

Development and application of methods to monitor the ecological health of the South Nahanni Watershed

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Introduction

Maintaining healthy ecosystems amidst increasing levels of industrial development is a central challenge to the management of Canada's north. Water-borne transportation of contaminants, including trace metals, arising from expansion of mining activities in Canada's north has raised concerns about the cumulative environmental effects of increased metal pollutant loadings in receiving waters, and their subsequent effects on ecological communities.

Despite the recognition of the potential negative effects of mining activities on ecological integrity, local communities and government organizations (e.g., Indian and Northern Affairs Canada, Environment Canada, and Parks Canada Agency), currently lack the tools to monitor concentrations of metals in stream ecosystems. The "Nahanni National Park Reserve of Canada Management Plan" identifies an objective of maintaining high water quality and specifically

states “The water quality of the South Nahanni River watershed has long been considered a key measure of the park reserve’s ecological integrity and health”. With two existing industrial developments potentially influencing the water quality of the South Nahanni River and more being proposed, an effective and comprehensive aquatic monitoring program comprising assessments of water quality and biological communities in the South Nahanni River Watershed is critical.

The South Nahanni Watershed represents one of Canada’s most recognized pristine northern wilderness environments. It has been designated by the United Nations Educational, Scientific and Cultural Organization Convention as a World Heritage Site to recognize its exceptional natural and cultural values. The South Nahanni River, which flows through the South Nahanni Watershed, has also been recognized as part of the Canadian River Heritage network as a reflection of its ecological and social importance on the Canadian landscape.

The proposed work addresses the valued component of water quality in the South Nahanni River, and more specifically to: i) develop tools to monitor levels of metals in aquatic food webs that the river supports, and ii) assess the ecological health of the entire South Nahanni Watershed.

The “Nahanni National Park Reserve of Canada Nah a Dehé Management Plan” identifies an objective of maintaining high water quality and specifically states “The water quality of the South Nahanni River watershed has long been considered a key measure of the park reserve’s ecological integrity and health”. With two existing industrial developments influencing the water quality of the South Nahanni River and more being proposed, an effective and comprehensive aquatic monitoring program comprising assessments of water quality and biological communities in the South Nahanni River Watershed is critical.

Under Measure 3 from the Report of Environmental Assessment of Canadian Zinc Corporation’s Phase III Drill Program, our research specifically supports the requirement of INAC to ensure the development of a cumulative impact monitoring program at the Prairie Creek mine. Study Component 1, performed in 2007-2008, supported the development of a method to monitor levels of metals in food webs adjacent to the mine, whereas Study Component 2 (scheduled for 2008-2009 to 2009-2010) provides a method to monitor the present and future health of receiving waters in the South Nahanni Watershed.

The objectives of the proposed work were initially two-fold:

1. To identify important trace metal indicators in stream ecosystems in the South Nahanni Watershed to better direct monitoring efforts; and
2. To assess the ecological health of streams and rivers in the South Nahanni Watershed.

With the level of funding provided for the 2007-2008 funding year, *Component 1* of the current proposal was implemented. *Component 2* will be implemented in the 2008-2009 funding year under a separate funding proposal. This report summarizes the results of *Component 1*.

Relevance of Component 1.

Component 1 of the proposed work achieved this objective by comparing concentrations of metals in water with those in sediments, benthic insects, and fish that live in streams in the South Nahanni Watershed. These data will allow our research team to identify the most appropriate way to monitor metals in streams in the South Nahanni Watershed, and thus to determine whether concentrations of metals in northern streams are changing through time. This information is crucial to local communities and regulatory organizations such as the Mackenzie Land and Water Board, as they monitor the effects of current mining activities on the health of the South Nahanni Watershed and consider applications for the expansion or changes in mining practices in the basin.

We had also proposed under Component 1 to complete laboratory studies with slimy sculpin to assess effects and establish toxicity thresholds for this important northern indicator species. Due to a lack of funding and unanticipated personal challenges faced by Ms. Spencer in the 2007-2008 year, these experiments were not and will not be completed in the immediate future.

Thus all CIMP funds were spent on the field program examining metal distributions.

Personnel

The project is co-lead by Dr. Monique Dubé (University of Saskatchewan) and Dr. Garry Scrimgeour (Parks Canada Agency).

