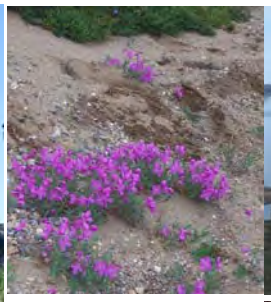
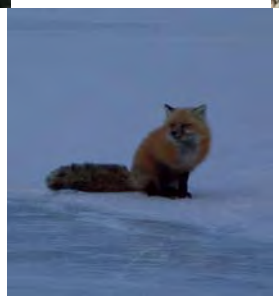
Annual Report
of
Research and Monitoring
In
Torngat Mountains National Park

2008

Parks Canada Parcs Canada

Canada

Many people contributed to this report.
We wish to acknowledge them for their commitment to the project,
and their timely submission of reports.

ACKNOWLEDGEMENTS

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Natural Resources Canada Research

MONITORING

INTRODUCTION

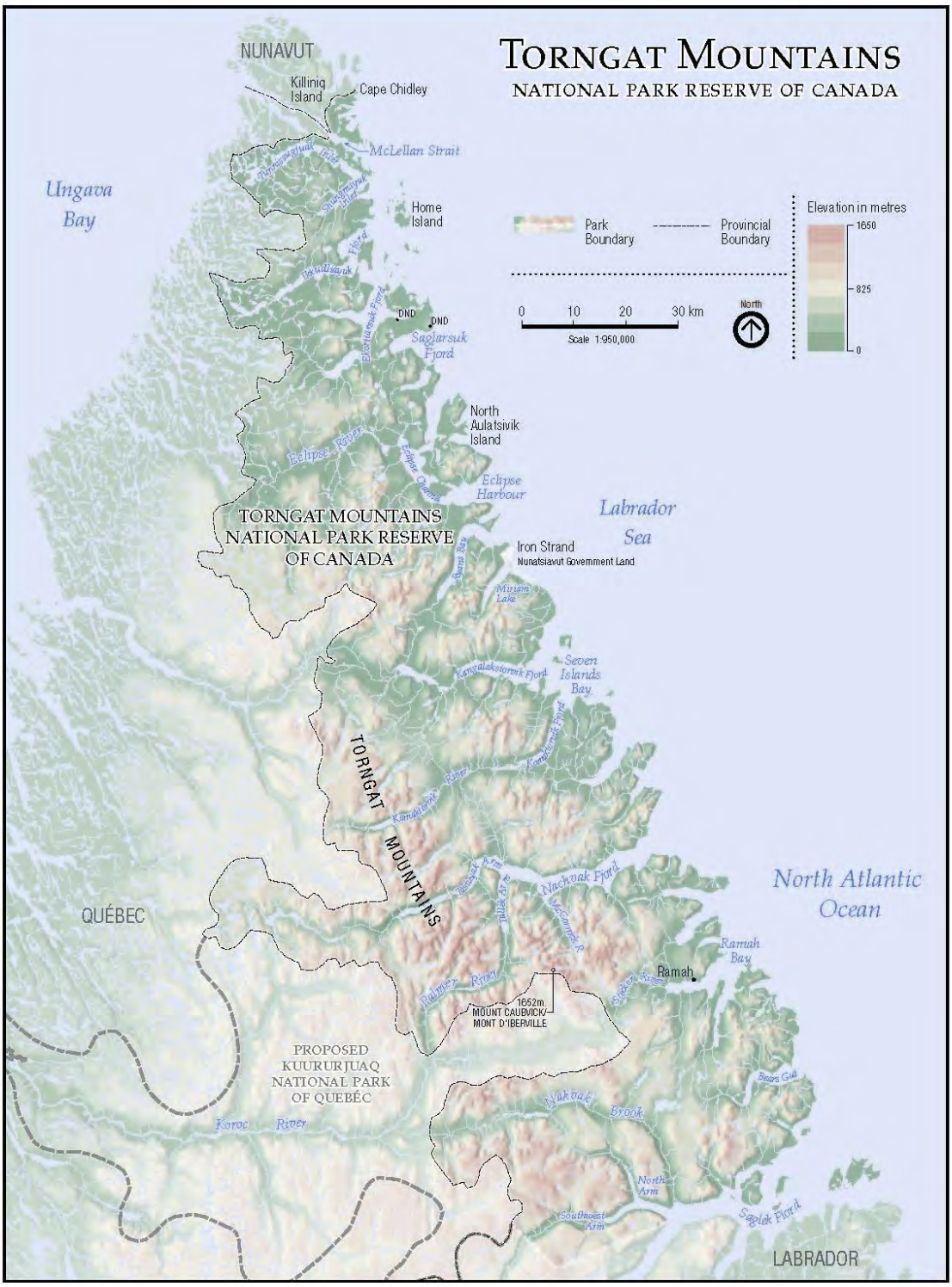
Research and monitoring are essential for managing protected heritage areas such as Canadian National Parks. Research activities are conducted to improve our basic understanding of cultural and ecological resources. Monitoring is conducted to document how these cultural-ecological systems change over time, especially in response to human activities and climate change. The information research and monitoring programs generate is vital for measuring the success of management actions and improving future activities, and also for allowing open and informative reporting on the state of the park.

A major challenge to implementing an effective research and monitoring program is making the resulting information widely available and accessible to people outside the science program. Consequently, the purpose of this document is to present a summary of research projects and monitoring programs conducted in the park in 2008 to the Torngat Mountains National Park Cooperative Management Board, to other cooperative management organizations in Nunatsiavut and Nunavik, to government agencies, and to the general public and Parks Canada staff. All research and monitoring activities undertaken in 2008 are included in this document, and key findings and accomplishments are summarized.

This document is divided into two main sections: **Research** and **Monitoring**. Projects in the research section are divided into four categories based on the principal affiliation of the researchers as well as their primary source of funding. These four categories are:

- Parks Canada Research
- ArcticNet Research
- International Polar Year Research
- Natural Resources Canada Research

We hope that this report serves as an informative synopsis of the current research and monitoring program in Torngat Mountains National Park of Canada. We welcome any feedback, and encourage interested readers to contact us for further details on specific projects or to become involved in the research and monitoring program.



Torngat Mountains National Park in Northern Nunatsiavut, Labrador

REPORTING ON RESEARCH AND MONITORING

Torngat Mountains National Park of Canada is a new park that is still in the early phases of program development. It was established in 2005 through the signing of the Labrador Inuit Land Claims Agreement and is managed in partnership with Inuit through Park Impacts and Benefits Agreements (PIBA) signed with both Labrador and Nunavik Inuit. These agreements provide a blueprint for park management, and in particular call for the development of a research and monitoring program. Direction for establishing and supporting this program in Torngat Mountains National Park comes from a number of sources.

First and foremost, consultation and collaboration are central to developing an effective research and monitoring program for the park. Both the Labrador Inuit PIBA and Nunvik Inuit PIBA require consultation with a variety of research and land management organizations during the development of a research strategy. These institutions include:

- Torngat Mountains National Park Cooperative Management Board;
- Nunasiavut Government;
- Makivik Corporation and any Makivik Designated Organization;
- Torngat Wildlife and Plant Co-Management Board;
- Torngat Fisheries Co-Management Board;
- Torngasok Cultural Institute;
- Government of Newfoundland and Labrador;
- Other institutions the Field Unit Superintendent deems appropriate.

The research strategy sets out the methods that will be used to gather social, cultural and ecological information about the park and will include five components: a traditional knowledge component; an ecosystem component; an ecological monitoring component; a threat specific component; and a communications component. The research strategy will identify research priorities for the park, guide future research and monitoring, inform the State of the Park Reporting and Management Planning processes, and ensure consistency with regional research priorities in Nunatsiavut and Nunavik.

At the national level, the Canada National Parks Act identifies the “maintenance or restoration of ecological integrity through the protection of natural resources and natural processes, as the first priority when considering all aspects of the management of parks.” Accordingly, research is needed to provide a detailed understanding of the natural resources and processes of the park. National parks provide a unique opportunity for researchers to study in relatively natural landscapes free from intensive land use. As such, parks are valuable “laboratories” for learning and research and are ideal for supporting effective education and outreach programs.

Park staff must continuously monitor the state of park ecosystems in order to develop effective management programs and demonstrate that the agency is meeting the expectations of the Canada National Parks Act. Consequently Parks Canada Agency has developed comprehensive guidelines for Ecological Integrity (EI) monitoring in national parks and heritage areas. These EI monitoring programs are used to assess the condition of park ecosystems and the effectiveness of management actions, and are the primary source of information used to evaluate the state of park ecological and cultural integrity. Research underway in Torngat Mountains National Park is integral to the ongoing development of an effective, informative, and scientifically credible monitoring program.

Future initiatives will include collaboration on research and monitoring programs with the newly created *parc national de la Kuururjuaq* in Quebec. This park, which encompasses the entire Koroc River watershed, shares a common boundary with Torngat Mountains National Park and

strengthens and protects the cultural and ecological connections between Nunavik and Nunatsiavut.

STRUCTURE OF THE REPORT

This report covers all research and monitoring projects conducted in 2008, and also describes some projects that were initiated in previous years. Each project summary follows a common format that provides a brief overview of the project. Contact information for the principle investigator is included for readers seeking more detail.

Summaries for each project include:

Rationale
A short paragraph describing why the project is being conducted and why it is important.

Objectives
A description of the main objectives of the project

Methods and Information Collected
A brief description of the study site or area, the methods used, and the data collected.

Years of Data
Lists the years for which data are available.

Partners
A list of organizations that were involved in the project.

Funding
A list of organizations that provided funding for the project

Results
A summary of results available at the time this document was prepared (Winter 2008).

Contacts
Contact information for the principal researcher

RESEARCH

RATIONALE

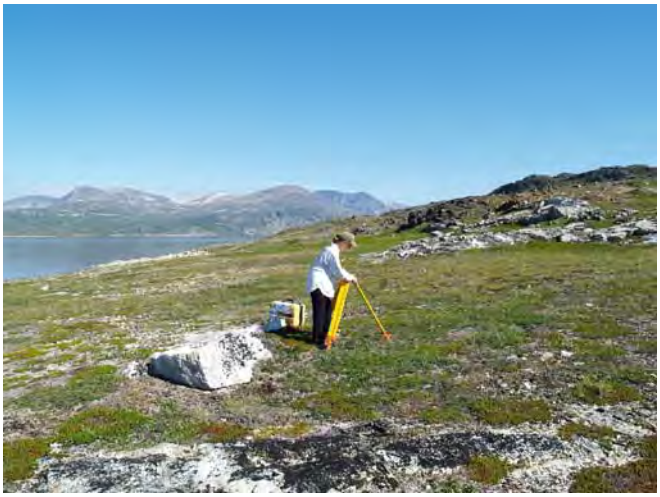
Sallikuluk is a focal point of the Inuit cultural landscape in Saglek Fjord. Numerous sod houses and graves are located on the island. In addition more than a dozen archaeological sites illustrate a human history of the island, and surrounding areas, which reaches back more than 5000 years. Visitors to the park often come to Sallikuluk to experience the history and the landscape. Due to the importance of Sallikuluk this project was begun to document the archaeology and oral history of the island.

Parks Canada Research

SALLIKULUK ARCHAEOLOGY AND ORAL HISTORY PROJECT

OBJECTIVES

- Update the information we have about the archaeological sites on Sallikuluk;
- Evaluate the condition of cultural resources and identify threats;
- Document oral history related to Sallikuluk.



Jenneth Curtis setting up on Sallikuluk

METHODS AND INFORMATION COLLECTED

This project focused on the archaeology of Sallikuluk (Rose Island) in Saglek Fjord. Previous archaeological research documented thirteen archaeological sites on the island representing 5000 years of human history. Our goal for this project was to revisit each of these sites to:

- Verify and correct existing information including site location, the number and kind of cultural features and the location of previous excavations;
- Determine and map the site boundaries;
- Assess the condition of the site;
- Assess potential threats that may impact the condition of the site;
- Recover artefacts exposed on the surface that are rare and at risk of loss;
- Map and record individual cultural features (eg. sod houses, graves).

We had also planned to document Inuit oral history related to Sallikuluk, but due to bad weather that delayed our arrival in the park we were not able to do so.

YEARS OF DATA

- Memorial University of Newfoundland projects led by James Tuck 1969-1971
- 2008 Parks Canada

FUNDING

- Parks Canada

RESULTS

- Visited two key sites on Sallikuluk;
- Updated information on a deeply stratified site that includes cultural layers of Maritime Archaic (4500+ to 3500 years ago), Early Palaeoeskimo (4000 to 2200 years ago) and Late Palaeoeskimo (2500 to 700 years ago) occupation;
- Collected several artefacts that were exposed on the surface in patches of erosion, but overall noted that the site is in stable condition;
- Updated information on a large Inuit sod house site – this site has more than twenty overlapping Inuit sod houses that represent 500 years of successive occupation;
- Noted the location of a potential archaeological site that has not yet been documented in our inventory.

Tool fragments made of Ramah chert.

Palaeoeskimo soapstone pot fragment.

Inuit sod houses on Sallikuluk.

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RATIONALE

Numerous solid waste sites resulting from historical human use were known to exist in TMNP. These sites include old fuel caches containing 205 litre fuel drums, plane crash sites, garbage associated with old campsites, and a variety of other sites having structures, fish weir debris and other assorted material. Some of these sites may contain hazardous material such as fuel. In a letter to Parks Canada, the TMNP Cooperative Management Board requested that Park staff initiate work to identify all solid waste sites, assess them for possible contamination, and clean up the waste. In 2008, Park staff completed an inventory of all known sites in the park.

Parks Canada Research

LOCATION, ASSESSMENT AND CLEAN UP OF SOLID WASTE SITES IN TORNGAT MOUNTAINS NATIONAL PARK.

OBJECTIVES

- Locate and document all solid waste sites in the park.
- Complete an inventory of material at each site.
- Produce a master map of sites in TMNP.
- Develop a strategy for assessing the potential for contamination at each site.
- Remove waste from these sites and remediate any contaminated sites.

Old fuel drums near Komaktorvik Lake

METHODS AND INFORMATION COLLECTED

- Since 2005 park staff travelling throughout the park have opportunistically documented sites containing solid waste.
- Once located, each site was photographed and the following information was recorded: location coordinates, type and amount of solid waste, condition of any fuel drums present and amount of fuel in each drum.
- In 2008 two days were dedicated to visiting all the known sites to complete the inventory and update the site records.
- Locations in the park that had not been surveyed were also visited to ensure as much of the park as possible had been surveyed.

