community-based or TK monitoring for use in integrated resource management.

This subject is explored in three ways: 1) interviews with individuals involved in this field, including regulatory board staff, Aboriginal lands department representatives, and traditional knowledge researchers; 2) a review of major environmental assessments and how they appear to have incorporated TK in their reasons for decision, and; 3) a comprehensive literature review and critical analysis of community-based/traditional knowledge monitoring for resource decision making as a major site for integrating TK in regional or science-dominant decisions, such as permitting. The final outcome of this project will be a description of the challenges of this process, and multi-level recommendations for improving how traditional knowledge can be integrated into monitoring cumulative impacts and resource management decisions.

Aboriginal Aquatic and Resource and Oceans Management (AAROM) Program: Northwest Territory Metis Nation

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In 2009-2010, the Northwest Territory Metis Nation (NWTMN) applied for and received funding under the Department of Fisheries and Oceans' Aboriginal Aquatic and Resource and Oceans Management **(**AAROM) program. In order to ensure that the program's mandate stay on track, a consulting firm was hired by the NWTMN to set goals and challenges. This exercise was completed in the 2014-2015 fiscal year resulting in a set of challenges along with strategies to keep the program on track with better communication from all three Metis councils (Fort Smith, Fort Resolution and Hay River). This would allow the program to be successful and meet the Councils questions and or concerns, allowing better communication from all parties involved.

The main focus of this presentation is to provide an overview of what has been done to date since filling the AAROM coordinator position last April. In addition, the presentation will show what activities have taken place this summer and what may be in works for the foreseeable future. For example, this includes the Elders' Fisheries workshop, Community-Based Water Quality program, net training, and the adopted Guardian program.

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. As a result, the NWT-wide Community-based Monitoring (CBM) program was developed and sampling started in 2012. The goal of the monitoring program is to get communities involved in water stewardship and collect water quality monitoring information to answer community questions about water quality. The CBM Program is designed to allow community members to decide where to monitor water quality and to have community monitors collect samples.

There are over 40 water quality monitoring sites in the CBM program. Sampling at these sites is conducted by community members three to four times a year during the open water season (between June and October). GNWT-ENR staff supported the sampling by providing equipment, training, and other technical support. Many factors influence water quality, some are natural and some are from human activities.

Water quality varied across the NWT. Water quality can vary depending on the sources of water and its flow. Hydrocarbons and metals dissolved in water are more able to get into plants, bugs, and fish than those attached to dirt, so they are important to monitor. Fish reproduction and human health can also be affected by certain levels of dissolved hydrocarbons and metals. Hydrocarbons and metals usually stay attached to dirt unless things like the pH and temperature of the water changes. In some regions of the NWT, there is evidence that permafrost thawing, caused by climate warming, is affecting water quality.

Substances above the Canadian Council of Minsters for the Environment (CCME) guidelines for the protection of aquatic life most often included aluminum, iron, and copper. These metals often attach to dirt and total levels exceeded guidelines more often in waters with naturally high turbidity.

Hydrocarbon levels were highest in 2014 but have since come down to pre-2014 levels. Hydrocarbon levels at all sites remained well below values that would harm fish. In 2014, forest fires were very extensive which may be the cause of the increased PAH levels at that time.

Barren-ground Caribou Traditional Mapping and Analysis

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For years, the Yellowknives Dene First Nation (YKDFN) has recorded traditional knowledge (TK) of Elders, hunters, and plant gatherers onto maps through community-based projects. Unfortunately, most of this material has been difficult to access, being stored away in unfiled paper formats within the Lands Department or housed offsite with restricted access. These projects include important historical information on the barren-ground caribou and could, thus, inform current efforts to protect this threatened species. Our project aims to make past and current TK of barren-ground caribou available to YKDFN Lands and Environment, community members, researchers, regulators and decision-makers to improve understanding and monitoring

of caribou. Specifically, we focus on cultural, biophysical, and ecological aspects of the Bathurst caribou herd in the Chief Drygeese Territory. Using workshops, interviews, and interactive mapping to document TK, we: determine what TK can tell us about how, where, and why movement, migrations, and populations have changed over time; highlight indicators that YKDFN use to monitor the herd and how these indicators can assist in cumulative impact monitoring; and use this information to direct future on-the-land monitoring to support cumulative impact understanding and management.

Traditional Knowledge themes include caribou health, migration and population patterns, habitat and vegetation conditions, and local climate changes. Our broader objectives are to: bring together TK of caribou that has been recorded in the past; identify gaps in previously recorded TK using spatial, temporal, and contextual analyses; guide research using gaps identified by knowledge holders; make a public internet-based research tool that includes TK; explore partnerships with neighboring First Nations; and strengthen relationships between Elders and youth. The information from this project both works to fulfill the mandate of the CIMP, and is keeping with First Nations principles of Ownership, Control, Access, and Possession, and the vision and commitments set out by the United Nations Declaration on the Rights of Indigenous Peoples (Article 31).

We present our progress and findings for Year One and Two. In the last two years, we built a TK mapping database of past YKDFN TK research on caribou that was previously not available. This secure, data management system and GIS includes more than 40 years of 102 interview records linked to audio recordings, photographs, maps and transcripts, 62 community maps, and 47 land use surveys involving caribou. Yellowknives Dene members received training on how to digitize and enter information into the system, how to run searches on its information, and how to document on-the-land activities using a mobile app that is connected to the data management system. We made a public web portal, where YKDFN can manage, select, and publish information of their choosing. Based on identified research gaps, we discuss our objectives for Year 3—the final phase of the project.

Biological Adaptability of Great Slave Lake Fisheries Ecosystem

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Great Slave Lake (GSL) is a typical oligotrophic system, experiencing multiple vectors of natural and anthropogenic disturbance. Detection, assessment and predictions of the biological adaptability can be strategically promising and critically essential to understanding how the

subarctic great lake ecosystem service responds mechanically to resilience of the disturbance. Since 2011, a multidisciplinary survey, including limnology, zooplankton and benthos as well as fish and fisheries, has been taken in the main basin of GSL during June through mid-August. Through the field survey, the overarching objectives were 1) to establish baseline conditions and their variability, 2) to explore the effective indicators of cumulative changes, and 3) to characterize the aquatic productivity, biodiversity, and the environmental association with changing arctic climate.

During 2011-2016, the field survey has been conducted in a rotate format over Resolution Bay, Moraine Bay, Yellowknife Bay and Simpson Islands while the western basin of GSL has been surveyed every summer. Over six management areas and eight depth strata (20 m intervals), water temperature showed a consistent thermocline structure in 10-12 m below the surface, whereas turbidity changed by years when discharges from the Slave River were altered by water regulation and natural fluctuations of evaporation and precipitation. Copepods dominated zooplankton abundance, comprising 80% of all samples. Approximately 78 % of the total zooplankton density from all samples occurred in shallow sites (<20 m) and was negatively correlated to depth. Benthos was dominated by ostracods (mean ± SE; 599 ± 74 individuals/m^2) and amphipods (551 ± 47 individuals/m^2) which accounted for over 69% of the total density of benthic invertebrates, followed by oligochaetes, bivalves and chironomids. Among 387 effective gillnet settings, three coregonids, Lake Whitefish, Least Cisco and Lake Herring, dominated the multispecies community compositions. Spatial distribution of total fish abundance differed among management areas whilst significant difference in biomass density was found through depth stratified settings. Thus, site depth, temperature and turbidity have played in critical roles dictating the spatiotemporal dynamics and multispecies fisheries production in the lake.