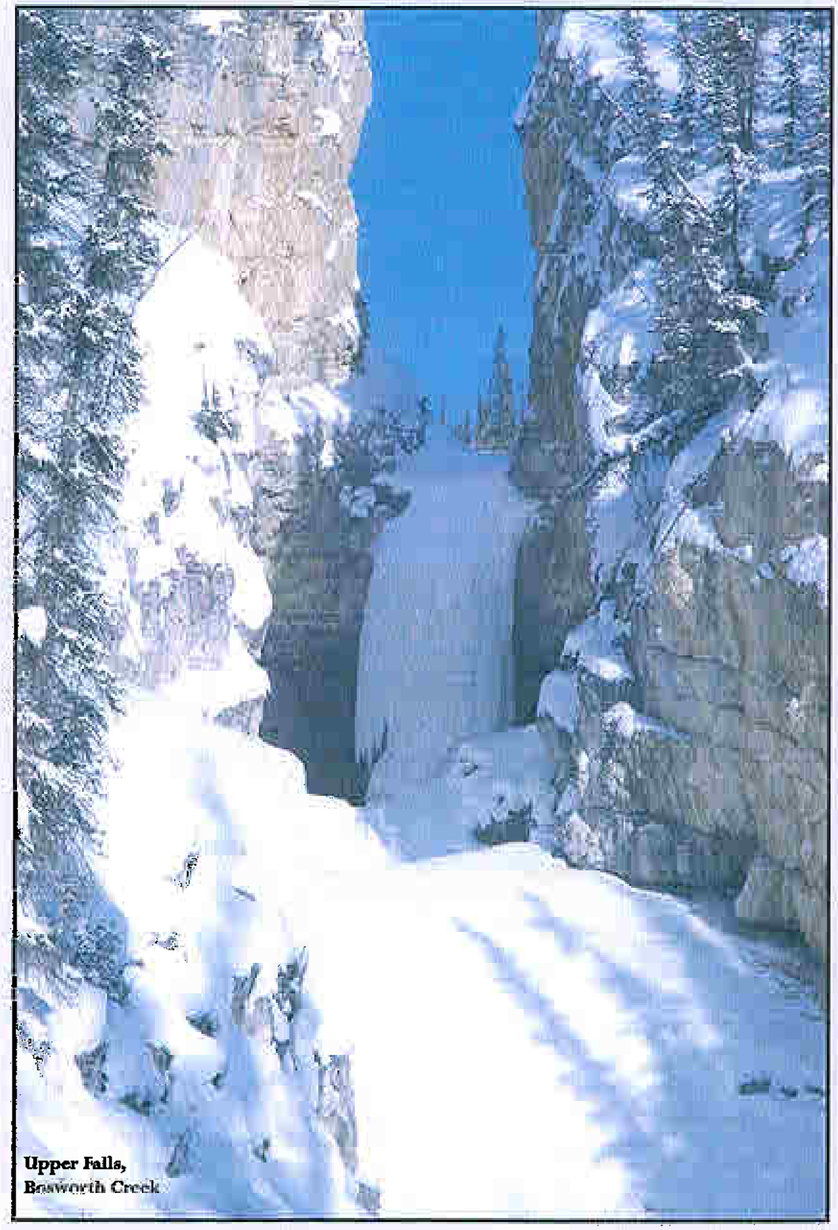
Bosworth Creek Monitoring Project

2006/2007 Annual Summary Report

March 31, 2007



Upper Falls, Bosworth Creek

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Table of Contents

Table of Figures

Bosworth Creek Monitoring Project

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Project Overview

The Bosworth Creek Monitoring Project is a high resolution habitat study of a drainage basin dominated by a major creek system that enters the Mackenzie River at Norman Wells, Northwest Territories (NWT) (Figure 1). This long term project is facilitated by the Sahtu Renewable Resources Board and provides students from Mackenzie Mountain School with opportunities to undertake real research and make original contributions to science.

Bosworth Creek has played an important role in local history. Natural flow was impeded with the construction of a weir in 1960 at an existing bridge approximately 250 metres from its confluence with the Mackenzie River (Figure 2). The pond created behind this weir supplied both the oil refinery and the Town of Norman Wells with drinking water. The town abandoned this water source in 1991 and closure of the refinery in 1996 prompted channel flow reclamation as recommended by the Government of the Northwest Territories (GNWT). The weir was removed and natural flow restored in 2005 under Imperial Oil Resources NWT Limited's Reclamation and Restoration Plan (Govier and Aho 2001).

The Project was developed following concerns raised by local residents regarding the absence of whitefish and other aquatic species. The general question was "Now that the barrier has been removed, will these fish re-inhabit the stream on their own or should they be re-introduced?" The Sahtu Renewable Resources Board contacted the Department of Fisheries and Oceans (DFO) regarding this question and requested information about possible mitigation. Since the barrier no longer exists, it was decided that re-stocking the creek was unnecessary and that changes in the biotic community should progress naturally.

The recent restoration of Bosworth Creek offers a unique scenario for local high school students by enabling them to learn about local fish, invertebrates, hydrodynamics, sedimentology, streambed morphology, sampling techniques, data collection and evaluation. Therefore, the primary goal of this project is to expose Mackenzie Mountain School students to a wide range of scientific equipment and applications and to learn how to report their findings to the scientific community through public presentations and publications. Publishing original articles in science journals and working in cooperation with government and industry will give these students significant advantages over other candidates when they apply for post-secondary education.

The first task of this project is creation of comprehensive baseline inventories for plants and animals. These inventories are generally lacking throughout the proposed Mackenzie Gas Pipeline (MGP) route and predominantly under-represent aquatic invertebrates and fishes. For example, preliminary investigation suggests that fish species are under-represented in published inventories on Bosworth Creek by MGP proponents.

Project Guidelines

The Bosworth Creek Monitoring Project is guided by the belief that there is no substitute for excellence. To this end, the project employs the highest quality of field and laboratory equipment, professional analytical services, and academic expertise.

Field Equipment

The program acquired an extensive inventory of sampling gear and diagnostic equipment during 2006/2007 year. This was necessary due to the magnitude of data collection required to fulfill the parameters of this study. Namely, the levels of precision and accuracy must exceed those of a simple high school project. For example, there are several methods for determining water pH through litmus paper tests and basic chemical solutions. These methods provide consistent results and are used to supplement electronic pH monitor precession baseline values. All aquatic plants and animals live within well defined ranges of pH and many are vulnerable to small variations of their individual ranges of pH tolerance (Voshell 2002). A host of other factors can also negatively impact biota and the ability to discern between suspected agents is essential. Therefore, the tools used by this project are the same high quality instruments as those used by government, academia and industry. Finally, the diversity of this investigation requires an extensive inventory as each area of study utilizes specialized equipment.

Standards

All sampling employs professional standards and appropriate equipment. Dissolved oxygen, water pH, soil pH, water flow, and water temperature are determined in the field using high quality field testing equipment. Other parameters are analyzed by professional analytical services to ensure consistent and accurate results. Water and soil chemistry samples are flown to Taiga Environmental Laboratories, Yellowknife, NT on the day of collection by Canadian North Cargo. A number of fish species will be sampled during the summer of 2007 for genetic identification and possible contaminants. These samples will also be analyzed by appropriate commercial laboratories. Other biotic sampling has enlisted the cooperation of several universities and the Royal Ontario Museum. The project contributes original data and specimens to researchers at these institutions who provide assistance with taxonomic identifications and professional development for team members.

Professional Development

In order to undertake a project of this magnitude, the participants must be knowledgeable in a diverse number of areas. To this end, professional development provides the team members with hands-on instruction from leading specialists. The Regional Office of the GNWT Department of Environment and Natural Resources (ENR) is providing assistance with logistics, GIS and mapping, wildlife conservation education resources, environmental protection training and consultation, and forestry management support. Other local resources include personnel from the Department of Indian and Northern Affairs Canada Norman Wells office, a visiting University of Windsor Honours student specializing in benthic habitats, and several long-time Norman Wells residents with intimate knowledge of the creek system, its history and surrounding geography.

Professional academic affiliations are a viable means to accelerate the learning potential in this type of project. The Bosworth Creek Monitoring Project is currently working in cooperation with Dr. Douglas Currie, Senior Curator of Entomology, Royal Ontario Museum and University of Toronto; Dr. Donna Giberson, Department of Biology, University of Prince Edward Island; Dr. Susan Kutz, Research Group for Arctic Parasitology, University of Calgary; Dr. John Acorn, Entomology and Protected Areas, University of Alberta; Dr. Erling Holm, Assistant Curator of Fishes, Royal Ontario Museum; Ruth Errington, Peatland Technician, Canadian Forest Service; and Danna Schock, the Detroit Zoo. Further affiliations will likely develop as the project matures.

The Department of Fisheries and Oceans Canada is partly responsible for the project concept, which was initiated following discussion of fish stocks in Bosworth Creek with George Lowe, Fisheries Management Biologist DFO Hay River and Briar Young, Fish Habitat Management, Yellowknife in March 2006. Once the basic project goals and design were established, Briar Young and Peter Brunette, DFO Geomatics Coordinator, Yellowknife traveled to Norman Wells in July 2006 and provided field training to team members. This training is expected to continue with two further field workshops in the Spring and Summer of 2007.

The Team

The Bosworth Creek Monitoring Project currently employs three full-time team members. Yvonne Meulenbroek is the Team Leader and responsible for overseeing the coordination of other team members and their data. She is also the lead investigator for aquatic vertebrate and terrestrial invertebrate studies. Nate Gregory is studying aquatic invertebrates and assisting with terrestrial invertebrate collection and identification. Mark Meulenbroek oversees chemistry, sedimentology, geology and vegetation studies. Mark is also in charge of creating transects and profiles of the creek system.

Part-time assistance with sample collection has been provided by other Mackenzie Mountain School students including Aisla Phillips, Nigel Gregory and Bryson Rogers. Full-time team membership will increase this spring to oversee meteorology, ornithology and other areas of interest. All participants are required to record their observations about any wildlife encountered. Two recent examples include sighting reports submitted to the *Christmas Bird Count* and the *Great Backyard Bird Count* projects.

The team normally spends 5 or 6 hours every weekend on project tasks other than fieldwork. These include providing short presentations on topics relevant to their particular studies, literature research, laboratory exercises, and writing exams.

The presentations provide several benefits: (1) team members practice research skills during preparation, (2) a continual growth of the project's reference collection, (3) team members are informed about the progress and discoveries of others, and (4) team members can practice and perfect their presentation skills.