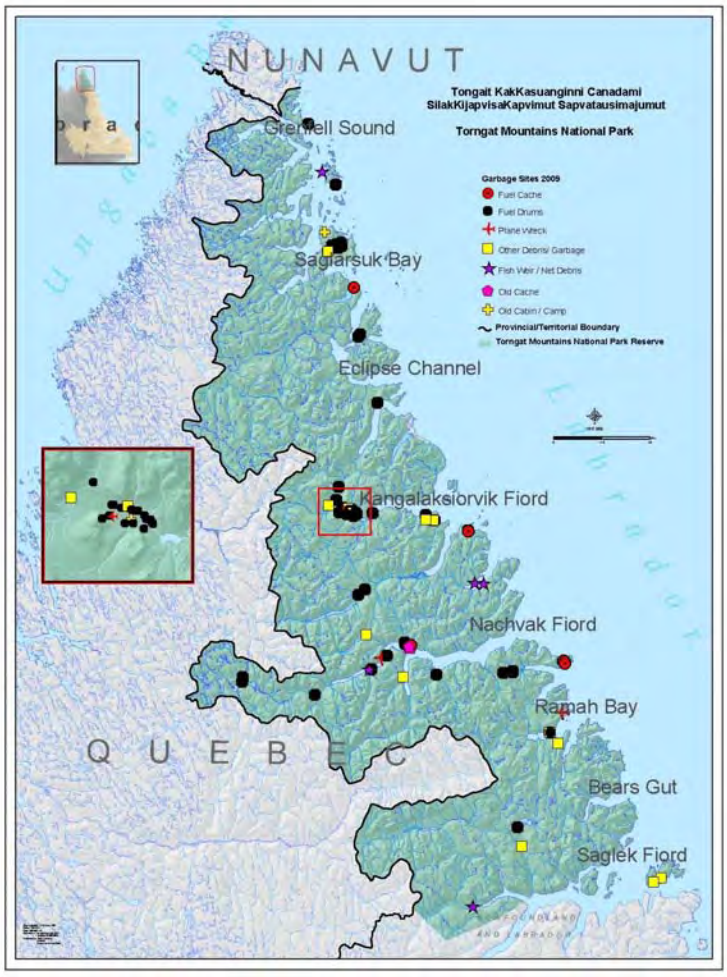
Old Cessna crash site near Ramah Bay

RESULTS

- A total of 74 solid waste sites have been identified in the park. This includes 60 sites having 1 or more fuel drums, 3 plane wreck sites, an old wooden cabin, two old campsites, and foundations and garbage associated with 3 old houses. There are also sites that contain debris from the char weir fishery in Southwest Arm Brook.
- There are at least 160 abandoned drums at the 60 sites, many of these drums still contain liquid
- In addition, there are 7 active fuel cache sites in the park that contain variable numbers of 205 litre drums of jet A-1 aviation fuel (similar in composition to kerosene).

Next steps

- An application will be prepared for funding to conduct a Phase I assessment for any potential contamination of solid waste sites.
- Assessment work is tentatively scheduled to begin in summer 2009.



Solid Waste Sites in Torngat Mountains National Park

Old fuel cache site near Gulch Cape

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RATIONALE

In 2008, Parks Canada initiated a long term Visitor Research Program to understand who is visiting the Torngat Mountains National Park and what kind of experiences these visitors are having. The program gives the TMNP an opportunity to understand visitors, visitor trends, and where possible, provide an opportunity for the park to respond to what it sees and hears from visitors so that it can continue to facilitate future experiences that are relevant and unique.
The Visitor Research Program consists of a number of online post trip surveys that were administered to the following groups of visitors:

- Park researchers (Parks Canada staff, university researchers, etc.)
- Independent park visitors (sailors, climbers, trekkers, etc.)
- Cruise ship visitors

A survey was also developed and administered to cruise ship operators during the 2nd Expedition Cruise Forum, which was held in Corner Brook in October 2008.

Parks Canada Research

VISITOR RESEARCH PROGRAM

OBJECTIVES

Hikers in the Palmer River Valley

2008 Researcher Survey
The objective of this particular survey was to gather feedback from park researchers in hopes of better catering to their needs in the future while also gaining a deeper understanding of the types of connections that are being made between the Inuit and the scientific research community that is involved with the Torngat Mountains National Park.

2008 Visitor Survey
The objective of this particular questionnaire was to gather feedback from visitors in hopes of better catering to their needs in the future while also gaining a deeper understanding of the types of experiences people are having in the Torngat Mountains National Park.

METHODS AND INFORMATION COLLECTED

Surveys were developed by TMNP staff in collaboration with social scientists from Parks Canada's Atlantic Service Center during the winter and spring of 2008. Email addresses were collected by TMNP staff from independent visitors and park researchers during the summer of 2008. Email invitations to complete the respective surveys were sent out to each group during the fall of 2008. The online surveys were conducted using SurveyMonkey.com, one of the leading online survey tools on the web.

Sailboats and cruise ships visiting TMNP

YEARS OF DATA

2008 was the inaugural year for the Visitor Research Program. Data collection will continue indefinitely.

FUNDING

This project was entirely funded by Parks Canada.

RESULTS

2008 Researcher Survey

- Demographically, the individuals that came to TMNP to conduct research in 2008 were:
  - Predominantly from Atlantic Canada (53%), Ontario (19%) and Québec (14%).
  - 59% male / 41% female
  - A relatively young group, with over two-thirds under 35 years of age.
  - 67% English-speaking / 25% French-speaking
  - Very well educated, with nearly 70% having obtained a Master's or Doctoral degree.
- Two out of three researchers were visiting the Torngat Mountains National Park for the first time in their lifetime in 2008. The remaining 33% had previously visited to conduct research.
- When asked about their interactions with Inuit at Base Camp, all of our survey respondents indicated having had the opportunity to do so. In fact, 96% of researchers either 'strongly agreed' or 'somewhat agreed' with the statement: *'Base camp enhances the opportunity for researchers to connect with Inuit.'*
- On average, researchers spent 14 days in the park, 9 days at Base Camp and 6 days camped outside of Base Camp.
- 4 out of 22 researchers (18%) indicated having encountered/spotted polar bears during their last visit to the park.
- Overall, 82% of the researchers that responded to this survey responded that they were "very satisfied" with their last visit to the TMNP. An additional 14% were "satisfied" with this experience.

2008 Visitor Survey

- Demographically, the respondents to the 2008 TMNP visitor survey were:
  - Mostly American (57%) and Canadian (28%)
  - 71% Male / 29% Female
  - A relatively older group, with two-thirds over 55 years of age.
  - 79% English-speaking / 21% French-speaking
  - Well-educated and relatively affluent; 46% earn over $100,000 a year
- Travel parties consisted of roughly 5 people, on average (±4 males, ±1 female)
- Over half (55%) of visitors saw/encountered polar bears during their visit to the Park.
- On average, visitors' trips to the TMNP, including travel, cost them over $3,600 per person.
- When asked to rate their overall visit to the park, 90% of visitors that responded to the survey were either 'very satisfied' or 'satisfied'.

KANGIDLUASUk – home to researchers and reception centre for visitors.

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RATIONALE

Cirque glaciers in the Torngat Mountains of northern Labrador are the only glaciers on mainland Canada east of the Rocky Mountains and represent the southernmost limit of glaciers in the eastern Arctic. Although relatively small in extent, these glaciers play an important role in local freshwater and marine ecosystems through meltwater inputs, related geomorphic processes and nutrient cycling. Changes in the mass balance of these glaciers will therefore directly impact local ecosystem dynamics and integrity. Apart from a brief monitoring period on four glaciers in the 1980s, there has been no attempt to gauge the impact of changing climate on the volume and extent of the Torngat Mountain glaciers.

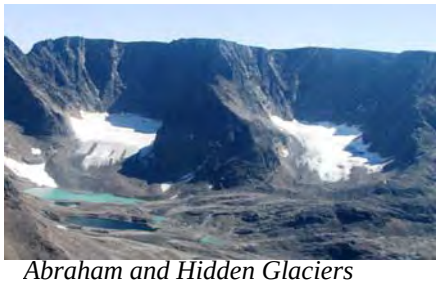
ArcticNet Research

RECENT GLACIER CHANGE IN THE TORNGAT MOUNTAINS, NORTHERN LABRADOR

OBJECTIVES

The Torngat Glacier Project has the following objectives:

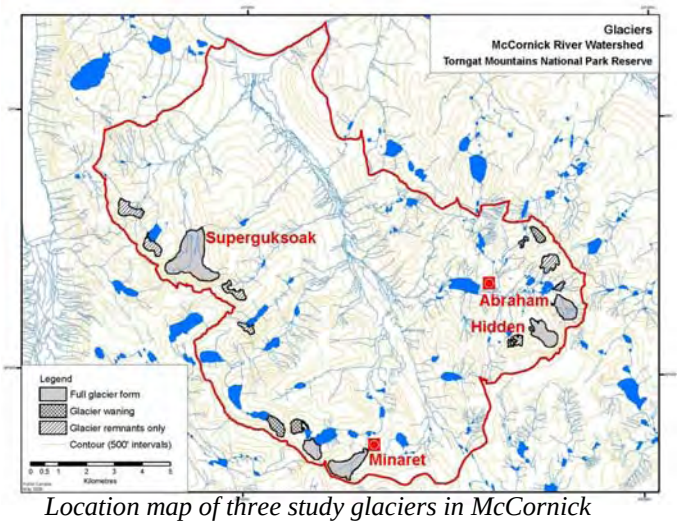
- To compile an inventory and digital database of the glaciers in the Torngat Mountains
- To determine change in glacier extent over the period 1959/60-2007
- To determine volume change of the largest glaciers over the period 1959/60-2007
- To document cirque glacier recessional history over the past centuries to millennia in the Torngat Mountains using lichenometric techniques on moraines
- To investigate the relationship between glacier change and climate change
- To assess the impact of glacier melting on local ecosystem dynamics and integrity



Abraham and Hidden Glaciers

METHODS AND INFORMATION COLLECTED

- Fieldwork was conducted from August 2 to 13, 2008.
- Surveys of glacier surface elevation and frontal position were carried out on Abraham, Hidden and Minaret glaciers using a differential global positioning system (DGPS).
- Temporary datums set up in 1981 by R.J Rogerson near the snout of Abraham Glacier were relocated and precisely surveyed.
- New temporary datums were established in front of the three study glaciers for Parks Canada staff to monitor marginal change.
- DGPS was used to measure a selected number of static points on stable, non-moving (i.e. rock) terrain surrounding the three study glaciers. These points are used for three dimensional ground control in a digital elevation model.
- Glacier surface elevation is complimented by bed topography derived from ground penetrating radar (GPR). Together, these data will be used to estimate glacier ice volume today and ice volume loss over the last 50 years or so.

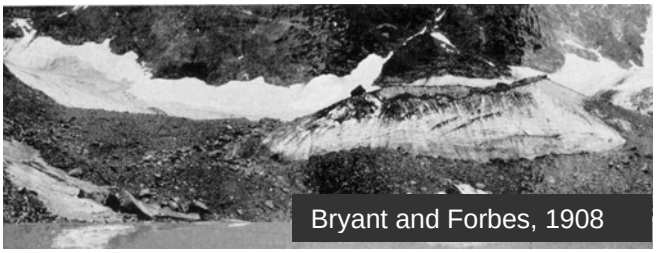


Location map of three study glaciers in McCornick River watershed.

- Data from four lichen growth stations located near fly camp in the Cirque valley will be compared with initial measurements when the stations were established in 1975. The new data will help to refine the growth rates for *Rhizocarpon* section *Rhizocarpon* and *Alectoria miniscula* species in the Torngat Mountains.

YEARS OF DATA

1908 Bryant & Forbes
1931 Odell
1975 McCoy
1981-83 Rogerson.
2008 Bell & Sharp


Bryant and Forbes, 1908


Bell, 2008

Bryant's Glacier - 100 years of photography

PARTNERS

- Memorial University of Newfoundland and Labrador
- University of Alberta
- ArcticNet
- Parks Canada

FUNDING

- ArcticNet

RESULTS

- An updated inventory of published Torngat glacier locations was compiled
- The margins of Torngat glaciers on SPOT5-HRS satellite imagery (2007) were identified.
- Preliminary estimates of aerial extent of 34 glaciers on 2003 aerial photographs provide a total ice area of 12.62 km^2. Measurements of these same ice bodies on the 2007 SPOT5 imagery indicate a decrease in ice extent of 3.25 km^2.
- A comparison of ice frontal change on Abraham Glacier between 1981and 2008 suggests an average ice marginal retreat of 77m since 1984.
- As part of an IPY science legacy and in partnership with Parks staff, Bryant's Glacier and Mt. Tetragona were re-photographed in 2008 from the same location as 1908 and 1931.
- Inuit elders were hosted in our fly camp and on Abraham Glacier to talk about the work and to learn about their perspectives on glaciers and the environment.

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RATIONALE

Fresh water and sediments from rivers play important roles in nutrient and other material transport to the coastal ocean (i.e., contaminants), thus influencing both terrestrial and marine ecosystems; human alteration of the landscape and/or water runoff can alter marine delivery of water and sediment; and fresh water (and probably sediment) delivery is known to be changing in northern Canada, probably in association with climate change. The basic purpose of this study is to gain a better understanding of patterns and variability of sediment and fresh water delivery from land to sea in the fjords of Nunatsiavut and Torngat Mountains National Park over time scales extending from seasons to approximately the past two centuries.

ArcticNet Research

MARINE RECORDS OF RIVERINE WATER AND SEDIMENT DISCHARGE, TORNGAT MOUNTAINS NATIONAL PARK

OBJECTVES

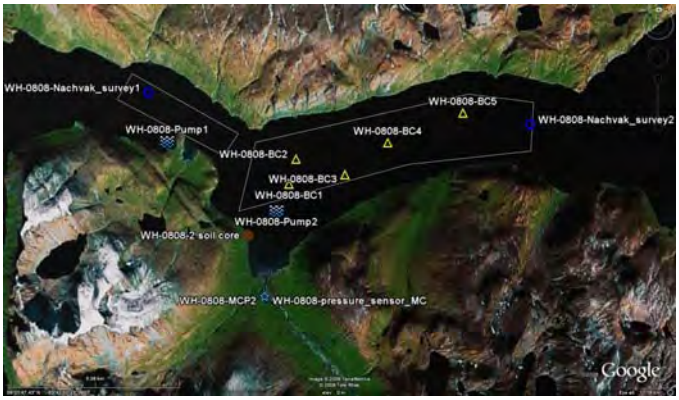
Specific field objectives for the 2008 field season were as follows:

- Map thickness, extent, and age of sediment deposits of riverine origin in marine basins;
- In stream water, deploy pressure sensors in the beds of the McCornick River and Nachvak Brook to determine seasonal magnitude and variability of stream flow;
- In fjord waters, measure concentrations of sediment, and ^{7}Be and ^{210}Pb to assess delivery of these materials from stream to ocean.

Elisabeth Kahlmeyer and Leo Angnatok collecting stream measurements in Nachvak Brook

METHODS AND INFORMATION COLLECTED

- Sample sites were located in Saglek Fiord and Nachvak Brook (unglaciated river, draining into Saglek Fjord), and in Nachvak Fiord and McCornick River (glaciated river,draining into Nachvak Fjord).
- Sample types include:
  - Sonar surveys of marine basins close to river mouths, producing sub-bottom profiles of sediment stratigraphy and maps of surface sediment acoustic properties.
  - River Discharge- A SonTek Acoustic Doppler Velocimeter was used to measure stream velocity in 1-2 meter intervals across the stream.
  - Soil Samples- will be studied for Pb-210 produced in the atmosphere and stored in the soil through radioisotope analysis.
  - Water Samples- Sea water was pumped and filtered by passing through three cartridges, two of which have been impregnated with iron and manganese oxides, allowing collection of dissolved radioisotopes.



Satellite image of Nachvak Fjord, showing sample and survey locations for Summer 2008 field work

- Box Cores- seabed processes, characteristics and ages are studied through radioisotope analysis of sediments with focus on the particle-bound radioisotopes.