Dr. Monique Dubé holds a Ph.D from the University of University New Brunswick, and holds a Canada Research Chair in Aquatic Ecosystem Health Diagnosis, in the College of Veterinary Medicine and Toxicology Centre, at the University of Saskatchewan. As an ecotoxicologist she has developed innovative approaches to assess river health, including development of technology (e.g., artificial stream systems, assessment software) to assess effects of various contaminants on fish. She has been involved with the development of cumulative effects thresholds with the Northern Ecosystem Initiative and has extensive experience with aquatic effects monitoring, cumulative effects programs, and ecosystem health.

Dr. Garry Scrimgeour holds a Ph.D from the University of Calgary, and is an Adjunct Professor in the Department of Biological Sciences at the University of Alberta. As a recipient of post-doctoral fellowships from the Natural Sciences and Engineering Research Council of Canada, Sir Izaak Walton Killam Foundation and University of Calgary, he has considerable experience and scientific expertise related to environmental effects assessments. He serves as an Associate Editor with the Journal of the North American Benthological Society. Garry has in excess of 20 years of experience in environmental consulting and assessment and has held positions within regional governments, universities and research institutes.

Dr. Michelle Bowman holds a Ph.D from the University of Alberta. She has considerable experience in the development of innovative statistical approaches to identify environmental degradation and routinely provides expert opinion on detecting environmental degradation and designing biological monitoring programs. As a Research Associate in the Toxicology Centre at

the University of Saskatchewan, she has been instrumental in the analysis and interpretation of data collected from the South Nahanni Watershed.

Ms. Dana Haggerty holds a M.Sc degree from the University of British Columbia and currently serves as a monitoring biologist with Parks Canada Agency. She has considerable expertise in habitat assessment including the application of hierarchical-based habitat models. She has substantial knowledge in the design and implementation of aquatic monitoring programs.

Ms. Shelley Humphries and Mr. Salman Rasheed provided assistance with the field collections as part of field studies scheduled for completion in 2007. Ms. Humphries and Mr. Rasheed hold postgraduate degrees (Master of Science) from the University of Calgary and University of Alberta, respectively, and have considerable experience in the design and implementation of aquatic monitoring programs.

Similar Work

This research builds from the research program begun on the Nahanni by Dr. Dubé and Ms. Spencer in 2006-2007 where monitoring programs were implemented both on the Flat River, Prairie Creek and part of a larger regional monitoring program throughout the watershed. This research was supported by INAC, NSERC, Canadian Zinc and North American Tungsten. The work on the Flat River was used by the mine as part of their Environmental Effects Monitoring Program. These relationships were developed and supported through the University of Saskatchewan. In 2007-2008, the partnership was expanded to include Parks Canada. The work reported herein and any resulting publications will conclude the University of Saskatchewan research in the Nahanni watershed.

Methodology

Study Component 1.

We have designed and implemented a field program to quantify spatial variation in metal concentrations in water, sediment, benthic algae, benthic macroinvertebrates and fish at sites adjacent to the Canadian Tungsten and Canadian Zinc mines. We collected water, sediment, algae, macroinvertebrates and fish from eight sites located upstream and downstream of each mine. More specifically, we collected samples immediately adjacent to water treatment facilities at each of the two mines and then progressively upstream (i.e., 3 sites located approximately 0.5, 1 and 2 km upstream) and downstream (i.e., four sites located 0.5, 1, 2, and 3 km downstream) of these point source discharges. Sites were sampled once in the fall of 2007. Concentrations of a broad suite of metals in water and sediment samples, and samples of benthic algae and invertebrates, and fish have been determined using standard methods.

These data are being used to quantify concentrations of metals in water and specific parts of the food web, and can also be used to determine whether levels of metals in one component of the food web can be extrapolated to other parts of the food web. These data provide a scientifically rigorous method to quantify concentrations of metals in streams and rivers, and to develop a

monitoring program capable of determining whether mining activities are resulting in progressive increases in levels of metals in northern stream food-webs.

Involvement of Community Organizations

The field collections in 2006 and 2007 involved community members assisting with field collections. In 2007-2008 this continued. Our research was designed to provide meaningful training opportunities for northern residents. Mr. Chuck Blyth (Superintendent, Nahanni National Park Reserve) contacted the Deh Cho First Nations to discuss the proposed research. He, along with other members of the research team invited local people interested in learning more about the proposed work to accompany the field crew in 2007 and in 2008. These discussions, along with communications with partners, provide the opportunity to review the study objectives, research study design, delivery of a communication plan, and provide familiarity with the research at its onset, as well as provide an opportunity for partner feedback.

We also had discussions with staff at Nahanni National Park to ensure that local people had the opportunity to better understand the proposed work and to accompany the field crew. Because the research team was (2007-2008) and will be (2008-2009) based at mine camps when completing the field collections, opportunities also exist for mine employees to interact with the research team. Accompanying the field crew provides the opportunity to gain experience in field techniques related to water quality sampling, sediment sampling, and fish sampling.