While individuals undertake research for their seminar presentations outside meeting times, at least an hour a week is devoted to catching up on pervious Bosworth Creek related research. The weir removal project for example, generated many documents from industry and government totalling hundreds of pages. No less is true for the Mackenzie Gas Project that has generated a number of habitat and other environmental assessments at or near the proposed Bosworth Creek crossing. In addition, the team must become competent with terminology and concepts particular to their individual fields of study. The project is continually adding to its literature inventory and time is specifically devoted at each meeting to review manuals, books and other papers.

Laboratory exercises include benthic identification using microscopes and taxonomic keys, testing water samples collected for pH and other physical properties, dissections and examinations of freshly killed or previously frozen minnows and their parasitic companions, becoming adept at equipment use and maintenance, adding to the project's herbarium collection through plant press and other forms of specimen preservation, and reviewing chemistry data generated by this project.

The exams are given about once a month and are challenging but provide obvious satisfaction when completed. These hypothetical problems are based on possible scenarios that the project may encounter (e.g., Figure 3) and the students must defend their conclusions in a seminar-type atmosphere. Exams help to keep the team focused, provide a means to track progress and identify areas that need improvement.

2006 Field Season

The 2006 field season began in July with basic fisheries training by DFO personnel. Techniques included channel transect profiling (Figure 4), live specimen captures using minnow traps (Figure 5), assessing basic river morphology (Figure 6), using a seine net (Figure 7), and collecting benthic invertebrates with a dip net (Figure 8).

Preliminary benthic invertebrate studies began in summer 2006 and samples were collected throughout winter for study whenever possible. These organisms are diverse and require a significant time investment for identification. However, considerable progress has been made and several key Families have been identified.

Water and sediment samples were also collected from a number of specific sites along the creek system. Subsequent monitoring will allow investigators to identify untoward changes in the creek's chemical health that can then be mitigated by appropriate authorities. Basic measurements and observations were recorded in one study area to track the changes in the physical properties of the creek bed over time. This snapshot of bedding substrate will be used to asses a number of potential and actual impacts on this section of the creek.

The state of aquatic and riparian vegetation is another focus of the project. Both forms of vegetation reflect habitat health and provide indications of contamination or disease. The riparian zone is essential for providing shade and nutrients to the aquatic community, as well as providing an ecological buffer zone from surrounding habitat. Aquatic vegetation acts as a nutrient resource for benthic organisms and is paramount in maintaining acceptable levels of dissolved oxygen.

Ornithology is a key component of the project. The team records all sightings and photographs unknown birds for later identification. A full-time team member will be added to oversee the avian component in spring 2007.

The Bosworth Creek Monitoring Project has endeavoured to create comprehensive inventories as part of the on-going NWT Cumulative Impact Monitoring Program (CIMP) Valued Component investigations. These inventories and other related data are far from complete. However, additional work this season will result in a better understanding of local plants and animals.

The diversity of information collected in this study and the limited observation periods require a set of data collection forms that capture as much information as possible and allow easy cross referencing of information between forms. Therefore, the project has developed a number of component specific data collection forms (Figure 9).

<u>Fishes and Parasites</u>

This project has documented four previously known Bosworth Creek fishes, two unknown forms of sculpin [*Cottus sp.*], and a large unidentified bottom feeder that was observed twice. The known specimens include lake chub [*Couesius plumbeus*], slimy sculpin [*Cottus cognatus*], arctic grayling [*Thymallus arcticus*], and emerald shiner [*Notropis atherinoides*] (Scott and Crossman 1998). These fishes were captured at different or overlapping times in the same general location. This suggests that other species will be identified in the 2007 summer season as the team will sample a greater number of fish habitats over a longer duration. The team has acquired the assistance of Dr. Erling Holm for species assessment. A number of specimens will be sent to Ottawa for visual and genetic identification and some specimens will be added to the Royal Ontario Museum's comparative collection.

Wildlife health is essential for human health and many of the kinds of fish that inhabit Bosworth Creek are common foods for northern residents. Therefore, assessing fish health is as vital as identifying the specimen. So far, the project has identified a significant occurrence of tapeworms in sculpin (Figure 10). A cursory examination suggests that these specimens belong to the genus *Triaenophorus* (Sterwart and Bernier 1999). A tumour-like growth was also observed on one sculpin (Figure 11). These and other pathologies will remain a focus of this study and their possible impacts on human health will be monitored throughout the life of the project.

Benthic Invertebrates

Benthic invertebrates are the most important aquatic biological component because they are efficient decomposers and primary producers (Voshell 2002). Preliminary sampling has so far identified blackflies (*Simulium sp.*), green stoneflies (*Sweltsa sp.*), water boatman (*Corixa sp.*), riffle beetles (*Narpus sp.*), and dragonflies (Family Libellulidae) due to a late start last summer. Refinement of literature-based identification skills over the last several months and on-site guidance by Dr. Douglas Currie this summer will elevate this component to a new level.

As most of these organisms remain active throughout the year, the team was able to study live specimens so long as samples could be collected through the ice or open water. The most practical retrieval system involved scooping mud and other substrate out with one's hand. While this technique is less rigorous than others, it nonetheless provides live specimens for study and identification over winter.

Chemistry

Sampling for water nutrients, routine factors, total metals, hydrocarbons and BTEX (benzene, toluene, ethylbenzene, and xylene) began in September, 2006. Other water testing parameters including chlorophyll A, Coliforms, biochemical oxygen demand, and Sulphide were added later in the season. Based on data obtained from this and other studies (IORVL 2005a, 2005b), the team has discovered that the creek has two kinds of water chemistry depending on the time of year. Summer water chemistry is influenced by a number of factors including snow pack melt, general run-off, and subsurface origin. Winter water chemistry is largely based on spring sources that occur throughout the channel's length, which account for a significant flow throughout the winter in many locations, often resulting in patches of open water and significant overflow events. It is therefore crucial for team members to be able to distinguish between seasonal chemistry fluctuations and changes due to other factors.

Sediments were sampled for hydrocarbons and metals. Most of these samples were obtained between November 2006 and February 2007 due to scheduling. This often required team members to work in harsh winter conditions typically averaging -35° C in addition to wind chills (Figure 12). Nevertheless, nineteen sites were sampled; eleven for sediments only, two for water only, four for water and sediments, and two ice samples that were tested for total metals and Sulphide; one from average river ice and the other from overflow. These data represent the most comprehensive chemistry baseline information on any creek in the Sahtu Settlement Area (Figure 13). Each location was chosen as either representative of specific geography or as monitoring points to assess natural or human produced impacts on the creek's chemistry. For example, the team has collected sediment samples that straddle the winter road, the Enbridge Pipelines (NW) Incorporated crossing, the proposed Mackenzie Gas Pipeline crossing route, the weir site, and areas of large erosion potential (Figure 14). This chemistry profile can be used to identify change and track its origin (e.g., Figure 15).

Streambed Morphology

This project is examining the morphological changes that occur in a 10 metre long, 36 metre wide section of creek habitat (Figure 16). Since changes in substrate spatial distribution are an indication of flow rate (McKee *et al.* 1967), the team will track changes that may occur in the positions of selected cobbles and boulders due to the influences of water and ice flows (e.g., Figure 17).

All Terrain Vehicles (ATV) are another influence on creek bed stability. These vehicles provide local enthusiasts with access to remote locations throughout the Bosworth Creek watershed. There are several points along the creek that are dedicated crossings where damage is evident but localized. These crossings must be maintained for local use and some interest has been expressed by DFO to mitigate current erosion at one of them. However, the team also observed many examples of ATV tire tracks running along the length of the creek (Figure 18). This traffic is the result of two factors; (1) the creek provides an easy access route for unskilled activists and (2) driving down the creek is a convenient way to wash vehicles at days end. The resulting damage to fisheries habitat by these vehicles is potentially significant and the team has launched an ambitious public education campaign in response. The team will seek to educate ATV users through printed material, word of mouth and local television. Informal discussions with local employers regarding this issue have been positive and may lead to corporate-sponsored support through education workshops and company memos. The intent is not to restrict local residents to recreation, but to limit access to environmentally sensitive areas along the creek's route.

Vegetation Studies

The creek's riparian zone is primarily dominated by black spruce (*Picea mariana*), white spruce (*Picea glauca*), Alaska birch (*Betula neoalaskana*), tamarack (*Larix laricina*), and a number of willow (*Salix*) species comprising the greatest percentage of shrubbery. There are also many other kinds of plants in this assemblage and the team will catalogue as many species as possible in the 2007 season, including their associations with surrounding geography and other vegetation. In addition, the team will take incremental cores from major tree species following Canada's National Forest Inventory Ground Sampling Guidelines (Jozsa 1988). Samples will be sent to the Canadian Forest Service Northern Forestry Centre where they will be analyzed for tree growth and wood quality. This affiliation not only benefits the Bosworth Creek project by providing expertise but also contributes original data to the National Forest Inventory.

Aquatic vegetation provides nutrients, shelter and oxygen to creek inhabitants. Since many organisms have limited ranges of tolerance for dissolved oxygen, the presence, abundance and types of aquatic vegetation limit the variation of species inhabiting the creek. Changes in vegetation and the organisms associated with their oxygen production could provide an early indication of various negative impacts to the creek system.

Bird Studies

There are many different avian microhabitats throughout the Bosworth Creek watershed. This project had begun preliminary vegetative studies that will aid in locating nesting bird locations this spring. Recently, a possible dipper over-wintering location was discovered during a water sampling expedition. This location will be observed over the next couple of months, as this bird has been seen in the area on a few rare occasions.

Discussion is currently underway with the Canadian Wildlife Service regarding the acquisition of an avian-recording monitor system. This apparatus would be placed well upstream away from human activity and would record bird songs by a sound activated microphone.

The project team contributed to the *Christmas Bird Count* and the *Great Backyard Bird Count* projects in 2006. These observations recorded information from previously under-represented local habitat. Additional spotters will be recruited next year so that more territory can be covered.

Valued Components

This project has made significant progress with its initial investigations into aspects of all NWT CIMP Valued Components originally targeted. These include Water and Sediment Quality; Fish Quality; Fish Habitat, Populations, and Harvest; Birds; and Vegetation. Previously unknown baseline information on these and other disciplines related to the Valued Components have been collected throughout the 2006 season. Further additions to these inventories will be made throughout the 2007 season including Snow, Ground Ice and Permafrost. This Valued Component is currently being studied throughout the North and is of interest to the team for a number of reasons including snow quality data, snow cover thickness data, and duration of pack and melt rate. These and other snow related parameters ultimately influence the stability and diversity of the creek. The Bosworth Creek Monitoring Project will begin snow studies this winter using sampling protocol developed by Tracy Hillis, Bob Sharpe, Peter Kershaw and GLOBE Canada. This methodology is standardized throughout the three territories and the team will build upon earlier work done by teachers and students from Mackenzie Mountain School.