YEARS OF DATA

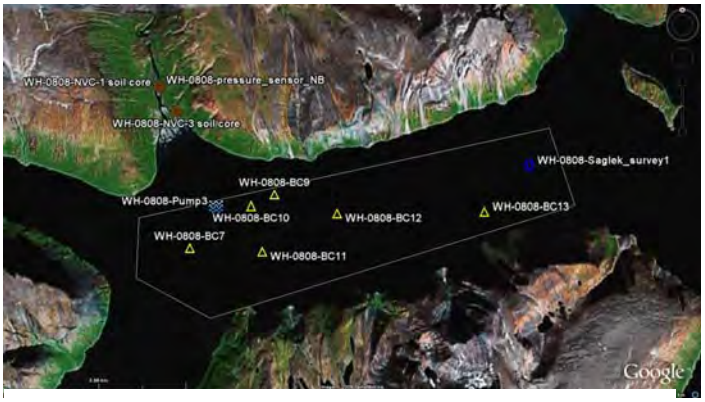
- 2008

PARTNERS

- Nunatsiavut Government
- Parks Canada
- Environmental Sciences Group, Royal Military College, Kingston
- Memorial University of Newfoundland

FUNDING

- ArcticNet, Parks Canada, Environmental Sciences Group, Memorial University Newfoundland.



Satellite image of Saglek Fjord, showing sample and survey locations for Summer 2008 field work.

RESULTS

Marine Record of Sediment Flux from Glaciated and Unglaciated Catchments

- Preliminary analysis suggest that the thickness of postglacial sediments in the marine basin for the McCornick (16km² area, 150-170 m deep) river is 5-10 m, and 10-20m in the basin off Nackvak Brook (20 km², 250m deep), implying that sediment volumes are proportional to catchment area.
- Sediments have been deposited in wedges that thicken towards the river mouth. X-radiographs of sediment cores show very faint layering. The presence of layering suggests that there was rapid sediment delivery (such as by gravity-driven mechanisms), rather than from water-column plumes.
- These layered sediments appear to be well preserved and therefore good indicators of river discharge in the recent past.
- Radioisotope analyses suggest that sediment accumulation rates vary between fjords from 0.3 cm/y in Nachvak Fjord to 0.35 cm/y in the Saglek Fjord, over approximately the past 100y.
- Ongoing work will evaluate core data for possible changes in sediment accumulation rates over the past few centuries, which would be indicative of changing river discharge over time.

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RATIONALE

Within Saglek, PCB concentrations in the surface sediments and marine organisms, such as shorthorn sculpins (*Myoxocephalus scorpius*) and black guillemots (*Cepphus grylle*) have decreased during the last decade. However, relatively high PCB concentrations have been found in some ringed seals (*Phoca hispida*) from Saglek Bay (range ΣPCB = 496 - 9376 ng/g ww). The exact reasons for the large range and the high concentrations are unknown. A possible explanation for the high PCB concentrations in some seals is a difference in diet. Another possible explanation is a difference in annual and seasonal movement patterns (i.e. these "hot" seals may have been within the Saglek Bay area for most of the year). This study was designed to address these concerns.

ArcticNet Research

RINGED SEAL SATELLITE TELEMETRY IN A NORTHERN MARINE ECOSYSTEM: UNDERSTANDING TROPHIC INTERACTIONS IN THE FACE OF LOCALIZED PCB CONTAMINATION

OBJECTIVES

- To capture and deploy ringed seals with Platform Transmitter Terminals (PTTs) in Saglek Bay.
- To describe ringed seal movement patterns and diving behaviour along the coast of northern Labrador to assess the impact of a local source of PCB contaminated sediments (Saglek Bay) on this important species.

A satellite tag mounted on a ringed seal

METHODS AND INFORMATION COLLECTED

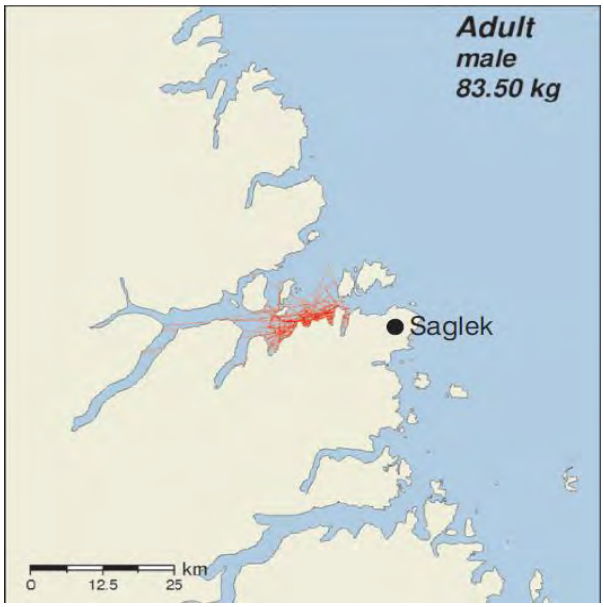
- Fieldwork took place from August 9 to August 28, 2008.
- In addition to the researchers, the field team consisted of Inuit from northern Labrador, including Bennett Barbour, Jacko, John and Eli Merkuratsuk, Elias Obed, John Andersen and Harry Haye. Ches, Joe, and Jarrett Webb also participated in the operations.
- We carried out our work either from base camp in St. John's Harbour, or from the "Robert Bradford" longliner. Our work consisted of travelling to selected sites to deploy specially designed monofilament nets (11" stretched mesh size) in relatively shallow water (up to 8 m), anchored to shore on one end and to the bottom on the other.
- Once caught and retrieved, seals were manually restrained and morphometric measurements taken (body mass, length, girth), and a PTT was glued to the dorsal fur before they were released. No drugs were used to sedate the seals and the tag is designed to fall off once the seals moult.

YEARS OF DATA

- 2008 (Year 1 of 2)

FUNDING

- Parks Canada
- ArcticNet
- Torngat Joint Fisheries Board
- Nunatsiavut Government
- Fisheries and Oceans Canada
- Department of National Defence



Movement of an adult male ringed seal from August to December, 2008

PRELIMINARY RESULTS

- Three ringed seals were successfully deployed with satellite tags. This included two males (an adult and a juvenile) weighing 83.5 and 25 kg, respectively, and a juvenile female weighing 36.5 kg.
- Although data analyses are still being performed, movement tracks show that the female seal has used Saglek, Bears Gut, and Ramah Bay to similar extents. The large adult male seal, however, has remained exclusively inside Saglek Bay. The juvenile male seal, in contrast, has travelled south to the vicinity of South Aulatsivik Island and back north to Okak Bay, covering almost 300 km during approximately 2 months. Since then, the juvenile seal has traveled north, close to the shelf break off the tip of Labrador, and seems to be skirting up and down the ice edge.

Movement of a juvenile male ringed seal from August to December, 2008

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RATIONALE

Northern Labrador is of key importance to understanding the very different regional dynamics and impacts of global climate change in Canada's North. Using a paleolimnological approach, we will construct paleoclimate proxy records that will allow regional comparisons with ice core data from the Greenland inland ice as well as with paleoceanographic data from surrounding marine environments, including Labrador fiords. By studying the changes to fossil assemblages in lake and marine sediments over time we can reconstruct the past local and regional climate conditions and understand its evolution over time. One of our research objectives this past summer was to assess the impact of natural (climate) and anthropogenic (PCB contamination) changes on lake ecosystems in the Saglek Bay area. By comparing the historical trends in lakes located near the source of PCB contamination and in non-contaminated lakes, we will be able to asses the impact of this kind of pollution on the water quality and aquatic biota in this region.

ArcticNet Research

MULTI-PROXY PALEOLIMNOLOGICAL ANALYSIS OF CLIMATIC AND ENVIRONMENTAL VARIABILITY IN THE SAGLEK AREA, NORTHERN LABRADOR

OBJECTIVES

- To collect data on the present and historic conditions of freshwater lakes in the Saglek Bay area.
- To document the extent, duration and amplitude of environmental and climatic changes in the area by using microfossil indicators
- To assess the sensitivity of these lake systems to natural and human induced stressors.

METHODS AND INFORMATION COLLECTED

- Fieldwork was conducted between August 4 and 6, 2008.
- A total of 4 lakes were chosen.
- Prior to sediment sampling, the lake bottom was mapped with a echosounder (Lowrance LMS480D) using an inflatable zodiac and paddles.
- 1 Litre water samples were collected 15 cm beneath the water surface
- The water was sub-sampled and filtered for future water chemistry analysis.
- Basic water properties were measured using a secchi disc and a Quanta Hydrolab Surveyor.
- The 20 cm diameter Secchi disc was used to determine the maximum depth of light penetration, which marks the euphotic zone.

Location of the four lakes sampled and of the Base Camp in the Saglek Fiord area.

- The Hydrolab provides profiles about temperature, pH, conductivity and oxygen.
- Coring of sediments of each lake was performed with an Aquatic Research piston corer.

YEARS OF DATA

- 2008

PARTNERS

- Nunatsiavut Government
- Parks Canada Agency
- Laval University
- Environmental Sciences Group, Laval University

FUNDING

- ArcticNet,
- Parks Canada
- Environmental Science Group, Laval University
- Northern Scientific Training Program.

Lake sediment core

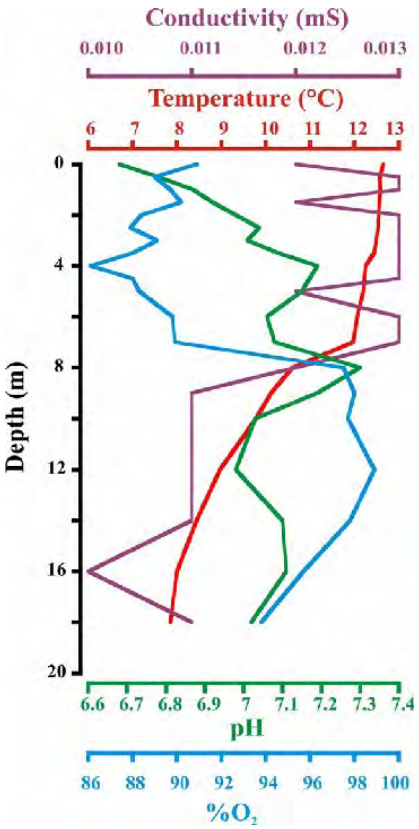
RESULTS

- At Lake Lab-001 and 002, 2 sediment cores for micropaleontological analysis were taken.
- The first core was sub-sampled from top to bottom at an interval of 0.5 cm in the field, and the second was kept for archiving purposes.
- For lakes Lab-003 and 004, an additional sediment core was taken for Dr. Derek Muir at NWRI.
- This sediment core was sub-sampled from top to 10cm depth at an interval of 0.5 cm, then at an interval of 1 cm to the bottom.
- The sediments will be analysed for different types of contaminants, including persistent organic pollutants (POP's) like PCB's and heavy metals.

Future Analysis

For each core:

- The sub-samples will be used to determine the changes in the composition of the fossil diatom assemblages (species composition and abundance) and their downcore variations in absolute and relative abundances.
- Perform several geochemical analysis, such as Itrax analysis (qualitative measurements of the chemical composition by radiofluorescence X), CAT scans and CHN analysis.



Lake LAB001, water profile Hydrolab measurements: Temperature (°C), Conductivity (mS), pH and %O2

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Zodiac used for sampling

RATIONALE

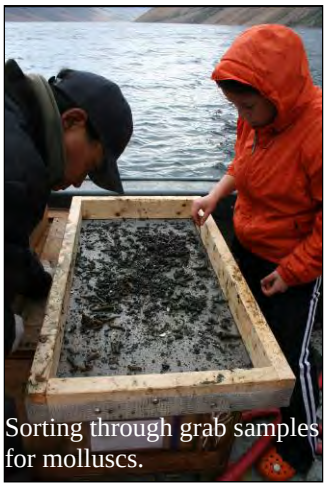
Labrador Inuit are concerned about the impact of stressors, such as climate change and contaminants, to the marine environment in northern Labrador. This study under *Nunatsiavut Nuluak*, an ArcticNet project providing a baseline inventory and comparative assessment of four fiords in northern Labrador, examines the utility of two key indicators to assess and monitor ecosystem change through time. Effective monitoring indicators provide (i) an understanding of baseline ecosystem structure and function; (ii) detection and evaluation of long-term changes in ecological condition; and (iii) an understanding of ecosystem response to environmental and anthropogenic stressors. This research in Saglek and Nachvak fiords will provide the quantitative and qualitative information necessary to identify suitable monitoring indicators as well as assess stressors and their ecological impacts. Results of this study will provide Parks Canada with the data required to help establish the park's long-term marine monitoring program. It will also provide Labrador Inuit with a comparative snapshot of ecosystem health in relatively pristine reference sites.

ArcticNet Research

MONITORING FOR ECOLOGICAL INTEGRITY IN A NORTHERN LABRADOR FIORD-BASED ECOSYSTEM: NACHVAK AND SAGLEK FIORDS

OBJECTIVES

- To identify which components of the Nachvak and Saglek fiord marine ecosystems may be suitable marine EI monitoring measures.
- To evaluate, in detail, the validity of using the ecosystem components, molluscs and shorthorn sculpin (*Myoxocephalus scorpius*), as marine EI monitoring measures in Nachvak and Saglek fiords.
- To enhance the selection and evaluation processes using local Indigenous Knowledge.



Sorting through grab samples for molluscs.

Photo by: Jacquie Bastick

METHODS AND INFORMATION COLLECTED

Parks Canada staff, contractors and partners spent two weeks aboard the vessel *MV What's Happening* in Saglek and Nachvak fiords collecting information for this and other *Nunatsiavut Nuluak* projects.

- 11 sites were sampled in Nachvak Fiord and 10 sites were sampled in Saglek Fiord.
- Molluscs were collected using a box-core sampler at sites along a head to mouth transect in each fiord. An equal number of sites were selected in each habitat group: gravel bottom and muddy bottom. Samples were also collected in the PCB contaminated zone in Saglek Bay.
- Sculpin were collected at two background sites (one in each fiord) and from the PCB contaminated zone in Saglek Bay.

YEARS OF DATA

- 2007 and 2008

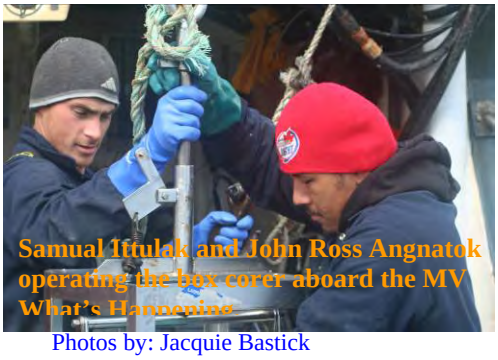
FUNDING

- Parks Canada

RESULTS

- There are two mollusc community groups in Nachvak Fiord based on habitat type, but no grouping in Saglek Fiord.
- The two most diverse sites in Nachvak Fiord are 44 and 37. These sites are located close to the mouth of the fiord while sites 1 and 8, which demonstrate the least diversity, are located at the head of the fiord.
- The two most diverse sites in Saglek Fiord are 244 and 116. While both sites are located at different ends of the fiord they are both located in gravel bottom habitat and in the 50-100 m depth class.
- Condition indices (condition factor (CF), gonadosomatic index (GSI), liversomatic index (LSI)) were calculated for shorthorn sculpin in background areas from both fiords and from the PCB contaminated areas in Saglek Bay (Ecological Risk Zone (ERZ)). There were no significant differences in condition indice values between sites.
- Some shorthorn sculpin from the PCB contaminated area appeared bright pink, in contrast to the typical grey colour of sculpin from background areas. Many of the sculpin from the contaminated area were also grey. Inuit field assistants had never seen pink sculpin before.

Pink and grey coloured shorthorn sculpin collected from the ERZ in Saglek Bay. Photos: Jacquie Bastick



Samual Ittulak and John Ross Angnatok operating the box corer aboard the MV What's Happening

Photos by: Jacquie Bastick

Preparing to measure sculpin.