Traditional Knowledge

The overall impetus for the proposed work arose from concerns raised by northern residents, including elders on the potential effects of mining activities on the health of the South Nahanni watershed. In fact, “Nahanni National Park Reserve of Canada Nah ą Dehé Management Plan” identifies an objective of maintaining high water quality and specifically states “The water quality of the South Nahanni River watershed has long been considered a key measure of the park reserve’s ecological integrity and health”. Given traditional knowledge of the South Nahanni River, and its importance to northern residents, it is not surprising that First Nations amongst others have raised concerns related to the potential ways in which mining operations could degrade the health of the South Nahanni River.

As has been noted by Dr. Dubé and Ms. Paula Spencer as part of their 2006-2007 proposal to CIMP Fund, traditional knowledge of the South Nahanni River has been the basis of many concerns raised by First Nations related to the potential effects of mining on the health of the South Nahanni Watershed. These include the following specific concerns expressed by the Deh Cho First Nations and Nahanni Butte Band during the EA process:

“we are concerned this project may pose both short-term and long-term significant adverse environmental impacts to First Nations’ lands and waters.”

“we are still concerned with the immediate and the potential cumulative effects that this project may have...the disturbance to waterways, fish and wildlife, and

potential for future mineral exploration and industrial in the South Nahanni Watershed.”

“Data deficiencies are particularly evident in regards to ... Cumulative Effects (the identification of indicators and thresholds).”

“we also urge the Board to give considerable weight to the thresholds and indicators for Cumulative Effects....”

The proposed work aims to fill data gaps identified by communities through incorporating traditional knowledge and community concerns into the objectives of the project. While the project team does not plan to interview elders, we would be grateful if elders could share some of their knowledge on the South Nahanni River at our meetings in Fort Smith, Nahanni Butte and Yellowknife anticipated in 2008-2009.

The selection of the South Nahanni Watershed as a study area arose because community members communicated their concerns to several management and regulatory boards. The selection of study sites immediately adjacent to the Cantung and Prairie Creek mines resulted directly from communicating these concerns.

Results and Discussion/ Conclusions

This research supported the CIMP category *Monitoring and Research*.

Valued Component and Rationale

The South Nahanni Watershed represents one Canada’s most recognized pristine northern wilderness environments. It has been designated by the United Nations Educational, Scientific and Cultural Organization Convention as a World Heritage Site to recognize its exceptional natural and cultural values. The South Nahanni River, which flows through the South Nahanni Watershed, has also been recognized as part of the Canadian River Heritage network as a reflection of its ecological and social importance on the Canadian landscape.

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Increasing knowledge of cumulative impacts

We will increase knowledge of cumulative impacts by: i) making presentations at several northern communities and at each of the two mine sites where northern residents work, and ii) by integrating northern community members into the research teams. Our research program will include presentations at Fort Smith, Nahanni Butte and in Yellowknife. These presentations provide opportunities to discuss what constitutes cumulative impacts within a stream environment, and when combined with participation of northern residents in the research team, allow for discussions of the importance of spatial and temporal dimensions of cumulative impacts and their assessments.

Our research will also result in the advancement of the science of cumulative impact assessments through the publication of three articles in scientific journals. One has already been completed and is appended to this report (Spencer et al., 2008). The other two publications are being written by Dr. Bowman with a completion date of April 2008. One presents the results and management implications from the 2006-2007 regional assessment in the Nahanni watershed and the second the results from *Component 1* of this project. These publications will be submitted to INAC and the CIMP program as well as all partners.

The significance of this research is that we have made (Spencer et al 2008) and will continue to make (with our future publications) recommendations on suitable indicators and cumulative impact monitoring programs to assess the effects of mines on sensitive northern aquatic rivers. The partnerships developed with the University of Saskatchewan, INAC, Parks Canada, industry (NA Tungsten, Canadian Zinc), the federal EEM program administrators, communities will ensure result uptake and use to guide development and ensure monitoring is defensible to assess changes if they are occurring.

Communication

Only partial funding was provided for the 2007-2008 year. Thus communication of findings for the 2007-2008 year will be undertaken by Parks Canada as follows:

- i) Delivering presentations on the project at Fort Simpson, Nahanni Butte, and Yellowknife.
- ii) Submission of publications to all funding partners with additional copies available to the public from the Nahanni National Park reserve office in Fort Simpson.

Appendix: Maps and pictures