Public Education and Project Promotion

Public education and project promotion are indispensable components. Two articles on the project's progress have appeared in the Sahtu Renewable Resources Board Newsletters (Guthrie 2006a, 2006b) and stories about the project have appeared in News/North (Curran 2007; Goline 2006; Hodgson-McCauley 2007). A presentation was facilitated by Yvonne and Mark Meulenbroek at Mackenzie Mountain School on December 4, 2006 (Figure 19). The topics included fish, parasites and chemistry and were presented to every high school student during the afternoon, followed by a public presentation. In addition to the lectures, a large static display of project equipment and literature was made available so that students and others were able to learn about the kinds of tools used in this project. Two large posters were created with the assistance of Regional GNWT ENR staff that portrays field work and local wildlife (Figure 20). These topics formed the basis for Science Fair projects presented at the Regional competition in Norman Wells March 1-3, 2007. Mark Meulenbroek presented original chemistry data from the project focusing on outliers obtained at one of the sample locations (Figure 21). The presentation by Yvonne Meulenbroek focused on parasites in fish and their relation to human health (Figure 22), and is one of three projects from the Sahtu Settlement Area chosen to compete at the National Science Fair in Turo, Nova Scotia, May 2007.

Another aspect of public education is being developed by the team in response to ATV damage to the creek bed. A public information campaign will seek to educate local ATV users about the impact their activities have on creek habitat health through print and other forms of media.

Finally, the team will host the senior high school students early this summer for an afternoon of creek habitat workshops. The team will demonstrate minnow trapping, seine netting, and transect modelling, as well as a seminar on bear safety.

Project Support and Acknowledgments

The Bosworth Creek Monitoring Project was created by and is facilitated through the Sahtu Renewable Resources Board. This community youth education project has expanded well beyond its initial intent. The potential impacts from any number of industrial and natural disturbances have made it necessary to broaden the range of research. This has been made possible through significant commitments by a number of organizations, agencies and individuals who have provided assistance through financial and other means.

Principal funding and in-kind support was provided by the Sahtu Renewable Resources Board, NWT Cumulative Impact Monitoring Program, Indian and Northern Affairs Canada Pipeline Readiness Office, Department of Fisheries and Oceans Canada, Government of the Northwest Territories Department of Environment and Natural Resources, Indian and Northern Affairs Canada Taiga Environmental Laboratories, Canadian Helicopters, and Canadian North Cargo (Figure 23).

Individual contributions provided essential local support. The GNWT Regional Office of the Department of Environment and Natural Resources assisted with several key areas of study and the project would like to thank Keith Hickling, Superintendent of Wildlife; Alasdair Veitch, Wildlife Supervisor; Richard Popko; Wildlife Technician, James Auld, GIS Specialist; Boyan Tracz, Cumulative Effect Biologist; Mike Bly, GIS Technician; and Paul Rivard, Forestry Supervisor for their invaluable contributions. Finally, I would like to thank Jody Snortland, Executive Director of the Sahtu Renewable Resources Board for her ongoing support throughout this project.

Summary

The Bosworth Creek Monitoring Project was created to answer some basic questions: Will fish that were previously unable to enter Bosworth Creek due to the weir, be able to do so now that the barrier has been removed and if so, how long will it take? While these appear to be simple questions on the surface, it became apparent that long-term monitoring and in-depth study of the creek system were required to supplement the current baseline habitat inventories and monitor the influences of industrial and natural processes.

Several cursory studies by MGP proponents looked at portions of the creek in August and September 2002 (IORVL 2005a, 2005b). These types of studies capture important information but do not (1) account for microhabitats beyond the range of limited geographic study, (2) provide information about year-round habitat health and prosperity, (3) provide a complete inventory of the waterway's inhabitants or (4) provide information about overwintering microhabitats.

Recent work by Mochnacz (2006) has demonstrated the important contributions provided by many small waterways along the pipeline route in the Sahtu Settlement Area. They offer suitable habitat for spawning, rearing and in some cases, overwintering in waterways that remain active throughout the year. These habitats provide refuge for many species including sculpin and whitefish and require further study to assess their importance to other types of fish.

The restoration of the creek bed downstream from the weir site appears to be very stable and successful. The occurrence of arctic grayling upstream from the weir site probably indicates migration from the Mackenzie River. This issue will be addressed over the following field season. The principal area of concern is a large silty mud deposit on the right bank upstream from the weir site. These sediments (Bottom of Figure 2) resulted from the annual deposition of silt and sand that would have normally been transported into the Mackenzie River. Flow reclamation resulted in a channel with at least a 0.5 metre thick mud floor situated approximately 3 metres below the top of the exposed deposits. While much of these deposits are stabilized by natural vegetation, the exposed sediments are in danger of rapid erosion. This could negatively impact downstream spawning habitat. Therefore, the team will monitor the erosional process and assess whether mitigation is necessary. As this process is natural and inevitable, bank stabilization would only require planting willow or grass species, thereby slowing the process to a rate manageable by habitat occupants.

The Bosworth Creek Monitoring Project has exceeded the study's initial expectations. Baseline chemistry data has been obtained for most major areas of concern, fisheries habitat training and other professional development has and will continue to be delivered by qualified instructors, and team members have made notable contributions to science. The addition of full-time team members this spring will further increase project productivity. Moreover, continued support by sponsors and others will allow this one-of-a-kind project to make serious contributions to environmental protection, the scientific community, and the futures of team members.

The Bosworth Creek Monitoring Project 2006/2007 field season operated under Aurora Research Institute Licence # 14026N and DFO Licence EDU-06/07-213 (Bosworth Creek). The 2007/2008 field season will operate under Aurora Research Institute Licence # 14113R and DFO Licences EDU-07/08-2000-HR (Bosworth Creek) and EDU-07/08-2001-HR (Hodgson Lake).

Work Plan for 2007 Summer Field Season: <u>June – September</u>

(April - June 2007)
Sediment collection from four additional sites (PRO 13, 14, 15, 16)
Continued weekly meetings

<u>June - Field Season Begins</u>
Unit One substrate assessment (1st)
Repeat sediment collection from PRO 3 and three additional random samples (PRO 3a, PRO 3b, and PRO 3c) that encircle PRO 3
Water collection from MGP A02-22 site
Water collection from Jackfish (Hodgson) Lake
Water collection from Unit One
High resolution aerial survey
Field Workshop: benthic invertebrate studies with Doug Currie, ROM, (11th to 15th)
Field Workshop: first follow-up session on fish collection techniques and streambed profile mapping with Briar Young and Peter Brunette, DFO Yellowknife

<u>July</u>
Unit One substrate assessment (1st)
Field Workshop: benthic invertebrates with Anna Swisterski, University of Windsor
Lab Workshop: benthic invertebrates with Anna Swisterski, University of Windsor
Field Workshop: amphibians with Danna Schock, Detroit Zoo
High resolution aerial survey
Benthic collections from Jackfish (Hodgson) Lake
Field Workshop: geology and sedimentology with Walt Humphries, NWT Mining Heritage Society

<u>August</u>
Unit One substrate assessment (1st)
Fieldtrip: Walk the creek from the Mackenzie River to Jackfish (Hodgson) Lake
Field Workshop: second follow-up session on fish collection techniques and streambed profile mapping with Briar Young and Peter Brunette, DFO Yellowknife
High resolution aerial survey
Field Workshop: benthic invertebrates with Anna Swisterski, University of Windsor
Lab Workshop: benthic invertebrates with Anna Swisterski, University of Windsor

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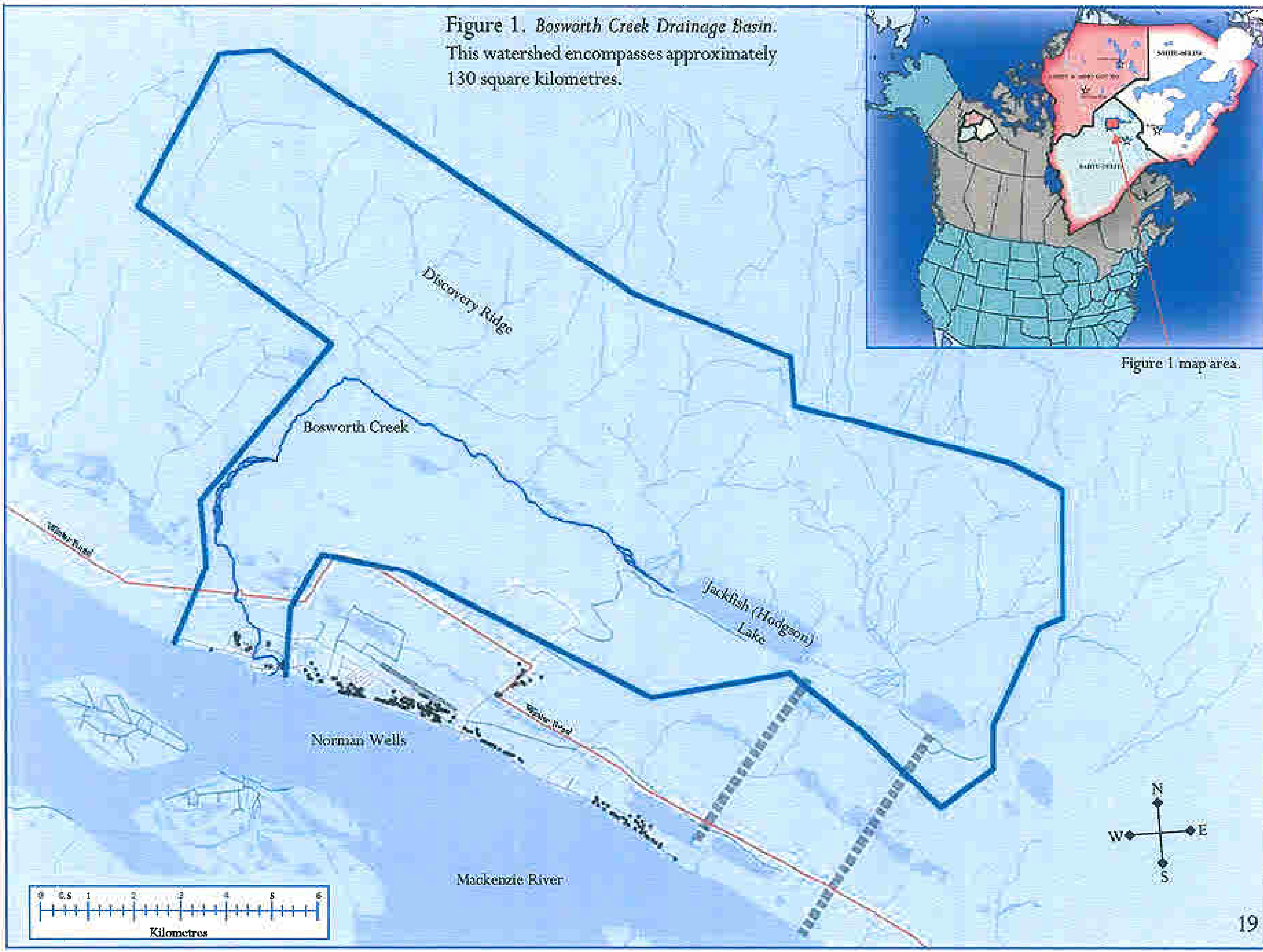


Figure 1. *Bosworth Creek Drainage Basin.* This watershed encompasses approximately 130 square kilometres.