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RATIONALE

Understanding the interactions of marine food web structure is a critical component to evaluating contaminant transfer. Developing this understanding is difficult in Arctic marine systems where free-ranging organisms are difficult to find and direct observation of species interactions is rare. Addressing this gap in knowledge by studying food web structure and evaluating the transfer of organic contaminants and mercury to various trophic levels will provide a better understanding of the trophic linkages that are fundamental to the overall understanding of energy and contaminant transfer. A possible change in food web structure due to climate change could have a dramatic effect on contaminant exposure for species like ringed seal (and therefore, also Inuit from the coast). By studying four fiords that stretch across a latitudinal gradient currently classified from low to high Arctic (and below to above the treeline), we will explore current as well as possible future effects of climate change on holistic food web structure and contaminant flow within Arctic coastal environments.

ArcticNet Research

MARINE FOOD WEB MODEL OF AN ARCTIC COASTAL REGION: USING CHEMICAL TRACERS TO MODEL ENERGY TRANSFER AND CONTAMINANT FLOW IN NORTHERN LABRADOR

OBJECTIVES

- To better understand the marine food web dynamics along the north coast of Labrador and determine how these are being affected by stressors such as climate change and industrial activities (e.g. mining).
- To determine if there are differences in food web dynamics between northern (Nachvak and Saglek) and more southern locations (Okak and Anaktalak) along the coast.
- To provide an opportunity for the exchange of knowledge between Inuit and scientists.
- To allow Inuit students to build on their knowledge and skills while working alongside researchers in the Torngat Mountains.

Jacquie Bastick, Dorothy Angnatok and Tanya Brown benthic invertebrate sampling

METHODS AND INFORMATION COLLECTED

We sampled four fiords across a latitudinal gradient in northern Labrador (Nachvak, Saglek, Okak, and Anaktalak) to model food web structure as well as contaminant and energy flow from the lower marine food web to upper trophic level organisms, such as ringed and bearded seal. Researchers, Inuit students and field assistants spent four weeks onboard the *MV What's Happening* during the summer and fall collecting samples for this project.

- Benthic invertebrates were collected and sorted using a grab sampler.
- Fish were collected using gillnets, fishing rods and beach seines
- Ringed seal were harvested and opportunistically collected from all four fiords.
- Inuit students were hired to work with this program.

YEARS OF DATA

- 2008 (Year 1 of 3)

FUNDING

- Parks Canada
- ArcticNet
- Torngat Joint Fisheries Board
- Nunatsiavut Government
- Northern Contaminants Program
- Department of National Defence
- Nasivvik and IPY funded the students

Elias Obed, Dorothy Angnatok, Minnie Okkuatsiak, Sheena Merkuratsuk and Anita Fells – 2008 Student Interns

RESULTS

- Analyses are currently being conducted at labs and preliminary results will be available by April 2009.

Tom Sheldon and Joe Webb Sampling a ringed seal

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RATIONALE

Climate change research is a broad and dynamic field, important on many ecological, social, and political levels. However, research into how climate change will affect the terrestrial ecosystems of northern Labrador is limited. In addition, systematic, baseline data on the terrestrial ecosystems of the Park are lacking. Thus, the purpose of the research in the Torngat Mountains study area was not only to catalogue and collect samples from the many vegetation communities and establish baseline climate monitoring for future modelling efforts, but to continue experimentation that will document how these communities are likely to shift under the scenarios of climate change. The ultimate goal is to develop, in consultation with Parks Canada, appropriate protocols for long-term sustainable ecosystem monitoring. The data collected by our group will be used to develop a model that will outline scenarios of landscape change.

International Polar Year Research

DETERMING THE IMPACTS OF CHANGING CLIMATE ON TUNDRA VEGETATION

OBJECTIVES

- To measure the impact of changing climate on tundra vegetation
- Assess the impact of experimental warming on plant community diversity and structure in wet vs dry tundra habitats
- Develop baseline collection of species and study spatial patterns

Establishing OTC (open-top chamber) on a "wet" site, representing sedge meadow tundra in August 2008, adjacent to LHRG fly camp. Quadrat (to left of OTC) shows location of the control plot. Nachvak Brook valley is in the background.

METHODS AND INFORMATION COLLECTED

- Twenty open-top chambers (OTC) were used to simulate increasing temperatures in wet vs. dry tundra habitats (Fig. 1)
- Ten new quadrats were installed and 2 OTCs that were established in 2007 were relocated; the final configuration was 10 OTCs in wet habitats and 10 in dry habitats (Table 1)
- Relative soil moisture was taken among the sites
- OTCs were chosen using the following protocol: two 1 m^2 plots were randomly chosen within each habitat type, marked using painted PVC tubing, GPS coordinates taken, and plant species present determined using the 100 pin drop method (1 m^2 is divided into 100 squares and the pin is dropped in the corner of each of the 100 - cm^2 and species the pin intercepts are recorded – ITEX protocol). This enables us to get a "snapshot" of the species present but also vegetation structure (shrubs, grasses, forbs, mosses, lichens) at OTC establishment
- The plots are randomly assigned to control or OTC and the OTC is then installed to enclose the treatment plot (see picture)

YEARS OF DATA

- 2007 and 2008

PARTNERS

- Memorial University (Biology and Geography)
- Parks Canada, Torngat Mountains National Park Reserve
- IPY- CiCAT program

FUNDING

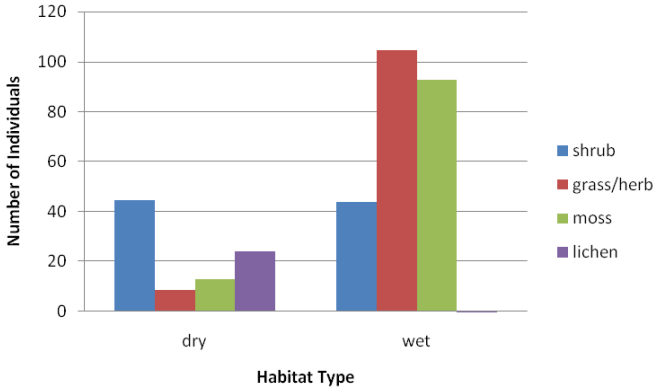
- International Polar Year
- Memorial University
- Parks Canada

RESULTS

- 10 new OTC sites were established bringing the total to 20 in the study area
- Vascular plant species were collected and classified at each quadrat
- Wet habitats are dominated by mosses and grasses compared with shrubs and lichens in Dry habitats (Fig. 2)
- The OTCs/controls should be resurveyed every 2-5 years

Table 1. *Site descriptions of 20 OTC/control plots around MUN fly-camp*

Site	Site type	Moisture type
1	Bilberry hummocks, moss understory	Wet
2	Lichen fellfield terrace	Dry
3	Dry fellfield	Dry
4	Wet meadow with sphagnum and sedge	Wet
5	Wet sedge meadow	Wet
6	Frost stripes	Dry
7	Calcareous site with Harmonella and Eriophorum	Wet
8	Rhacomitrium-dominated exposed fellfield	Dry
9	Birch-sedge meadow	Wet
10	Stereocolon dominated with Arenaria and Potentilla	Dry
11	Moss and lichen community with Antenaria	Dry
12	Moss and lichen community with Diapensia	Dry
13	Crustose lichen with some Carex	Dry
14	Moss and lichen with dwarf shrubs	Dry
15	Lichen dominated with Diapensia and Tofieldia	Dry
16	Carex-Salix-bilberry community with sphagnum understory	Wet
17	Dense Carex mats with abundant litter	Wet
18	Salix-Carex with diverse moss understory	Wet
19	Carex-rush community with abundant litter	Wet
20	Patchy Carex, rush and moss community	Wet



Comparison of plant functional types in wet vs dry habitats

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RATIONALE

Low shrubs such as dwarf birch (*Betula glandulosa*) can alter microclimate, for example by shading, providing shelter from the wind, and by trapping snow, so may play a central role in structuring tundra plant communities. Consequently succession or a change in growing conditions for shrubs, occurring for example as a result of climate change, may have broad implications for the structure of the entire vascular plant community. This project will investigate the role of facilitation by shrubs, particularly dwarf birch, in structuring tundra plant communities. This may offer insight into future effects of climate change on tundra vegetation.

International Polar Year Research

UNDERSTANDING THE ROLE OF SHRUBS IN STRUCTURING THE VASCULAR PLANT COMMUNITIES

OBJECTIVES:

- To assess the role of facilitation in structuring vascular plant communities and, particularly, interactions between dwarf birch and neighbouring plants.

METHODS AND INFORMATION COLLECTED:

- 15 x 15 m plots for the study of vascular plant community structure were located near the MUN fly in camp in the Nakvak Brook watershed.
- In each plot the location and size (length, width and [where applicable] height) of each dwarf birch was mapped and measured; similar measurements were made for the vegetation surrounding each birch.

YEARS OF DATA:

- 2008

PARTNERS

- Memorial University of Newfoundland and Labrador
- Torngat Mountains National Park
- IPY-CiCAT program

FUNDING

- International Polar Year
- Memorial University of Newfoundland and Labrador
- Parks Canada

Shrubs such as the dwarf birch in the background of this image may play an important role in the development of tundra plant communities.

RESULTS

- On the first plot a grid of 1 m^2 quadrats was established and the location and dimensions of all plants were measured. However this approach was very time consuming.

- To increase efficiency, for plots 2 and 3 a 1 m^2 quadrat was centred on each birch and all plants within it were measured. Four 1 m^2 subplots adjacent to each quadrat were also photographed so that measurements of vegetation cover could be made in the lab.

Site	Site description	Site size/ # quads	UTM
1	Dry rocky tundra with highly patchy low vegetation	15 x 15 m, 225 m^2	0479556, 6499733
2	Highly exposed rocky tundra with continuous, low vegetation cover	15 x 15 m, 42 m^2	0479646, 6500175
3	Dry lichen tundra with high shrub density	15 x 15 m, 20 m^2	0479487, 6499634

Shrubs blanketing the south facing slopes in Nakvak Brook valley

The field crew in the Nakvak Brook study area

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RATIONALE

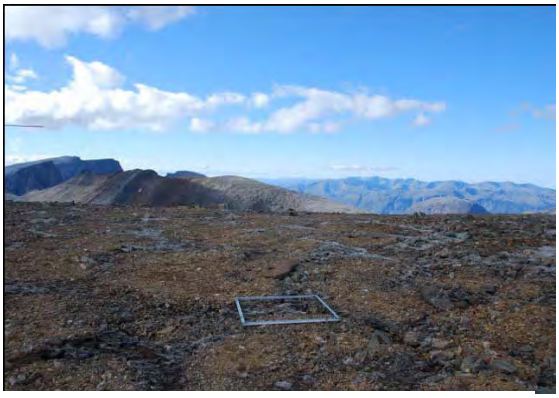
Monitoring ecosystem health and change in a large and remote area such as Torngat Mountains National Park presents a major challenge. One solution is to monitor a landscape unit that is representative of the Park's ecosystems. For example, watersheds are natural sub-divisions of the park that represent the area drained by a single river. Research and monitoring within a selected small park watershed serves as a pilot study and early step in the development of the park's ecological integrity monitoring program. Monitoring different systems (such as glaciers, tundra, freshwater, and fiord sediments) within the same watershed can lead to a better understanding of ecosystems, their interconnections, and the changes that affect their health. The watershed approach integrates different perspectives, experience and expertise and the information gathered can be used to understand and monitor other park areas and the overall park.

International Polar Year Research

INTEGRATING MONITORING PLOTS FROM SEA TO SKY WITHIN THE McCORNICK RIVER VALLEY

OBJECTIVES

- Bring together, share and integrate different sources of knowledge and expertise to better understand the ecosystems of a watershed as a functioning unit
- Develop integrated monitoring programs to measure ecosystem health and change.
- Determine the number and types of samples needed to obtain an effective monitoring design at different spatial scales and for different ecosystems
- Understand variation in climate patterns and topography using a portable climate station to monitor seasonal and local climate information



Sampling plot at the top of unnamed mountain above the Minaret glacier.

METHODS AND INFORMATION COLLECTED

- Potential sampling locations were selected using a vegetation map representing vegetation types from just below the glaciers to the outflow of the river. Six sample sites for vegetation, freshwater, glacier and climate were selected.
- At each site location, 1 m² plots were photographed and a soil temperature logger was deployed.
- A portable climate station was installed to record air temperature and humidity, solar irradiance, wind speed, precipitation, and soil temperature.
- Arctic BIONET researchers conducted stream surveys at 4 locations within the watershed. (see their report titled: A baseline assessment of stream ecosystem structure and function in TMNP).
- The Torngat Glacier Project conducted surveys on three glaciers within the McCornick watershed (see their report titled: Recent glacier change in the Torngat Mountains, Northern Labrador).
- Sam Bentley's team measured stream characteristics and sediment discharge from the McCornick River (see their report titled: Marine records of riverine water and sediment discharge, TMNP).
- Donald McLennan's team have produced a preliminary ecosystem map for the McCornick River valley (see their report titled: The development of multi-scale terrestrial ecosystem inventories for northern national parks – a pilot in TMNP).

- The Canadian Centre for Remote Sensing team conducted ground surveys to understand the relationship between ground cover variability and satellite image signatures (see their report titled: Assessing the impacts of climate change on northern terrestrial ecosystems using satellite data).
- The MUN Labrador Highlands Research Group conducted a variety of research projects in the McCornick watershed as part of this integrated monitoring project.

YEARS OF DATA

- 2008

PARTNERS

- Memorial University (Depts. of Biology, Earth Science, Geography)
- University of New Brunswick, Canadian Rivers Institute
- Parks Canada, Torngat Mountains National Park
- IPY-CiCAT program

Sampling in a headwater tributary of the McCornick River Valley

The McCornick River Valley

FUNDING

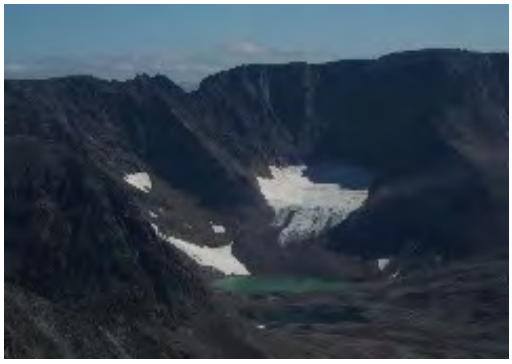
- International Polar Year
- ArcticNet
- Parks Canada
- Memorial University of NL

RESULTS

- Analyses of digital vegetation images will be completed by next summer
- See the individual project reports in this Annual Report for detailed results of each component of this project

Future Research

- Consultation with Inuit to document existing knowledge
- Vegetation sampling/monitoring in more detail at the selected sites
- Re-visit freshwater sampling sites
- If of local interest explore possibility of monitoring hydrology (underground flow) and berry production within established watershed sites
- Analysis of local climatic conditions in relation to regional climate.
- Re-visit and re-survey glacier fronts in the McCornick watershed
- Develop measures and indicators of change within the watershed
- Assess the interconnectedness of all the monitored components of the watershed



Abraham glacier – one of 16 glaciers that provide freshwater to the McCornick river valley.

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RATIONALE

Information on how climate change will affect terrestrial ecosystems of northern Labrador is limited, and systematic baseline data on the terrestrial ecosystems in Torngat Mountains National Park are lacking. This project will yield baseline data on many aspects of tundra moss communities and also complement work being done on plant communities in this same study area. In addition to the contribution this will make to increase knowledge of park biodiversity, documenting variation in life history strategies across an elevation gradient will yield information on potential effects of and responses to climate change, which will affect the structure of the tundra and animals that rely on tundra habitats.

International Polar Year Research

TO DETERMINE REPRODUCTIVE STRATEGIES OF KEY MOSS SPECIES ACROSS ALTITUDINAL GRADIENTS

OBJECTIVES:

- To investigate the life-history strategies of bryophytes.
- To determine whether reproductive allocation and recruitment (clonal vs. sexual) of *Polytrichum* spp. varies by habitat and degree of environmental severity.
- For *Polytrichum s*pecies, compare genetic structure of the soil disapore bank to that of surface vegetation.

Peter Koncz MSc student working on moss populations and reproductive structure.

METHODS AND INFORMATION COLLECTED:

- Sampling sites were established in the low elevation valley (three sites), along a mid elevation slope (three dry/exposed, two wet, and two mesic sites), and near a high elevation exposed summit (2 sites).
- Within each site two 5 metre transects were established.
- Vegetation type and physical parameters were assessed for each transect.
- Within the 5 meter transect at every meter, 20x20cm plots were established in which % cover of species and the gender and reproductive status (female, male; vegetative, sexual) of *Polytrichum* spp. was estimated (%) and measured (by pin-drop method).

Sporophytes of Polytrichum juniperinum. These are produced on female plants of this species

YEARS OF DATA:

- 2007 and 2008

PARTNERS:

- Memorial University (Dept. of Biology)
- Torngat Mountains National Park
- IPY-CiCAT program

FUNDING:

- International Polar Year
- Memorial University
- Parks Canada

Polytrichum juniperinum males showing this year's new growth.

RESULTS:

- 20-30 shoots/gender/plot were collected and are being maintained in a growth chamber at MUN.
- One cylindrical soil sample was taken (diameter of 7 cm, depth 10cm) adjacent to the transect.
- Soil samples are being cultivated in the lab to assess moss germination and for subsequent genetic analysis to determine if these populations are derived mainly from spores or asexual propagules.
- If male shoots with gemma cups were present in plots, yearly growth increments were measured.
- Any bryophytes growing adjacent to the transects in each habitat/elevation combination were collected to better describe habitat and vegetative structure.

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Polytrichum pilliferum. This species is found in drier, more exposed habitats.

RATIONALE

Many species of insects are highly mobile and have short life cycles, factors that may predispose them to respond quickly to climate change by colonizing new areas or disappearing from portions of their historic range. However, limited information is available on the distribution of most species of insects in northern Labrador. Butterflies are highly visible and readily identifiable, and also serve an important ecological role as plant pollinators, making them good candidates for biodiversity monitoring in areas potentially experiencing climate change. This project was centered on cataloguing the species of butterflies found in and around the Nakvak Brook study area, where the Labrador Highlands Research Group is investigating the influence of climate change on Tundra ecosystems.

International Polar Year Research

BUTTERFLY PROJECT

OBJECTIVES:

- To catalogue butterfly species found in Torngat Mountains National Park

METHODS AND INFORMATION COLLECTED:

- In total five samples were caught using a standard butterfly net
- Inclement weather resulted in arrival at our field camp after peak flowering season; therefore butterfly populations had declined, with few species still flying and thus a study on potential lepidopteran pollinators and their food plants was not completed

YEARS OF DATA:

- 2008

PARTNERS

- Nunatsiavut Government
- Parks Canada Agency
- Memorial University of NL
- Environmental Sciences Group, Royal Military College Kingston

FUNDING

- Arctic Net
- Parks Canada Agency
- Memorial University of NL
- Northern Student Training Programme

Arctic Fritillary photographed near Kangidluasuk, August 2009

RESULTS

Using "*The Butterflies of Canada"* by Layberry, Hall, Lafontaine (1998) and comparisons to collected samples, two species have been identified:

1. The Pink-edged Sulphur (3, *Colias interior,* a forest dweller*)*
   - The pink-edged Sulphur is a boreal zone species and our specimen is the furthest north record
   - The larvae of this Sulphur species feed on blueberry (*Vaccinium* spp.) and over winters

2. The Arctic Skipper (2, *Carerocephalus palaemon;* a meadow dweller);
   - The Arctic Skipper is a butterfly of Boreal and mixed deciduous woodlands. The furthest north record prior to this one was Nain

In addition, at least two Arctic Fritillary butterflies were observed and photographed. This species is found in open habitats throughout most of Canada and has been recorded as far north as Ellesmere Island.

Pink edged Sulphur seen near Kangidluasuk, August 2009

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RATIONALE

Climate data collected throughout the Polar Regions has shown a general increase in average temperatures. However, climate models predict that this warming trend will not be consistent across all arctic regions. Labrador for example, is expected to warm much more slowly than other locations in the Canadian arctic. However, baseline climate data for northern Labrador is limited so tracking the magnitude of this variation is difficult. This research will help to fill that data gap and provide important climatological information for other climate change research projects that are described in this report.

International Polar Year Research

CLIMATE VARIABILITY AND CHANGE IN MOUNTAIN REGIONS: CONSTRUCTING CLIMATOLOGIES IN REMOTE HIGHLAND AREAS OF LABRADOR

OBJECTIVES:

- To provide Parks Canada and other researchers with baseline climate information for Torngat Mountains National Park
- Establish quantitative links to the long term climate data available from other stations in the region

METHODS AND INFORMATION COLLECTED

- Fieldwork was conducted from August 3 to 15, 2008 adjacent to Nakvak Brook
- Data was downloaded from the climate station at the MUN fly camp and other recorders that were set up in 2007
- Parks Canada portable weather stations were set up at base camp (July 29-30, 2007) and McCornick River Valley (August 3, 2008). Both include three soil temperature probes as well as a rain gauge
- Downloaded and re-deployed 3 soil temperature loggers that were set up along the ridge to the east of fly camp in 2007
- Soil temperature loggers were placed in each of the Open Top Chamber pairs
- Soil and temperature/relative humidity loggers were installed at four different sites in the McCornick Valley and will contribute to integrated monitoring of this watershed.

YEARS OF DATA:

- 2007
- 2008

PARTNERS

- Memorial University (Depts. of Biology and Geography)
- Parks Canada, Torngat Mountains National Park
- IPY-CiCAT program

MUN Fly camp weather station in April 2008

FUNDING

- International Polar Year
- Memorial University of NL
- Parks Canada

RESULTS

Preliminary results from the July 29th, 2007 to August 14th, 2008 climate station:

- The maximum temperature of 26.5 °C for 2007 was seen during a July heat wave, a period during which temperature records were set across much of the Eastern Arctic
- As the average ground temperature for the three probes was –3.84 °C, the location is likely in permafrost

Photo of temporary climate station (before the electric fence was installed) at McCornick Valley (facing SW) August 3, 2008

Preliminary climatological data from July 29th 2007 to August 14th 2008, from MUN fly-camp climate station. This climate station records hourly and daily data.

Solar Radiation (kW/m^2), average daily	Wind Speed (max, m/s), average	Wind Direction	Air Temp. (˚C), average daily	Max. Temp. (˚C)	Min. Temp. (˚C)	Ground Temp. @ 5cm depth (˚C)	Ground Temp. @ 20cm depth (˚C)	Ground Temp. @ 50cm depth (˚C)
0.128	11.7	SSW	-5.0	26.5 (July 24/07)	-32.9 (Feb. 25/08)	-3.9	-3.8	-3.8

Since 2007, climate data has been collected at the Nakvak Brook field camp, located in the centre right of this photo.

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RATIONALE

A changing climate will have some effect on vascular plant species in the Canadian Arctic. While the future remains unknown, changes in vegetation during the past four decades can be quantified with the aid of properly classified remotely sensed data. In order to predict the changes that will occur in the Arctic, a spatial model will be constructed that will incorporate plant attributes as well as climate and landscape characteristics. This research will provide information on the changing structure of vascular plant species in the Torngat Mountains and produce a spatial model that can be adapted to other Arctic regions.

International Polar Year Research

GROUND-TRUTHING FOR SATELITE IMAGE ANALYSIS AND MODEL VERIFICATION IN TORNGAT MOUNTAIN NATIONAL PARK

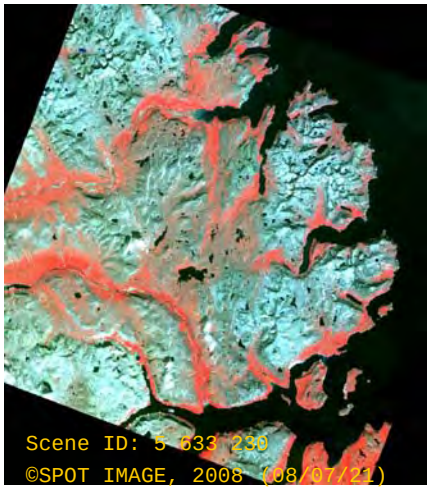
OBJECTIVES:

- To collect ground truth data near Nachvak Brook to classify both current and historical satellite imagery.
- To visit as many sites as possible to cover a large range in elevation and aspect.
- At each site, assess the vegetation type and percent cover of each species and produce a site description.

Data gathering associated with ground-truthing. Dan Myers (L) and Michael Upshall (R) are measuring plants within a sample quadrat, while Sarah Chan records data in Aug. 2008.

METHODS AND INFORMATION COLLECTED:

- Field work was carried out within 5 km of the MUN research camp
- Sampling was conducted at 92 sites.
- These sites were distributed over an elevation gradient of 840meters.
- At each site five 1m^2 quadrats were established. The following information was collected for each quadrat:
    - List of vascular plants
    - Aspect of each plot
    - Elevation
    - Approximate soil depth
    - Length of each species from base to longest branch
    - Soil moisture
    - Photo of each plot
- Site selection was based on differences in elevation, aspect, as well as spectral signatures obtained from the Landsat imagery



YEARS OF DATA:

- 2008

PARTNERS:

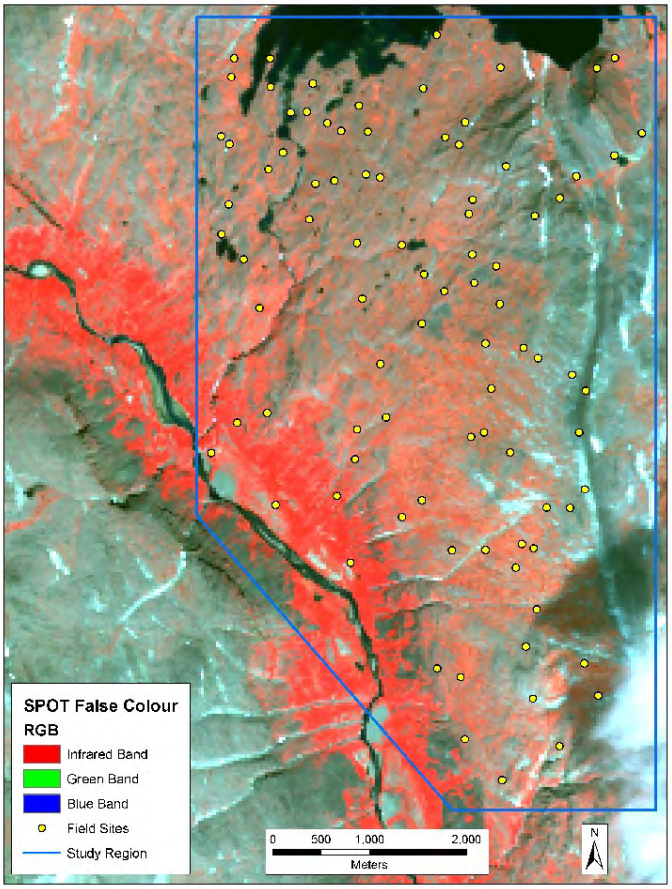
- Memorial University (Depts. of Biology and Geography)
- Torngat Mountains National Park
- IPY-CiCAT program

FUNDING:

- International Polar Year
- Memorial University of NL
- Parks Canada

RESULTS:

- The data collected during the 2008 field season will be used to classify satellite imagery and identify plant functional groups.
- Plant succession models will be developed for the study area in the future, based upon the combined results of the MUN CiCAT research team - pictured below.



False colour composite of SPOT satellite image from July 21, 2008. The red indicates vegetation and the green is rock and soil.

Labrador Highlands Research Group – Torngat Mountains National Park Summer 2008

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RATIONALE

The structure and function of Arctic rivers is expected to be significantly modified with climate variability and change (CVC). This climate change is predicted to reduce permafrost and, therefore, deepen the active soil layer. This will likely increase rock weathering and lead to a more rapid release of nutrients, sediments and contaminants to rivers. While predicting the impacts of these multiple effects is highly complex, expert consensus suggests that their cumulative effects will cause dramatic changes to arctic river ecology. The rationale for this study is to obtain a better understanding of the current river systems in the Arctic, in order to improve our ability to estimate the future effects of CVC on the ecology of these rivers.

International Polar Year Research

A BASELINE ASSESSMENT OF STREAM ECOSYSTEM STRUCTURE AND FUNCTION IN THE TORNGAT MOUNTAINS NATIONAL PARK.

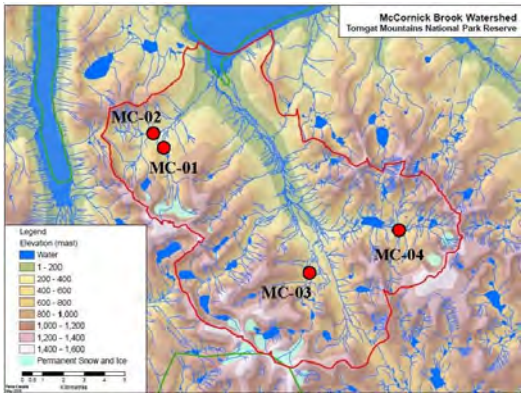
OBJECTIVES

- Assess baseline conditions of stream ecosystems within and adjacent to TMNP;
- Investigate the structural and functional differences between glacial fed, snowmelt fed and lake fed streams.
- Identify the role of Arctic Char within the food webs of the Torr Bay watershed using stable isotope analysis; and,
- Establish long-term monitoring sites that will contribute to the development of an effective and comprehensive biomonitoring program for the TMNP.

Andrea and Allison electro-fishing in Torr Bay Brook

METHODS AND INFORMATION COLLECTED

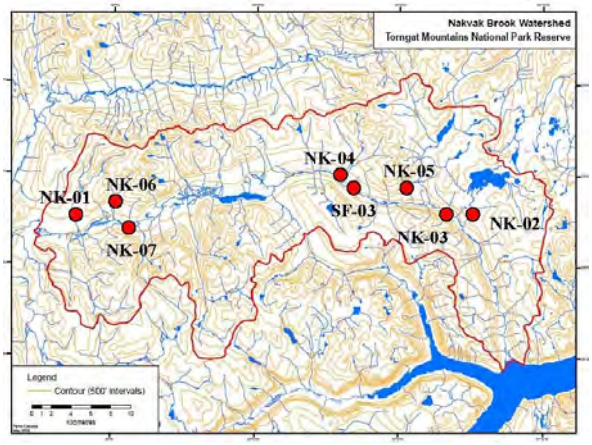
- The field program was conducted between July 23- August 28, 2008.
- Field sites during the research program were located on three watersheds: The McCornick River and Nakvak Brook watersheds which are within the TMNP boundary, and the smaller Torr Bay watershed adjacent to kANGIDLUASUK - Parks Canada and Nunatsiavut Government's basecamp.
- Conducted stream surveys on 8 sites within the Nakvak Brook watershed, 4 sites within the McCornick River watershed and 6 sites within the Torr Bay area.