Figure 2. *Imperial Oil Weir Site.* The demand for water to run a steam generated electrical plant resulted in the construction of a weir in 1960 (Hodgson pers comm. 2006). The weir was built at the site of an existing bridge (below) near the Mackenzie River. The pond that was created behind the weir provided Imperial Oil with water for power and the Town of Norman Wells with drinking water. The weir was removed in the summer of 2005 by Imperial Oil who undertook extensive restoration.

The weir at the lower bridge (above) before 2005. Photo courtesy of Imperial Oil Resources Limited.

The lower bridge following removal of the weir in 2005 (above). Successful restoration of downstream habitat. Photo courtesy of Imperial Oil Resources Ltd.

The lower bridge (above) after removal of the weir.

The weir impeded the natural flow of water and created a pond upstream. This led to an accumulation of silty sand that would have normally been transported into the Mackenzie River. Removal of the weir has re-established natural flow. The gray sediments (left) are the remains of the accumulated material. These deposits are a source of concern as rapid erosion may impact habitat downstream.

..gure 3. *Testing.*

Test 8 - March 4, 2007

Problem #1

The Law of Superposition describes how sediments are deposited in a vertical sequence over time with the oldest at the bottom and the youngest at the top. This law assumes that objects or sediments that are being deposited on top of each other are not the products of previous depositional events that have undergone erosion and are being re-buried.

We just used a long coring tool to collect a sedimentary log from the giant bank of fine-grained silt up-stream from the Lower Bridge (sample site U 2; where we placed all the flags to track erosion). This sedimentary log represents approximately 45 years of seasonal deposition that began with the construction of the weir in 1960 until its removal in 2005. We are assuming that the first five years reflect what was happening before the weir was built.

There are three types of clams in this sedimentary record (A, B, and C).
They all eat the same thing.

(1) What appears to have happened to the original populations following construction of the weir?
(2) What seems to be going on between 1985 and 2005?
(3) Why did Clam A become so abundant until 1985?
(4) What is the probable explanation for **b** occurring between 1990 and 1995?
(5) Which Clam is a competitively pervasive species?
(6) Bonus Question: For 1,000,000 points, what is the most basic question raised by these data? The answer or answers to this question are irrelevant at this time. Ask the question.

2005–2000	C C C C **A** C
2000–1995	C C C A C C
1995–1990	C C A A C **b**
1990–1985	A C A A A A
1985–1980	A A A A A A
1980–1975	A A A A A A
1975–1970	A A A B A A
1970–1965	A B A A B A
1965–1960	A B A B A B

Stratigraphic Log divided into arbitrary five year intervals.

A, B, C = 100 clams each.
A = 50 A clams
b = 1 B clam.

Problem #2

Mark has been diligently testing Unit One water quality and chemistry for three years at PRO 4. There has been no change in pH or any other chemistry except dissolved oxygen. Yvonne has also noticed a change in the types of fish that are caught in Unit One. Species that typically live in lower oxygen environments have been replaced.

(1) What's going on and why?

Figure 4. Mark Meulenbroek determining a slope angle with a Clinometer.

Figure 5. Yvonne Meulenbroek setting a minnow trap.

Figure 6. DFO Biologists Briar Young and Peter Brunette teach the team how to assess creek bed morphology based on the size and composition of the substrate.

Figure 7. Yvonne and Mark Meulenbroek using a seine net. Aisla Philips collected the specimens while Peter Brunette (DFO) oversaw the exercise.

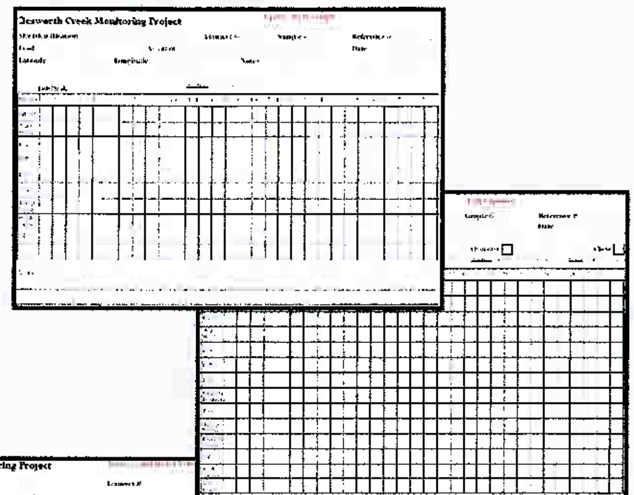
Figure 8. Briar Young (DFO) teaches Yvonne Meulenbroek and Aisla Philips how to use a dip net.

Figure 9. *Field Data Collection Forms.*

The Bosworth Creek Monitoring Program necessitates significant data collection in a number of different fields. The team currently employs seven forms that are designed to record the maximum amount of information and allow easy cross referencing between different components of the study.

Forms

Fish Captures
Aquatic Plants Sample
Channel Profile and Slope
Transect and Water Velocity
Channel Substrates and Sediments
Benthic Macroinvertebrate Sample
Riparian Zone Vegetative Composition



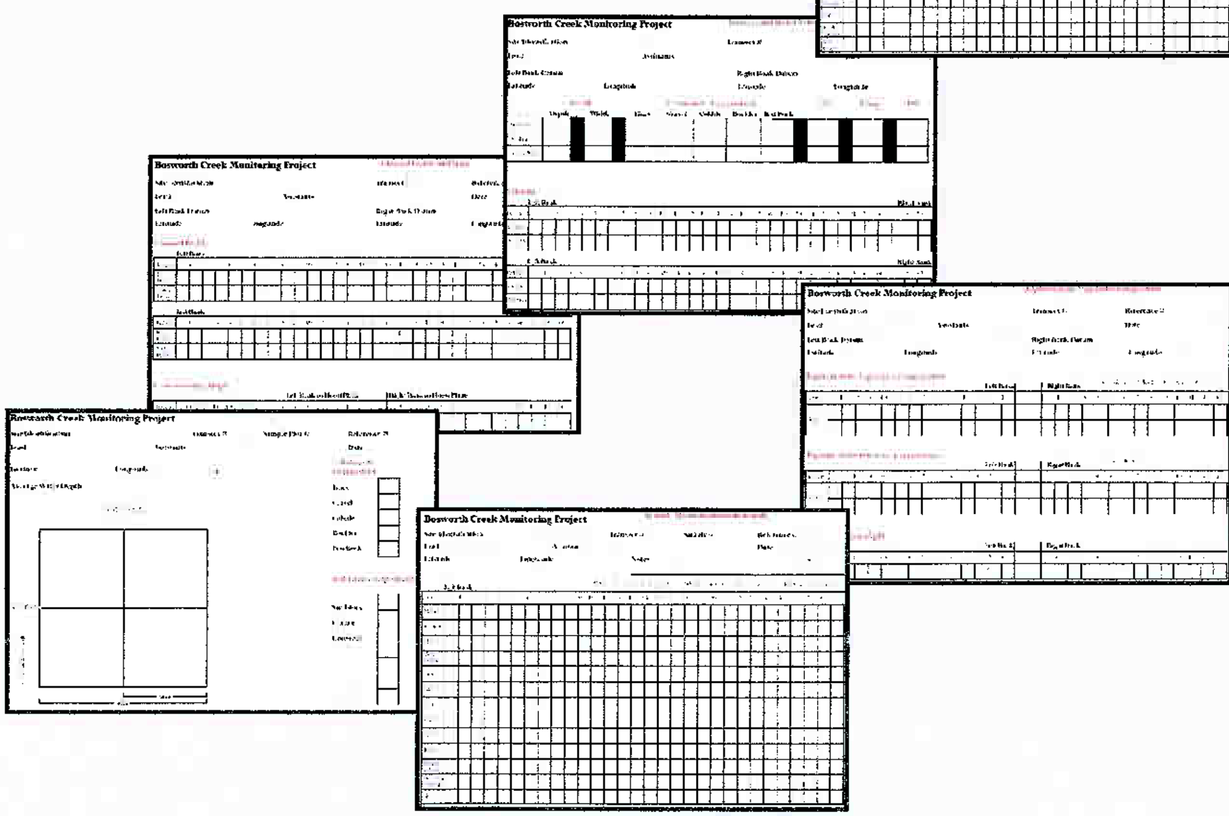
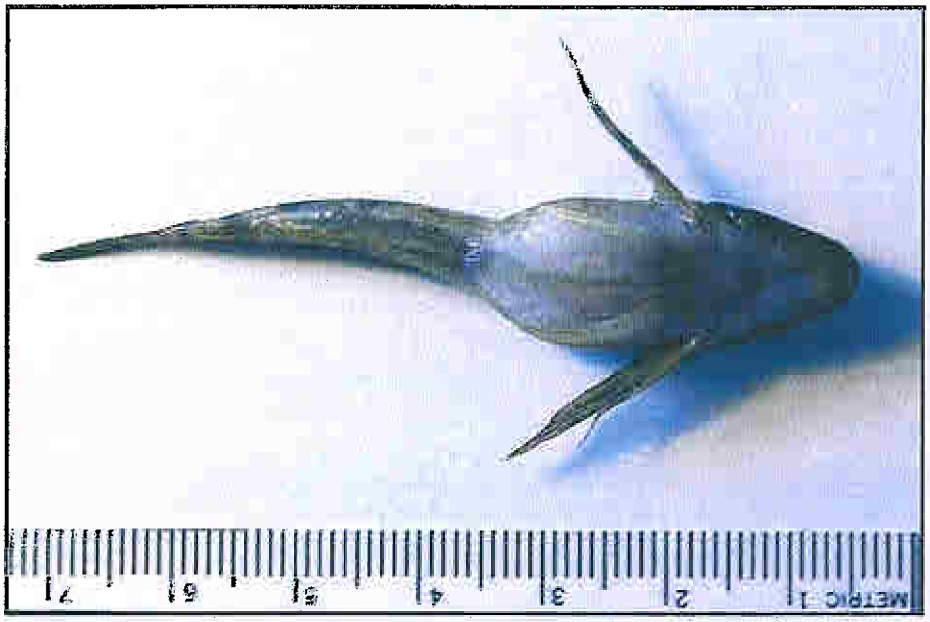


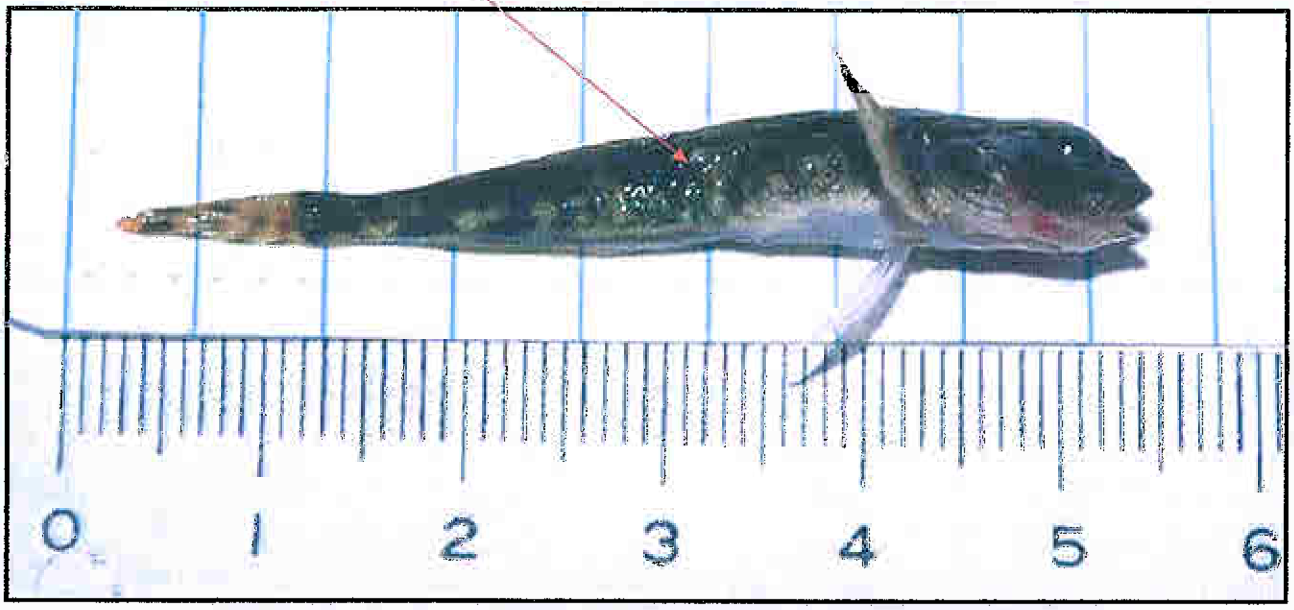
Figure 10. *Tapeworm in Sculpin.*



The sculpin above is typical of many that were observed to have distended abdomens.

Dissection revealed a tapeworm (above) measuring more than 3 centimetres longer than the fish.

Figure 11. *Tumour-like Pathology.*



This sculpin from Bosworth Creek exhibited a tumour-like protrusion on its right lateral aspect. Freshwater fishes in the Northwest Territories are susceptible to a number of diseases, many of which lack detailed study (Stewart and Bernier 1999). Although this pathology is similar to Lymphocystis, the diagnosis remains unconfirmed.

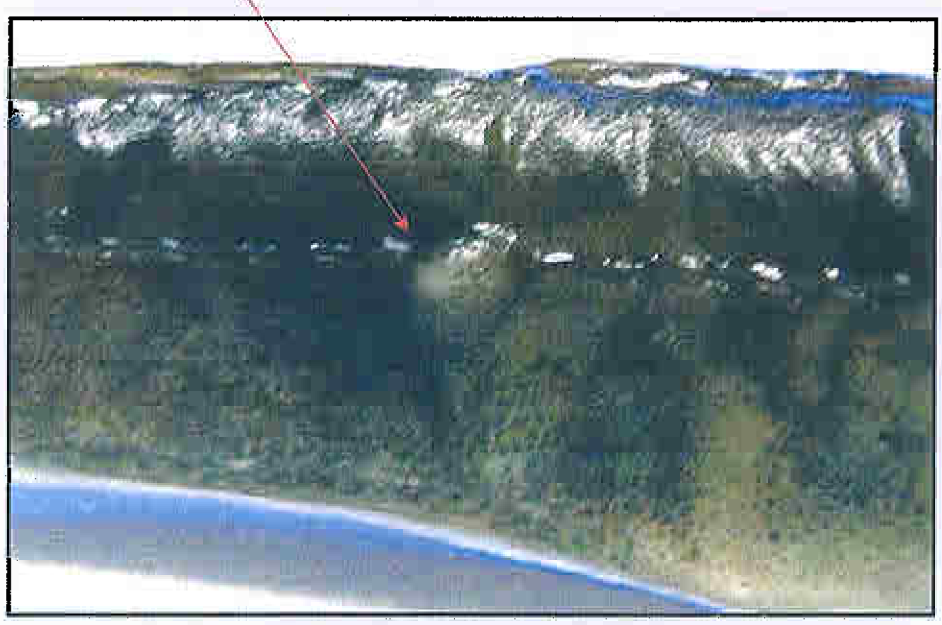
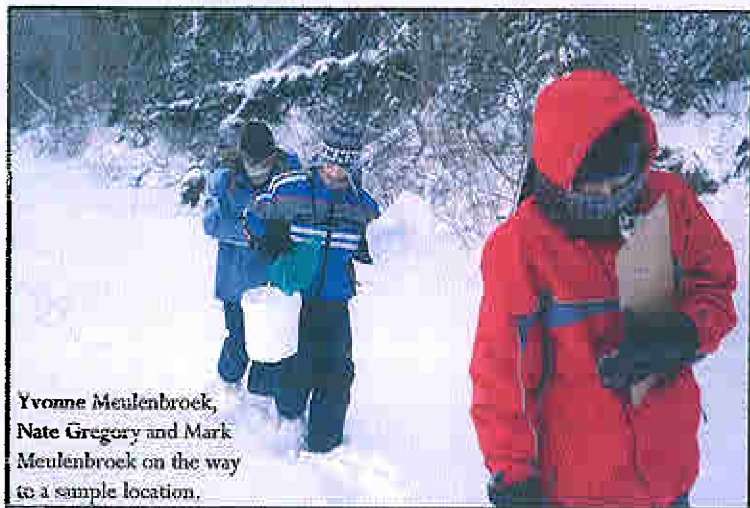
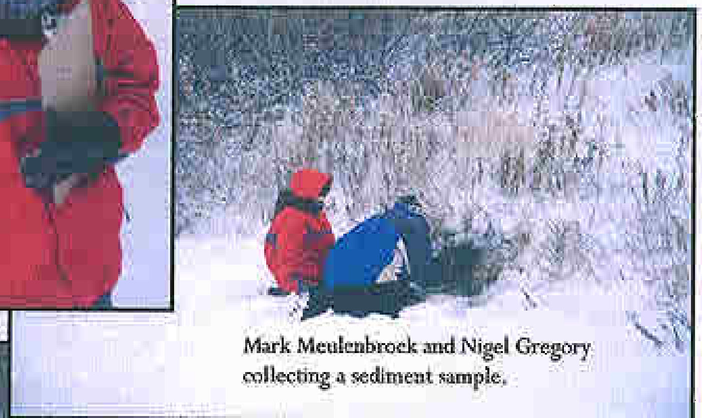


Figure 12. *Sub-Zero Fieldwork.*

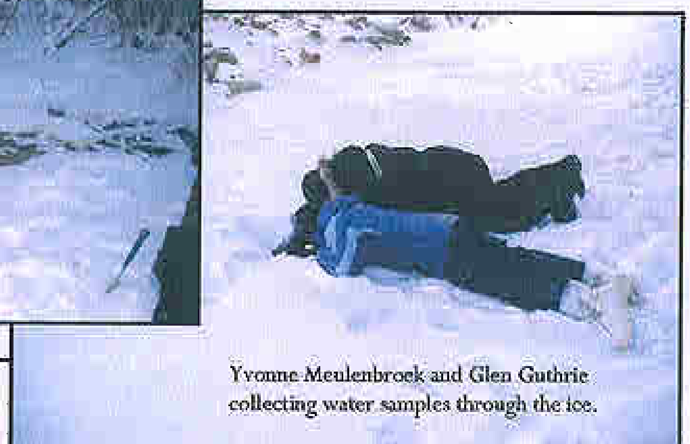


Yvonne Meulenbroek, Nate Gregory and Mark Meulenbroek on the way to a sample location.



Mark Meulenbroek and Nigel Gregory collecting a sediment sample.

Glen Guthrie (SRRB) collecting a benthic sample.



Yvonne Meulenbroek and Glen Guthrie collecting water samples through the ice.

Mark Meulenbroek collecting samples of overflow ice for metals analyses.

Collecting water, ice and sediment samples in mid-winter requires lots of energy and warm clothing. Some sites had to be accessed by long walks and sediment samples could only be collected after chipping them out with a rock hammer. Water samples were collected after making a hole in the ice or retrieved from a natural opening. Air temperatures ranged between -20° and -38° C. Wind chills frequently exceeded -40° C.

Figure 13. *Bosworth Creek sample locations.*
(March 31, 2007)