Surveys included:

- Collection of benthic invertebrates for biodiversity, stable isotope and growth rate analysis.
- Algae sampling for biodiversity, biomass and stable isotope analysis.
- Water sampling (chemical analysis – nutrients, trace metals, stable isotope analysis of fine particulate organic matter (FPOM))
- Water parameters (dissolved oxygen, conductivity, temperature, pH)
- Riparian vegetation (stable isotope analysis)
- Stream discharge in rivers small enough to cross safely

- Deployment of temperature and pressure loggers, left till summer 2009
- Conducted stream particle size surveys.
- Deployment of 6 cotton strips per site (decomposition analysis) were collected after 2 weeks and the remainder after 4 weeks.
- Deployment of Nutrient Diffusing Substrates
- Conducted electro-fishing surveys.



YEARS OF DATA

- 2007, 2008

PARTNERS

- Parks Canada
- Environment Canada

FUNDING

- International Polar Year

PRELIMINARY RESULTS

- 18 sampling sites were selected on tributaries within the Nakvak Brook, McCornick River and Torr Bay watersheds.
- Samples collected during the 2009 field season are being processed, with initial results anticipated for April 2009.

Study sites in the Torr Bay Brook watershed

General Indications from the Torr Bay Watershed

- Water quality data suggest that these waters have low nutrient concentrations and visual inspection of nutrient diffusing substrates suggests that phosphorus is the limiting nutrient.
- All 6 sites contained Arctic Char and three spined sticklebacks. Approximately 5 young of year char (3-5cm) and 5 juvenile char (6-9cm) were collected and 5 larger fish (10-15cm) were fin-clipped and released. All other fish were measured (length and weight) and released.
- Overall, the Torr Bay watershed appeared to be a very healthy system with varying levels of productivity at each site depending on their upstream influences.

Future Research

Resample the 2008 sites in all three watersheds
Data loggers deployed at 12 sites in 2008 will be collected and reset.
Evaluate the effectiveness of cotton strips as indicators of decomposition rates.

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RATIONALE

Arctic char (*Salvelinus* alpinus) is a circumpolar fish species that is distributed across a wide latitudinal and climatic range, which in Canada ranges from the High Arctic to temperate locations such as Newfoundland and southern Quebec. The char species lends itself well to investigations associated with climate and environmental variation. There is also scientific evidence indicating significant warming in much of the Arctic with possible consequences to various species including Arctic char. As part of a larger International Polar Year (IPY) initiative, led by Dr. Jim Reist, DFO Winnipeg, investigations on the ecology of Arctic char have been undertaken to try and better understand how populations may respond to events such as climate variability and change as this species is of particular importance to the Inuit peoples of northern Canada. TMNP represents an important site on an eastern north-south latitudinal gradient along the Lake Hazen-Labrador axis.

International Polar Year Research

CLIMATE VARIABILITY AND CHANGE EFFECTS ON CHAR IN THE ARCTIC

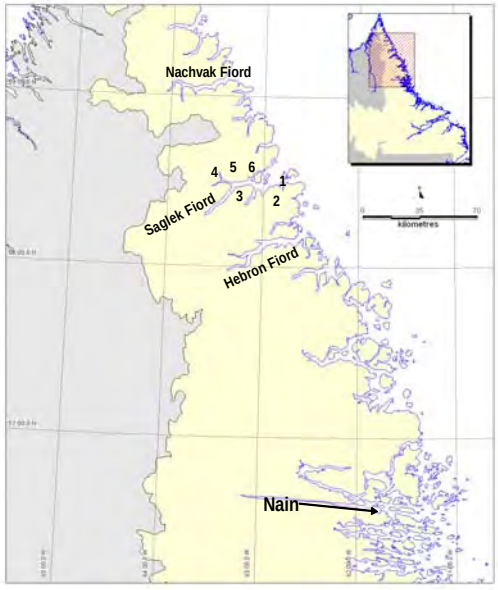
OBJECTIVES

- Determining the responses of char to variability in thermal (temperature) regimes.
- Identifying food web relationships of Arctic char by analyses of carbon and nitrogen stable isotopes
- Examining contaminant levels of anadromous and resident freshwater samples of north Labrador Arctic char
- Assessing the genetic and morphological variation, genetic population structure and variation in the dynamics of char populations within the Park in comparison with samples obtained from other locations and regions of northern Canada
- Contributing to the development of base data for the long-term monitoring of Arctic char populations in the Park.
- For 2008 collect additional YOY and adult fish from both lake and marine systems

METHODS AND INFORMATION COLLECTED

Sampling was carried out within Torngat National Park and also in areas adjacent to the Park. The following locations were sampled in 2008, where numbers refer to sample locations on the map above:

1. St. John's Harbour
2. Torr Bay Brook system
3. Upper Pangertok Lake
4. North Arm Brook
5. Nakvak lake
6. Branigan Lake



Sample sites 2008: 1 = St. John's Harbour, Saglek; 2 = Torr Bay Brook system; 3 = Upper Pangertok Lake; 4 = North Arm Brook; 5 = Nakvak Lake; 6 = Branigan Lake.

YEARS OF DATA
- 2007 & 2008

PARTNERS
- Department of Fisheries and Oceans
- Parks Canada Agency

FUNDING
- Department of Fisheries and Oceans
- International Polar Year

Arctic charr in fall spawning colours

RESULTS

Young-of-the-year samples of Arctic char were obtained from:

North Arm Brook, Saglek, N = 20
Torr Bay Brook, Saglek, N = 23

Biological characteristics data (length, weight, sex, otoliths for ageing and stomach contents) were also obtained from 11 anadromous char sampled from St.John's Harbour. Young of the year specimens from Torr Bay Brook and North Arm Brook were kept whole and sent to St. John's for further processing. Multi-mesh experimental gillnets were set in various lakes to try and access specimens of landlocked Arctic charr. However, at all lake sampling locations, no other Arctic char were caught or observed.

Sample Processing and Results
Young-of-the-year (age 0+) samples of Arctic charr will be forwarded in the fall of 2008 to the University of Waterloo. A PhD student will complete the processing of these specimens to remove otoliths and prepare same for the analysis of oxygen stable isotopes.
Oxygen isotopes are being analysed to infer the thermal history of the fish by providing inference on the average temperatures experienced during the period of early life rearing. Results from north Labrador sampling will be combined with data collected in other areas during 2007 and 2008 (Nain and Voisey's Bay area), historical data obtained from Ikarut River, Hebron Fiord, and with other samples obtained from various areas in northern Canada.

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RATIONALE

The Montane Cordilleran Ecozone, in which Torngat Mountains NP is located, presents some of the harshest conditions on the planet for the growth and survival of plants. In spite of this, a wide array of plants well adapted to these rigorous conditions are distributed across the park landscape in response to variations in local environmental conditions such as climate, soil properties, and ecological processes (flooding, seepage, ground ice effects, colluviation). As a result of the different ecological adaptations of different plants species, and the recurrence of similar suites of ecological conditions across the park, similar groups of plants recur in similar ecological conditions – these we call *plant communities*. When we combine the plant communities with the landscape positions in which they occur (floodplains, estuaries, steep rocky slopes) we can capture ecological diversity across the park in a series of Ecotypes that link the distribution of biota to the ecological processes that control the pattern of terrestrial ecosystems across the park.

The purpose of this project is to develop a cost effective method for identifying and mapping Ecotypes in northern national parks. Such an inventory will provide park co-managers with an ecological basis for managing and communicating many aspects of park ecological integrity, including mapping wildlife habitat, designing monitoring programs, and understanding and predicting ecological change.

International Polar Year Research

THE DEVELOPMENT OF MULTI-SCALE TERRESTRIAL ECOSYSTEM INVENTORIES FOR NORTHERN NATIONAL PARKS – A PILOT IN TORNGAT MOUNTAINS NATIONAL PARK

OBJECTIVES

The Multi-scale ecological inventory project has the following objectives:

- to acquire and organize aerial photos and different kinds of satellite data to aid in the delineation of Ecotypes within the park
- to identify, describe, and classify plant communities in the park
- to link plant communities to ecological processes through an ecological classification of park ecotypes, and to interpret the ecological drivers that control the distribution of park ecotypes
- to use the distribution of plant communities on zonal sites to delineate bioclimatic zones
- to develop detailed ecological mapping for 2 focal watersheds – McCornick River and Nachvak Brook
- to explore the usefulness of fusing Radarsat 2 imagery with SPOT5 imagery to better identify and delineate park wetland ecotypes

METHODS AND INFORMATION COLLECTED

- Preliminary ecosystem maps for McCornick River and portions of Nachvak Brook were prepared before fieldwork to guide and prioritize field sampling.
- Fieldwork was conducted from August 11 to 22, 2008.
- A total of 349 sample plots were established, principally south of Nachvak Fiord and focussed on McCornick River and Nachvak Brook
- Of the 349 sample plots 183 were Ground Inspection Plots and 166 were Visual Inspection Plots. At Ground Inspection Plots we estimated the coverage of all vegetation, including non-vascular plants, described and classified soils in a small survey soil pit, measured depth to permafrost as was possible, recorded 5 digital photos along the cardinal points and straight down, and, interpreted landform and ecological processes for the site. Visual Inspection Plots were similar except that we did not describe soils, plant lists were not always complete, and ecological interpretation was reduced.

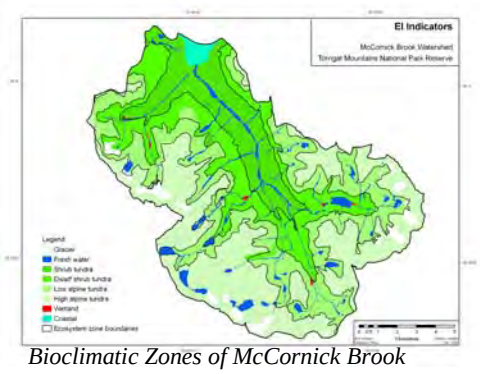
- At each sample site, plants were collected to confirm species names or to provide vouchers for new species. Botanical experts are presently confirming these collections. Mosses and lichens are presently at the Canadian Museum of Nature for species identification.
- All field data has been digitized and will be used to formalize the plant community and ecotype classifications.

PARTNERS

- Memorial University of NL
- NRCan – Canadian Centre for Remote Sensing
- Parks Canada

FUNDING

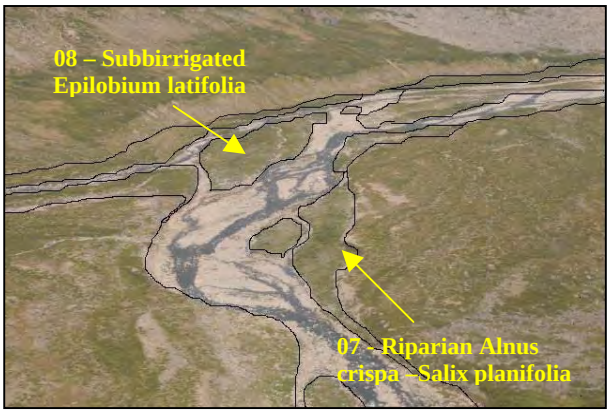
- International Polar Year



Bioclimatic Zones of McCornick Brook

RESULTS

- A collection of over 500 vascular plant specimens that include about 175 species
- A preliminary plant community classification following methods consistent with the Canadian National Vegetation Classification approach
- A classification and mapping of park bioclimatic zones based on the distribution of plant communities on zonal or normal sites (see map inset above). Preliminary names for bioclimatic zones are Shrub Tundra, Dwarf Shrub Tundra, Low Alpine Tundra, High Alpine Tundra; these zones link well to other classifications of arctic vegetation
- With CCRS, we are extrapolating the detailed work to the entire southern end of the park south of Nachvak Brook using a modelling approach that links the air photo interpretation with SPOT data using decision tree modelling software and digital terrain model correlates – initial runs for this model are very promising.



Fluvial ecotypes along McCornick Brook

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RATIONALE

Climate warming is more pronounced in northern latitudes than the global average. Climate warming may induce permafrost thaw and changes in terrestrial ecosystems, including changes in species types, community composition, and plant height and density, which could have important impacts on animal habitats, human land use and management, and feedbacks on the climate system. Since arctic tundra regions are large, remote, and costly to access, this study aims to develop approaches to monitoring northern ecosystems using satellite remote sensing imagery, which are available more and more frequently and with higher and higher spatial resolution. The fieldwork in Torngat Mountians National Park involved collection of ground truth data for this study.

Natural Resources Canada Research

ASSESSING THE IMPACTS OF CLIMATE CHANGE ON NORTHERN TERRESTRIAL ECOSYSTEMS USING SATELLITE DATA

OBJECTIVES

- Measuring plant biomass, leaf area index, active-layer thickness, soil moisture in typical ecosystem/community types in the park.
- Develop relationships between field observed vegetation variables (biomass and leaf area index) with remote sensing data.
- Using the above developed relationships, map the distribution of plant biomass and leaf area index.
- To monitor their changes with time using satellite images.

METHODS AND INFORMATION COLLECTED

Observation sites were selected at representative and relatively uniform plant communities in large areas (large enough to be seen in Landsat satellite images). We selected the sites based on Landsat images and survey from the helicopter. For each site, five plots were measured. Plant species, their coverage and heights were measured, and active-layer thickness was probed. Plants were harvested at five plots for above ground parts and at one plot for roots. Soil profiles were recorded, and soil samples were collected at some sites. Plant samples were brought back and sorted according to species. Leaves and stems are separated and their fresh and dry biomasses were recorded. The leaf area of each species was measured by taking pictures of the leaves spread on a paper of known size.

Fig 1:Sampling plots and processing samples with the Student Interns.

YEARS OF DATA

- 2008

FUNDING

- Canadian Space Agency's GRIP fund.
- Canada's IPY fund.
- Climate change program in Natural Resources Canada.
- Parks Canada - TMNP

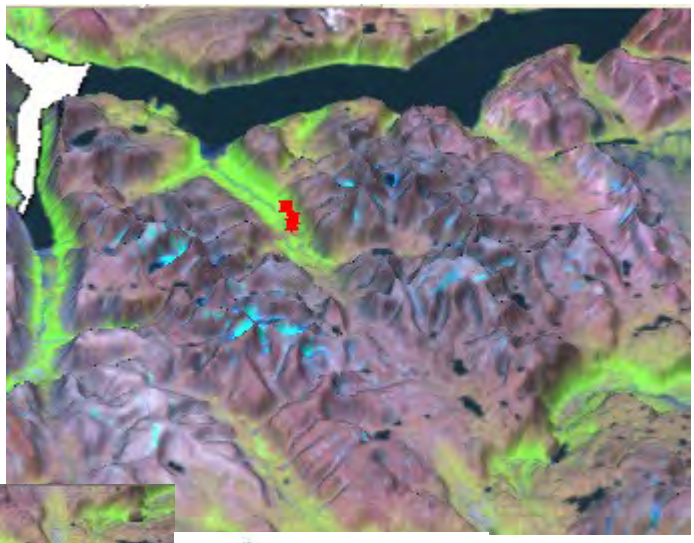
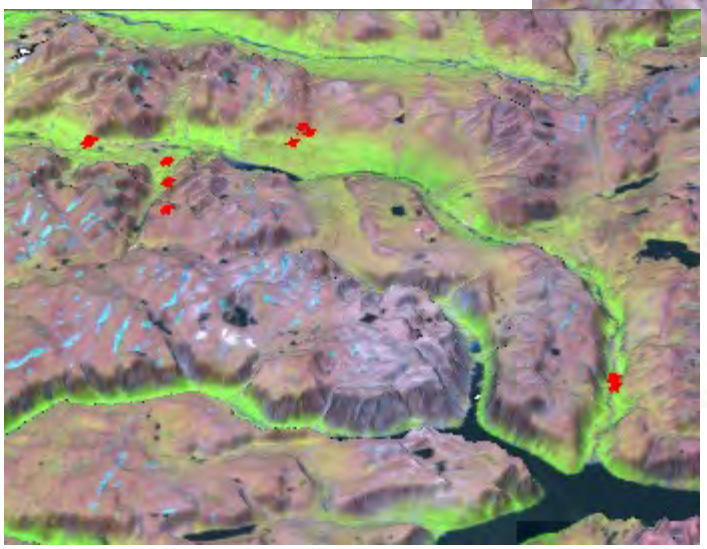
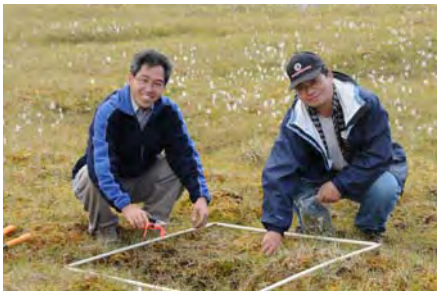


Fig 2:The distribution of the observation sites.