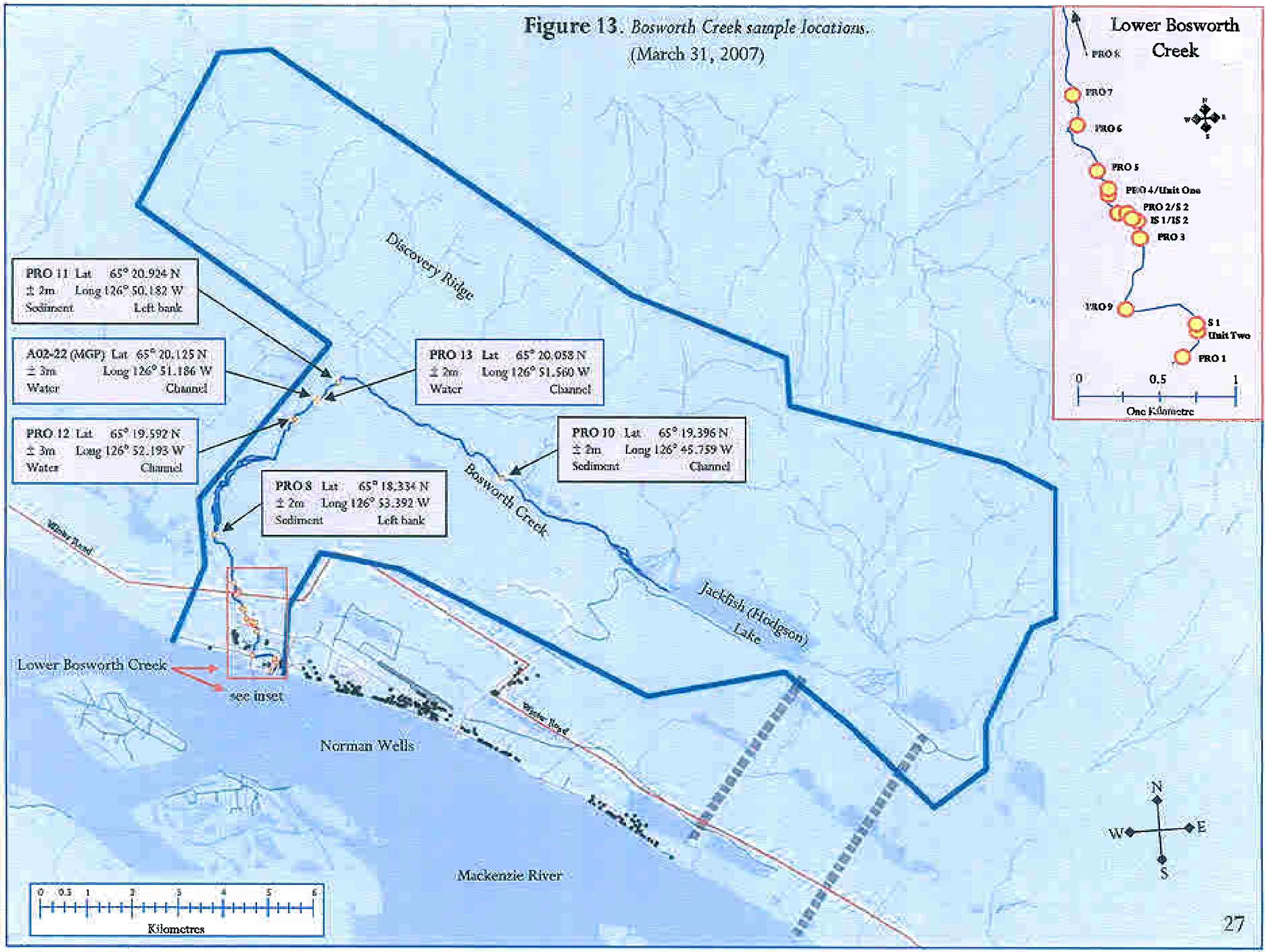


Figure 14. *Lower Bosworth Creek sample locations.*

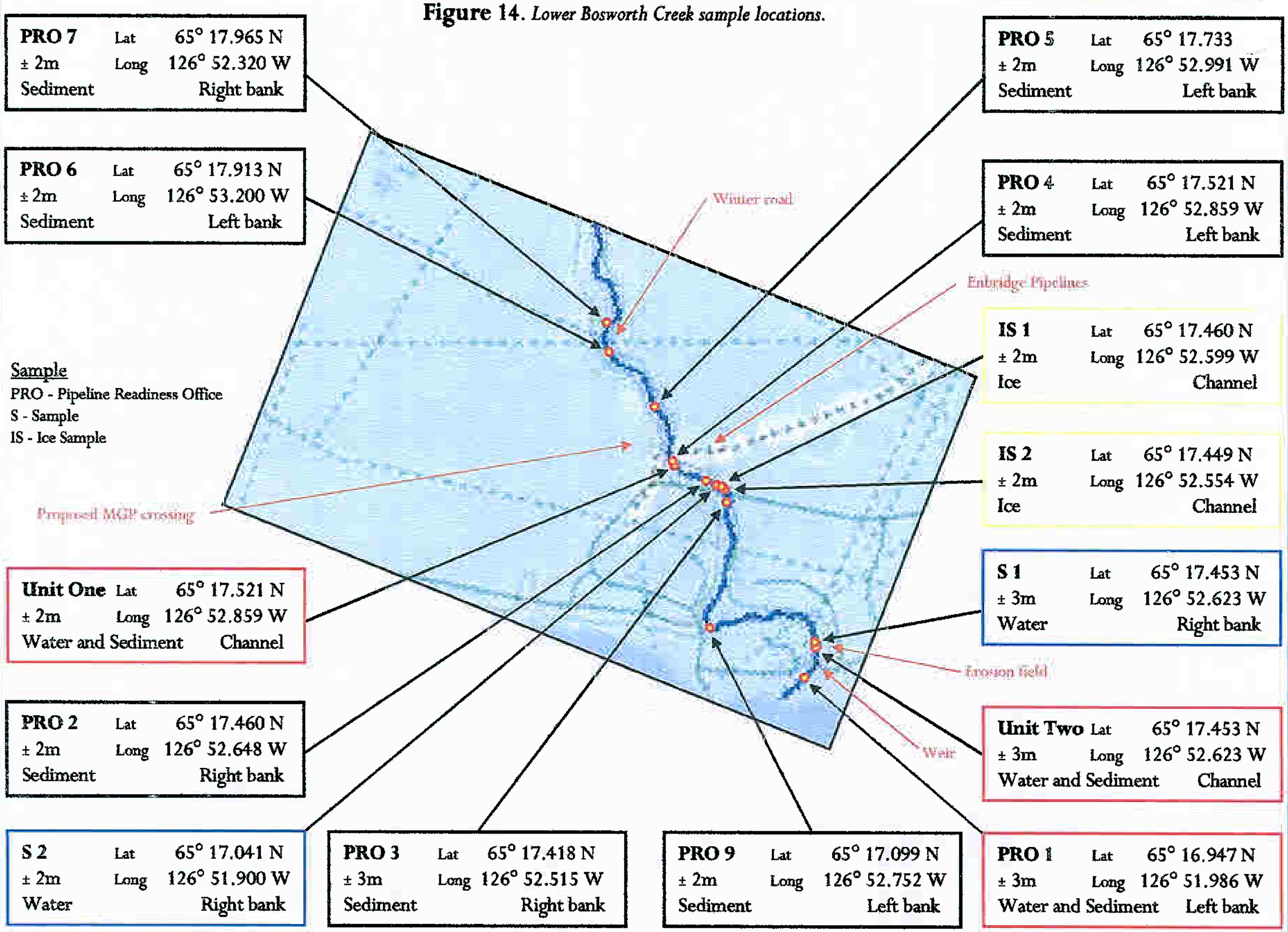
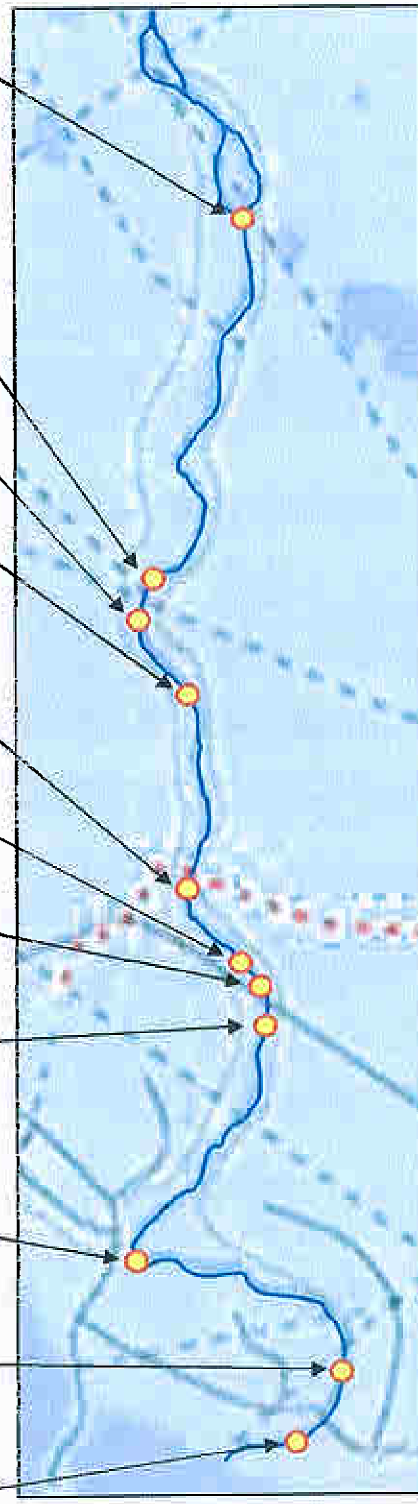


Figure 15. *Metals in Sediments.*



PRO 8	(µg/g)		(µg/g)
Manganese	287	Phosphorous	320
Mercury	0.07	Selenium	< 0.3
Molybdenum	1	Silicon	580

PRO 7	(µg/g)		(µg/g)
Manganese	309	Phosphorous	220
Mercury	0.04	Selenium	0.4
Molybdenum	2	Silicon	730

PRO 6	(µg/g)		(µg/g)
Manganese	342	Phosphorous	180
Mercury	0.03	Selenium	0.8
Molybdenum	2	Silicon	750

PRO 5	(µg/g)		(µg/g)
Manganese	363	Phosphorous	330
Mercury	0.06	Selenium	< 0.3
Molybdenum	< 1	Silicon	420

PRO 4	(µg/g)		(µg/g)
Manganese	358	Phosphorous	200
Mercury	0.04	Selenium	0.4
Molybdenum	2	Silicon	530

PRO 2	(µg/g)		(µg/g)
Manganese	604	Phosphorous	140
Mercury	0.05	Selenium	1.2
Molybdenum	7	Silicon	750

U 1	(µg/g)		(µg/g)
Manganese	450	Phosphorous	390
Mercury	0.04	Selenium	0.6
Molybdenum	2	Silicon	350

PRO 3	(µg/g)		(µg/g)
Manganese	144	Phosphorous	40
Mercury	0.02	Selenium	0.4
Molybdenum	3	Silicon	560

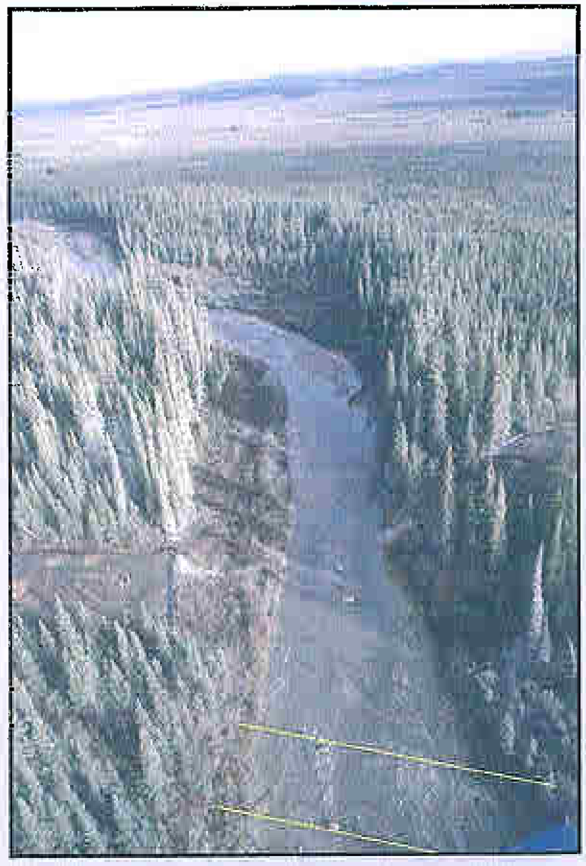
PRO 9	(µg/g)		(µg/g)
Manganese	446	Phosphorous	270
Mercury	0.4	Selenium	0.4
Molybdenum	1	Silicon	630

U 2	(µg/g)		(µg/g)
Manganese	389	Phosphorous	390
Mercury	0.04	Selenium	0.5
Molybdenum	1	Silicon	400

PRO 1	(µg/g)		(µg/g)
Manganese	379	Phosphorous	280
Mercury	0.04	Selenium	0.6
Molybdenum	5	Silicon	1120

Figure 16. *Unit One Study Area.*

Bosworth Creek Unit One study area (right) near the Enbridge Pipelines (NW) Incorporated crossing looking north. The yellow lines denote the ground position of the 10 X 36 metre study section.



Unit One 360 square metre creek bed study site (below). This study will enable the team to track changes in creek bed morphology by plotting changes in the positions of selected cobbles and boulders. Percent surface areas of coverage were calculated for fines and gravels in August 2006 and will be compared to Unit One's coverage on June 1st, July 1st and August 1st 2007. This will provide an indication of sediment distribution and re-modeling following break-up.

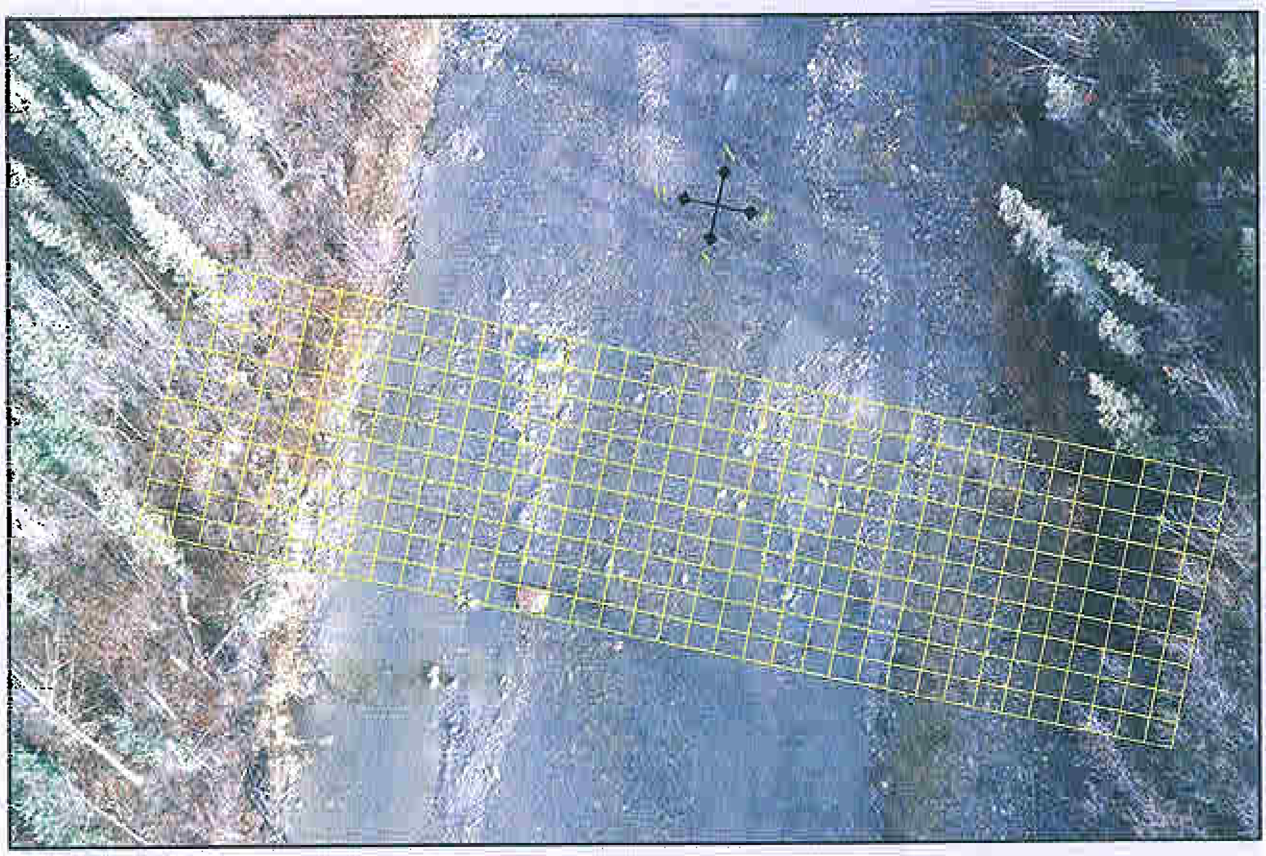


Figure 17. *Erosion and Deposition.* Positional measurements of selected cobbles and boulders. Distances to datum points on the bank and between targets will allow the team to track changes that may occur in relative positions of creek bed materials over time.

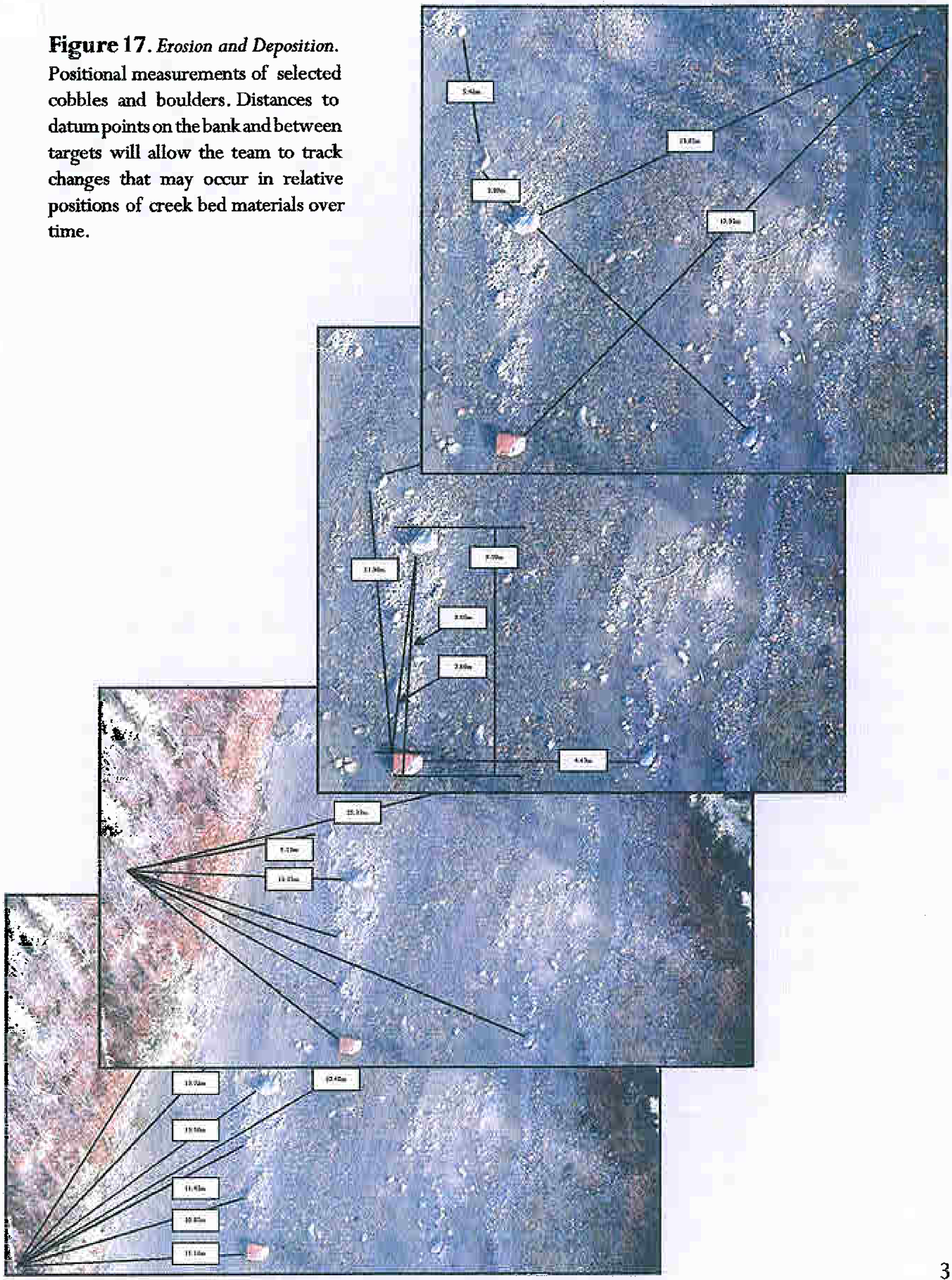


Figure 18. *All Terrain Vehicle Tracks.*

All Terrain Vehicle exploration of back country by local enthusiasts is a popular recreational pastime during the summer months. There are several trails and seismic lines that parallel portions of the creek along with permanent crossings. However, some local residents use the creek as an easy access to and from town. These drivers introduce foreign materials into the creek system and alter creek bed morphology. Both factors are detrimental to creek inhabitants.