RESULTS

- Sixteen sites for above ground biomass, plant heights and leaf area index, and six sites for root biomass were measured in Nakvak and McCornick watersheds. Lots of pictures at the measurement sites and along flight routes (with GPS coordinates) were recorded.
- Forty soil samples were collected for soil moisture measurements on the day when Radsat-2 was passing this area.



Yu Zhang and Junhua Li collecting biomass samples

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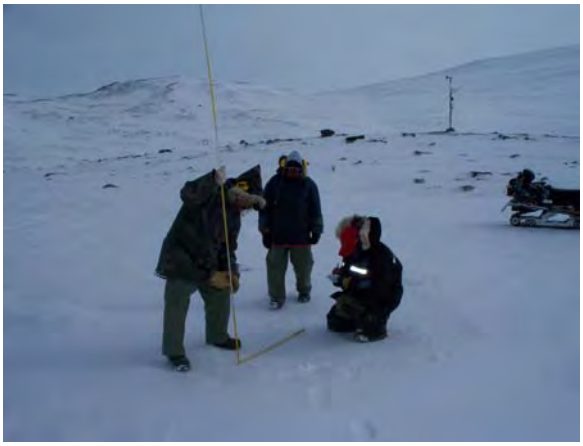
MONITORING



RATIONALE

Recording incidental wildlife observations is an inexpensive and effective method to compile information about long-term trends in the abundance and distribution of wildlife. It is also an activity that park visitors can participate in and thereby contribute to monitoring of park ecosystems. Observations of wildlife in Torngat Mountains National Park, and surrounding areas, are recorded on wildlife cards and the information is stored in a computer database. Special attention is paid to observations of Species at Risk such as peregrine falcon, wolverine, polar bear, harlequin duck, barrow's goldeneye, ivory gull, and short-eared owl. Observations of black bear, wolves and marine mammals are also recorded, as they are good indicators of environmental health.

Parks Canada Monitoring

WILDLIFE CARDS

OBJECTIVES

- To collect basic information (presence, distribution, relative abundance) about wildlife populations in TMNP and surrounding areas.

METHODS AND INFORMATION COLLECTED

- Parks Canada staff, contractors and visitors record incidental observations of wildlife on wildlife cards.
- Information collected includes: date and time of observation, name of observer, species observed, number of individuals seen, location of observation, elevation, aspect, age, sex of animal, evidence of reproduction, habitat, weather and remarks.
- Information from the wildlife cards is entered into an Access database.
- Summaries of incidental observations and maps of these observations can then be produced.

Polar Bear near Hebron in April

Humpback whale in Nachvak Fiord

YEARS OF DATA

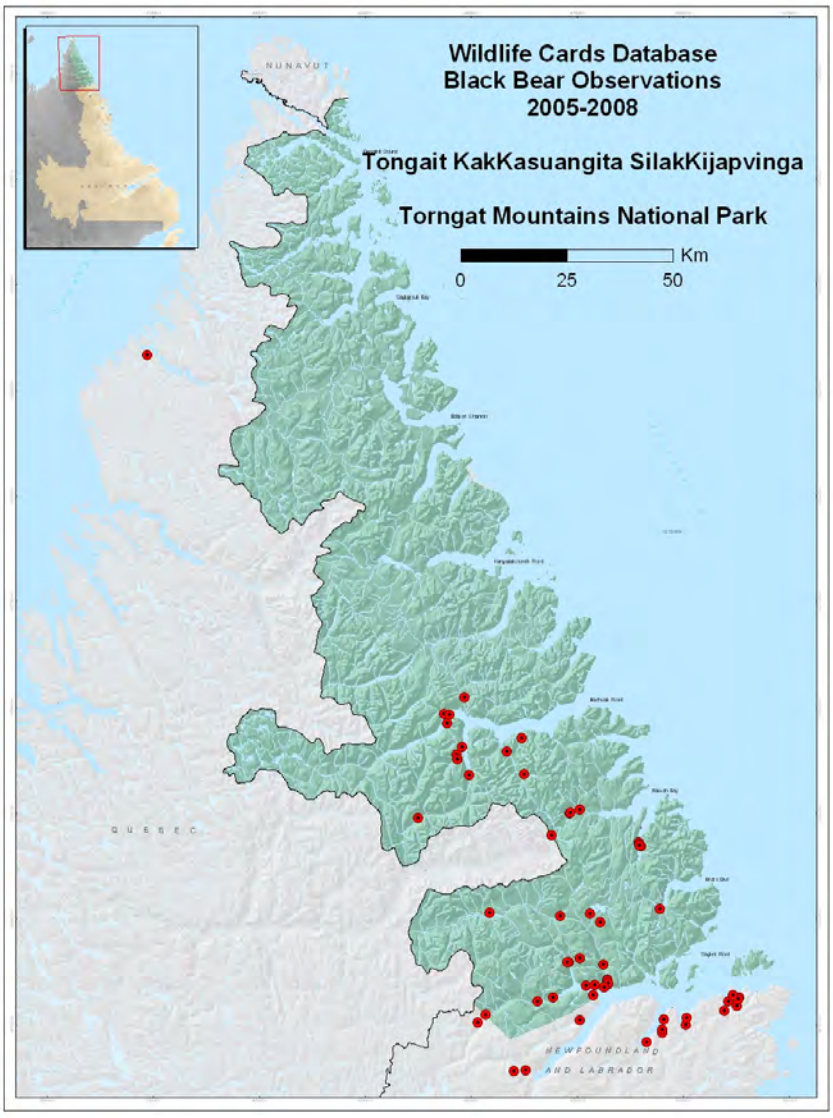
- 2005
- 2006
- 2007
- 2008

FUNDING

- Parks Canada

RESULTS

- There are currently 278 records in the wildlife cards database. This includes 95 records of polar bear observations and 57 records of black bear observations.
- In future years all visitors will receive wildlife cards as part of their pre-trip information package.
- All Researchers are asked record wildlife observations during their time in the park. This is a condition of their research permit.
- One observation of note was possible wolverine tracks in Hebron Fiord just south of the park. Wolverine sightings have been very rare in northern Labrador since the 1950's.



Black bear observations in TMNP 2005-2008

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RATIONALE

Torngat Mountains National Park spans the transition between the low Arctic and the northern boreal ecosystems, and includes a diverse range of coastal, estuarine, taiga, tundra, and montane ecosystems. Consequently a broad range of bird species reach their northern or southernmost breeding range limits in the park, while others use the park as a migration route and staging area. However accessibility has hindered bird surveys and relatively little is known about the distribution and status of many species in the region. Indeed for many species it is not even clear whether or not they occur in the park. Consequently a bird checklist has been prepared in order to encourage persons visiting the park to pay closer attention to the birds they see and then report their observations. This program compliments the wildlife cards program, and will improve our understanding of the status and distribution of birds in Torngat Mountains National Park. This is a cost-effective approach to building our knowledge of park wildlife, and over time will contribute to our understanding of changes to park ecosystems resulting from environmental factors such as climate change.

BIRDS OF TORNGAT MOUNTAINS NATIONAL PARK CHECKLIST

OBJECTIVES

- To encourage people visiting and working in Torngat Mountains National Park to observe and enjoy birds.
- To build a database of incidental bird observations.
- To increase knowledge on the diversity, status and distribution of birds in the park.
- To document long term changes in park bird communities.

METHODS AND INFORMATION COLLECTED

- A checklist of birds potentially occurring in Torngat Mountains National Park was prepared based on published accounts, observations by Parks Canada staff, and local knowledge. The checklist includes:
  - A list of all 94 bird species known or expected to occur in the park, including best available information on their abundance and status.
  - Check boxes to record descriptive information about the observations (location, habitat, weather).
  - A mailing address and request that visitors return a copy of their completed checklist to the park.
- The checklist is being distributed to individuals visiting or working in the park, and park staff are encouraging them to return their completed checklists to the park office.

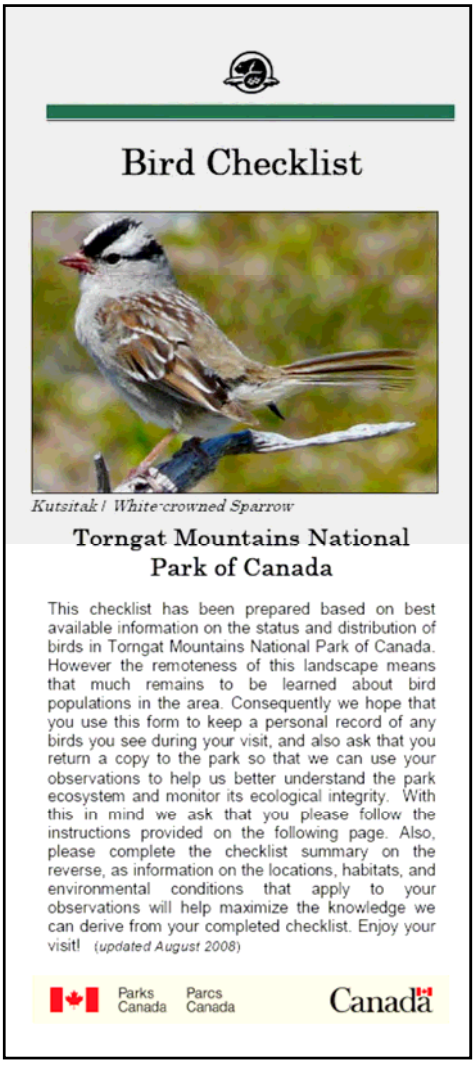
YEARS OF DATA

- The Bird checklist was first made available during summer 2008.

PARTNERS

- Anyone visiting or working in Torngat Mountains National Park

FUNDING



Bird Checklist

Kutsitak / White-crowned Sparrow

Torngat Mountains National Park of Canada

This checklist has been prepared based on best available information on the status and distribution of birds in Torngat Mountains National Park of Canada. However the remoteness of this landscape means that much remains to be learned about bird populations in the area. Consequently we hope that you use this form to keep a personal record of any birds you see during your visit, and also ask that you return a copy to the park so that we can use your observations to help us better understand the park ecosystem and monitor its ecological integrity. With this in mind we ask that you please follow the instructions provided on the following page. Also, please complete the checklist summary on the reverse, as information on the locations, habitats, and environmental conditions that apply to your observations will help maximize the knowledge we can derive from your completed checklist. Enjoy your visit! *(updated August 2008)*

Parks Canada Parcs Canada Canada

- Parks Canada

American pipit, Hebron

RESULTS

- Copies of the checklist were made available to numerous individuals visiting the park during summer 2008, including park visitors, tour group leaders, researchers and park staff.
- Numerous observations were collected and reported, improving our knowledge of the abundance and distribution of many common species. For example, in mid-August large numbers juvenile and adult **American pipit**, **savannah sparrow** and **white-crowned sparrow** gathered around base camp and Hebron, indicating that coastal areas afford important post-breeding habitat for these species.
- Observations in 2008 clarified several uncertainties regarding regional avifauna:
  - Evidence of breeding was documented for several species whose status was not previously clear. **Common loon** and **blackpoll warbler** were seen with young, while observations suggestive of breeding were also made for **northern shrike**, **American robin**, **Wilson's warbler**, and **dark-eyed junco**.
  - **Gray-cheeked thrush** and **yellow-rumped warbler** were observed; the presence of these species in the park was previously uncertain.
  - Some species not expected to occur in the region on a regular basis were observed, including **mourning dove**, **white-winged crossbill**, and **manx shearwater**. Future observations will clarify whether these species regularly occur in the area, or whether these were simply vagrant or transient individuals.
- New information from 2008 was used to prepare a revised checklist for future use.

Fledgling snow bunting near Caubvick glacier

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RATIONALE


Adult peregrine falcon (Geoff Goodyear)

Peregrine falcons (*Falco peregrinus*) are top-level predators, so are sensitive to the health of prey populations and also to ecological stressors such as pesticides and other persistent environmental pollutants. Peregrine falcons are listed as Threatened under the Province of Newfoundland and Labrador's *Endangered Species Act*, while under the federal *Species at Risk Act* the sub-species *anatum* is listed as Threatened and the sub-species *tundrius* as Special Concern. These factors make peregrine falcons important indicators of ecosystem health, and tracking their population is an important component of Torngat Mountains National Park's Ecological Integrity monitoring program. Since 1985 the Province of Newfoundland and Labrador has surveyed northern Labrador as part of the Canadian Peregrine Falcon Survey (CAPFS), a national census conducted at 5-year intervals (1985, 1990, 1995, 2000). In keeping with this the scheduled 2005 aerial survey was carried out during park establishment and will be repeated in 2010 and beyond. Opportunistic observations of falcons are also being collected annually.

PEREGRINE FALCON SURVEYS

OBJECTIVES

- To monitor occupancy of selected known peregrine falcon territories.
- To measure reproductive success of peregrine falcons in these territories.
- To identify previously unknown nest sites.
- To collect incidental observations of other raptor species.
- To collect incidental observations of other Species at Risk.

METHODS AND INFORMATION COLLECTED

- A helicopter-based survey of known and potential new Peregrine Falcon nest sites is conducted every five years; the next survey will be in 2010.
- Aerial surveys are conducted in late July when chicks are 1-3 weeks of age, a period when parents are likely to flush at the approach of an intruder and thereby facilitate observation. Other raptors have usually fledged by this time.
- The helicopter approaches potential and known cliff nest sites where orange lichen or fresh whitewash is visible. Two or three passes are made along the rock face looking for adult birds and nests.
- When a nest is located the number of eggs and/or chicks are counted, their age estimated, and sub-species of adult assessed.
- Opportunistic ground surveys are also carried out every year during hiking patrols, research and monitoring activities, and other park activities.