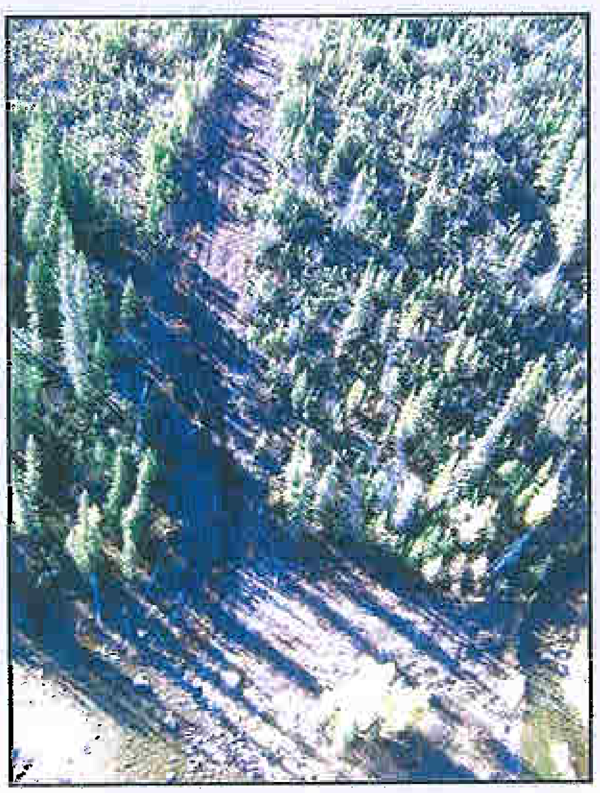


Figure 19. *Presentation Handout.*

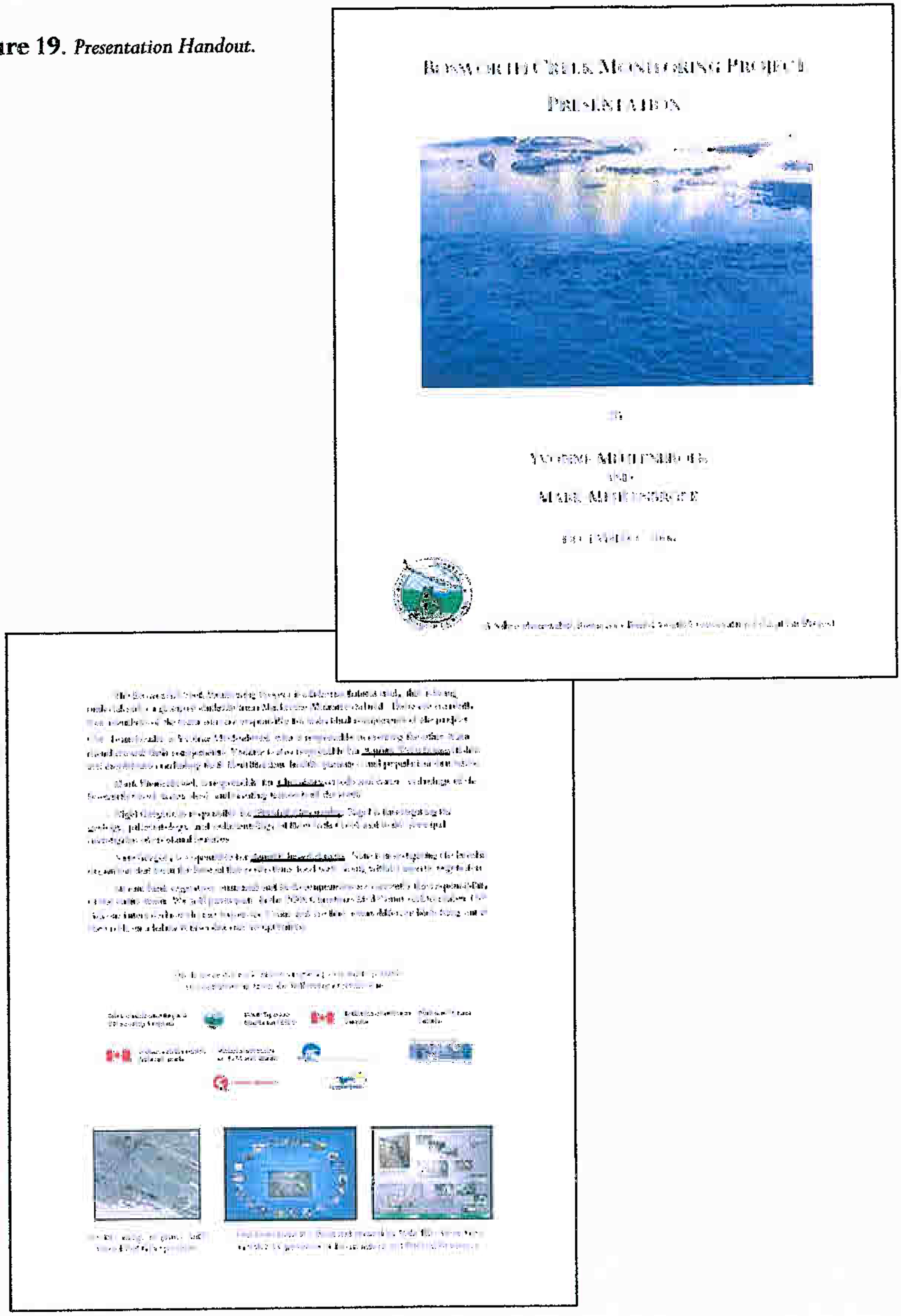
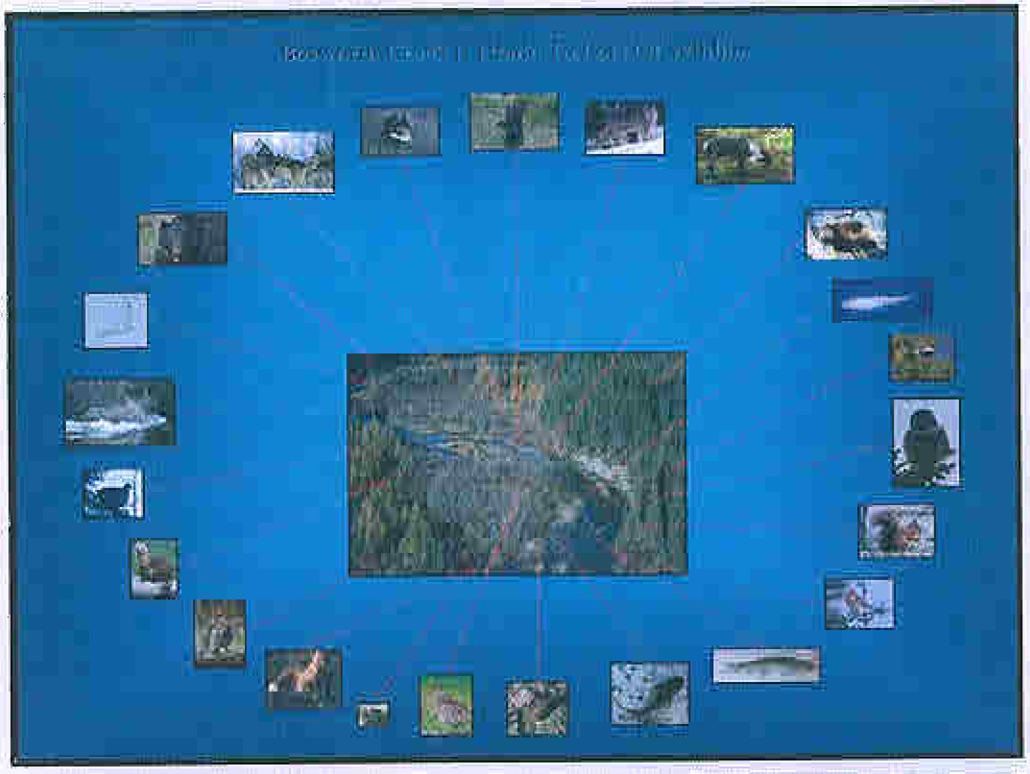


Figure 20. *School Presentation Posters.* Mackenzie Mountain School, December 4, 2006. Printings by Mike Bly, GNWT ENR.



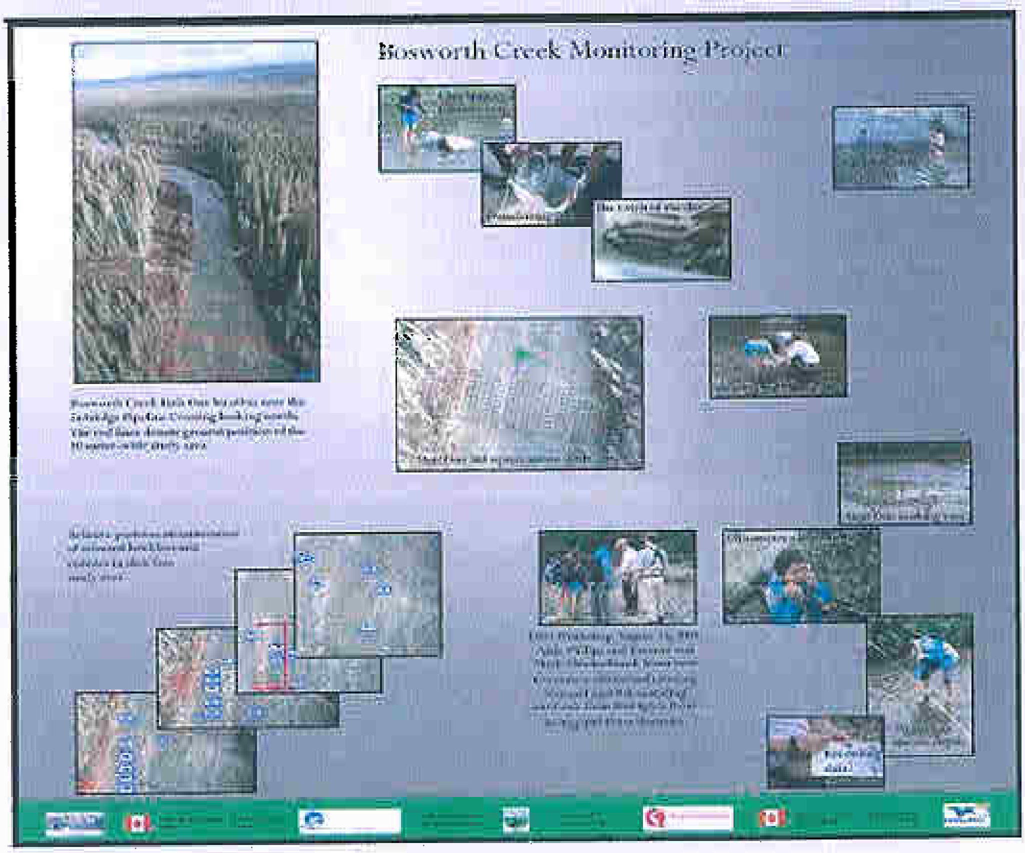


Figure 21. *2007 Regional Science Fair*. Project by Mark Meulenbroek. *Statistical Outliers?* addressed an actual example of outlier data from Bosworth Creek. Calcium is one of two metals that exhibit significant changes in abundance at one site. Mark demonstrated that the relative abundance of other metals can be more easily understood by removing the outliers and addressing them separately. Since the relative abundance of other metals are unaffected, these data may indicate actual contamination of the site. Follow-up sampling will hopefully resolved this issue.

Figure 22. *2007 Regional Science Fair*. Project by Yvonne Meulenbroek. *Parasitic Contamination* demonstrated actual laboratory procedures with fishes and parasites from Bosworth Creek. Her project performed analyses and drew conclusions based on her results using the scientific method. Yvonne will enter this project in the Canada-Wide Science Fair in Turo, Nova Scotia, May 2007.

Figure 23. *Our Sponsors.*

Bosworth Creek Monitoring Project

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