YEARS OF DATA

- *Historical surveys*: 1986, 1987, 1988, 1989, 1990, 1995, and 2000
- *Post park establishment*: 2005: aerial survey 2006-2008: opportunistic observations

PARTNERS

- Newfoundland and Labrador Wildlife Division
- Canadian Wildlife Service

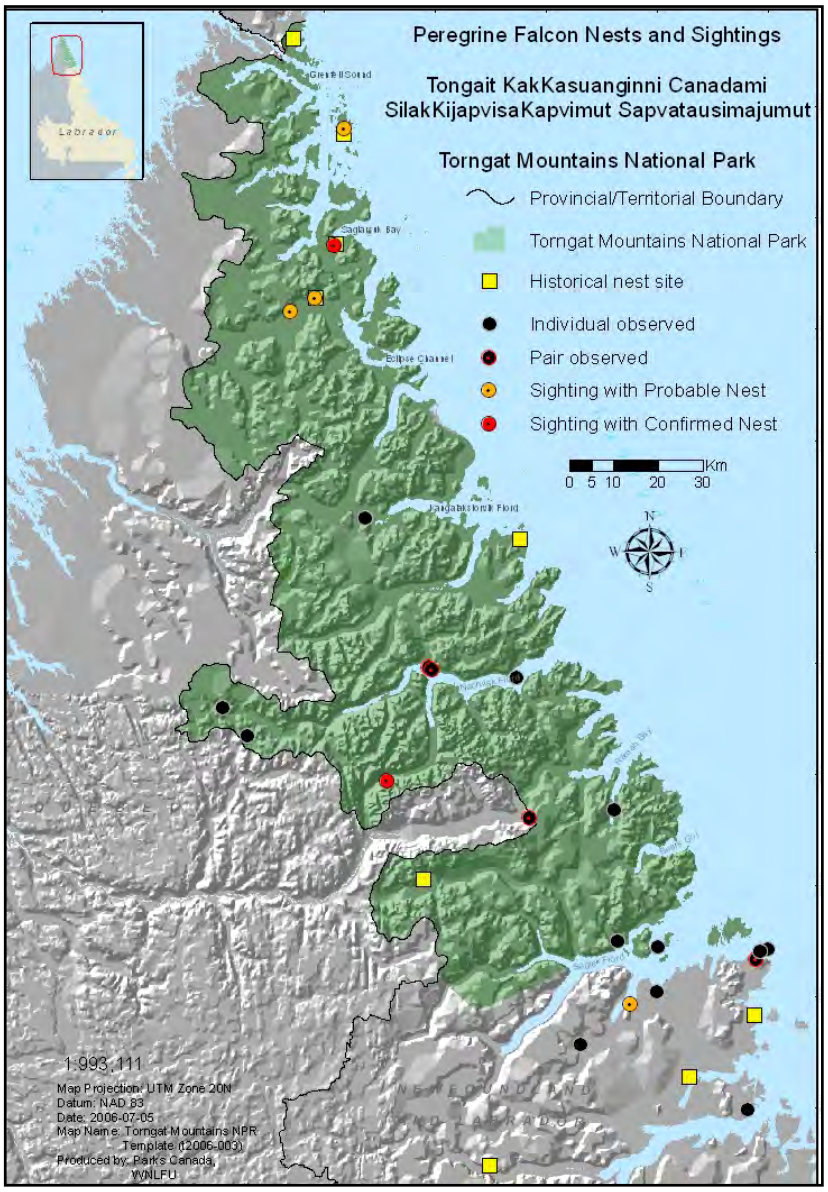
FUNDING

- Parks Canada Species at Risk Fund
- Government of Newfoundland and Labrador

RESULTS

Aerial Survey: July 27-31,2005

- One potential new nest site found in Eclipse valley
- One of 6 known nest sites was confirmed to be active. It had 2 adults and 2 chicks
- Adult birds observed in three other breeding territories but nests could not be located.
- In total 6 adults and 2 chicks were observed near historical nest sites, while three other birds were observed in areas where no nest has ever been found.



Opportunistic Ground Surveys

- Ground surveys occurred in Sept 2005, and July-August 2006, 2007, and 2008.
- Peregrine falcons observed regularly between Nachvak Fiord and Saglek Bay, occurring singly and in pairs away from known nest sites. This suggests the existence of previously unknown nests.
- Two adults and 2 fledglings were seen in Pangetok Inlet in late August 2006 and showed a strong affinity to a nest that had been occupied that season.
- In August 2008 a Parks Canada foot patrol identified a previously unknown nest in the upper Palmer River valley.

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RATIONALE

Since its inception in 2005, the number of people visiting TMNP has steadily increased. Visitors include researchers and other user groups who spend time in the park. Understanding the type of activities people participate in while in the park is valuable for long-term park management. Knowing the interests and needs of visitors helps park managers develop unique, safe and memorable experiences. It also helps to ensure that activities in the park do not affect ecosystem health or come into conflict with wildlife. While Inuit presence on the land is a central park management goal, Inuit are not considered visitors in TMNP. However, their numbers are included in the overall figures in Table 1.

Parks Canada Monitoring

HUMAN USE MONITORING IN TMNP

OBJECTIVES:

- To document the number of people visiting the park and record the type of activities they engage in and the locations they visit.
- To generate information necessary to adapt park planning and programs to best serve park visitors while maintaining park ecological integrity and meeting park management goals.

Cruise ship visiting kANGIDLUASUK in Aug 2008

METHODS AND INFORMATION COLLECTED:

- All visitors entering the park must register with the park administration office.
- The number of people in the park, the dates of their visit and the activities that they conduct are recorded.
- Visitors are categorized as: recreational boaters, cruise ship passengers, outfitted recreational visitors, non-outfitted recreational visitors, researchers, contractors, park staff, and base camp guests (everyone not included in the above categories).
- Where applicable, Inuit are included in the researchers, contractors, park staff, and base camp guests categories.
- An online visitor survey was conducted with researchers and non-cruise ship visitors. The cruise ship passengers will be surveyed in 2009. (see separate report in the research section of this document)

kANGIDLUASUK visitors on a shore excursion to North Arm, Saglek Fiord

YEARS OF DATA:

- 2006, 2007 and 2008

Table 1: Visitor statistics for years 2006-2008, categorized by major activity groups.

Activity	2006	2007	2008
Recreational boating/sailing	4	4	21
Cruise ships	150	275	364
Outfitted & non-outfitted trips	12	49	27
Researchers	31	58	51
Contractors	19	24	29
Park Staff	9	11	15
Base Camp Guests	47	63	58
Total	**272**	**484**	**565**

RESULTS

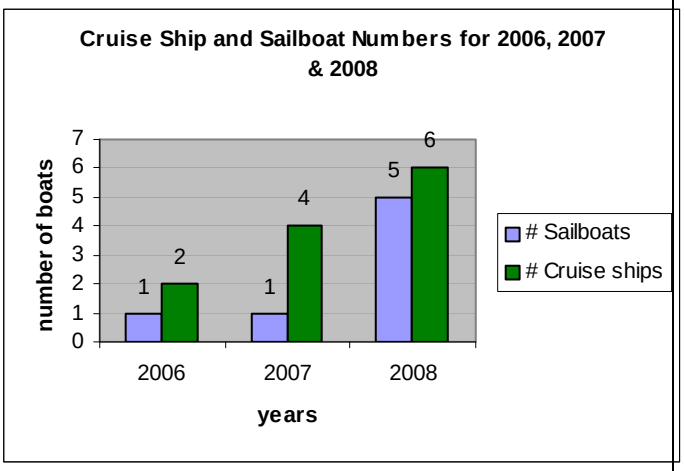
- Most types of park visitation have increased since 2006 (Table 1).
- Number of cruise ship visits has tripled since 2006 (Figure 1).
- The number of private yacht visits is also increasing as more sailors venture into northern waters.
- Parks Canada has operated a base camp (kANGIDLUASUK) at the southern boundary of the park since 2006. This camp facilitates access to the park for Parks Canada staff, researchers, Inuit and other visitors. It also serves as an orientation, reception and access point for visitors. The number of participants at kANGIDLUASUK has increased steadily since 2006 (Table 2).

Table 2: Number of participants at kANGIDLUASUK each year

Year	# people	Total person days
2006	63	600
2007	146	1381
2008	165	2033

Hikers camped above the Palmer River Valley over looking Nachvak Fiord

Figure 1: Numbers of sailboats and cruise ships visiting TMNP, 2006-2008.



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RATIONALE

Sea ice is a defining aspect of the northern Labrador coast. It is of direct importance to marine life, including such species as polar bear, ringed seal, seabirds and coastal fish, and has a profound influence on regional weather, climate, and ocean dynamics. It is also of vital importance to people living in the region, offering such benefits as enhanced coastal travel and hunting grounds during winter and spring, but also bringing inherent dangers to travelers as the conditions be come less predictable. Developing a monitoring program that can provide timely information about sea ice conditions will be of great benefit to northern people who rely on sea ice for travel and hunting.

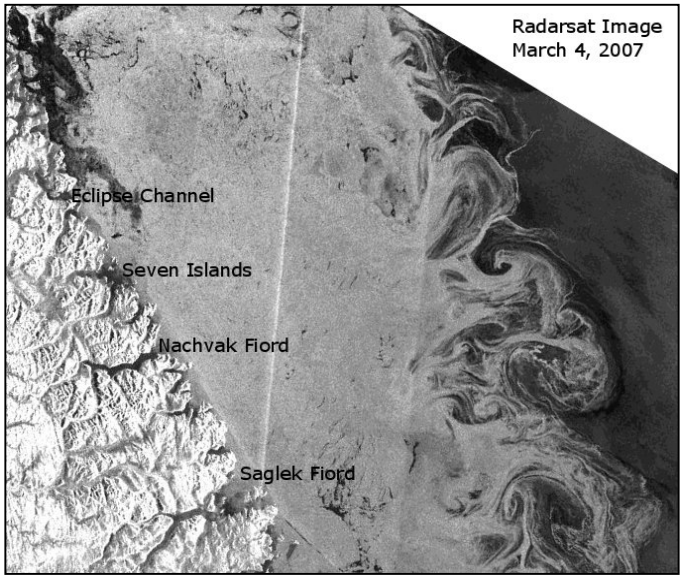
SEA ICE MONITORING

OBJECTIVES

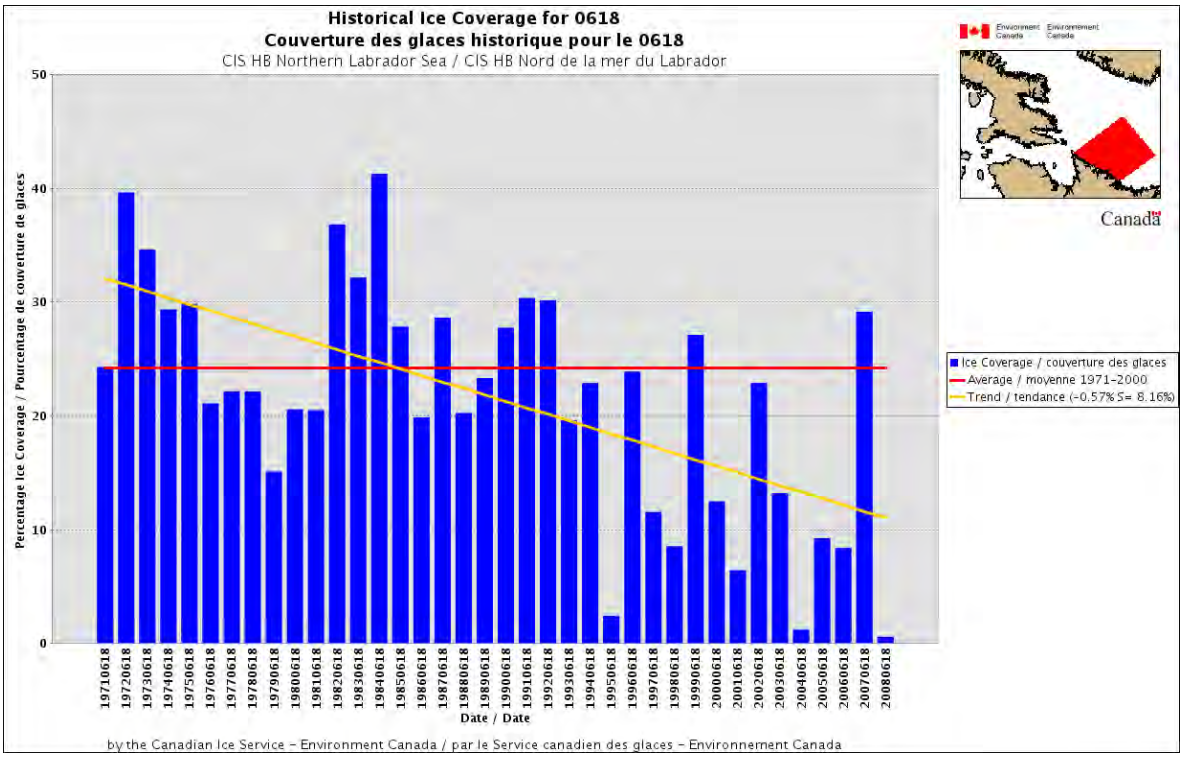
- To develop one or more measures that quantify status and trends in sea ice conditions along the coast of Torngat Mountains National Park.
- To relate patterns to those seen in other national parks in the Canadian Arctic.
- To provide information on short and long term patterns of sea ice coverage that incorporate and compliment observations of local Inuit.

METHODS AND INFORMATION COLLECTED

- A Parks Canada sea ice working group has been established and includes representatives from the Western and Northern Service Centre and national parks across the Canadian Arctic.
- A parks Canada sea ice database is being compiled by staff at the Western and Northern Service Centre. Data come from the the Canadian Ice Service's archives and consist of weekly ice coverage maps from 1971 onwards.
- The working group will develop a set of candidate sea ice monitoring measures. These will draw on scientific knowledge and local ecological knowledge, and may involve both satellite and community based monitoring.
- Sea ice measure(s) will include consideration of factors that are important to people, wildlife, and ecological and climate processes. Measures may incorporate such factors as ice extent, ice thickness, ice age, floe size, ice openings, and timing and duration of ice coverage.



Satellite images such as this Radarsat scene of the Torngat Mountains National Park coast are collected weekly by the Canadian Ice Service and can be used to monitor large scale patterns in ice coverage. Canadian Ice Service image.



Remote sensing data can reveal long-term patterns in sea ice dynamics. The yellow trend line in this graph indicates that the percent coverage of sea ice on June 18th of each year has declined in the northern Labrador Sea since 1971. Visual inspection suggests that there was a shift in 1995, after which the extent of ice coverage became more erratic.

YEARS OF DATA

- The Canadian Ice Service maintains a remote-sensing based sea ice data archive with weekly coverage from 1971 to present.

PARTNERS

- Canadian Ice Service
- Parks Canada - northern bioregion
- Local communities
- Canadian Centre for Remote Sensing- Natural Resources Canada

FUNDING

- Parks Canada

RESULTS

- Measures are still in development.
- Summary data on ice coverage in the northern Labrador Sea are currently available from the Canadian Ice Service (see figure).

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RATIONALE

Benthic invertebrates are used as indicators of water quality in many parts of the world and offer a promising approach to monitoring ecological change in northern parks. However, northern ecosystems differ considerably from those where these tools were developed. As such, research is required to better understand the characteristics of "healthy" invertebrate communities in northern ecosystems and to assess the value of this approach as a biomonitoring tool in the north.

FRESHWATER BIOMONITORING IN TMNP – 2008 SEASON

OBJECTIVES:

- To continue to sample macro-invertebrate communities, water chemistry and primary production in streams in Torngat Mountains National Park. This information will contribute to describing "reference conditions" for healthy areas in northern Labrador.
- To assess the feasibility of collecting and using benthic invertebrates for park monitoring. Sampling the same sites over multiple years will provide information on our ability to detect change in the North's unique ecosystems.
- To integrate local Inuit into this element of the monitoring program.

Dorothy Angnatok and Samuel Ittulak collecting periphyton samples

METHOD AND INFORMATION COLLECTED:

This sampling program relies on a standard set of field protocols developed by the Canadian Aquatic Biomonitoring Network, which have previously been used at several temperate field sites in Canada to characterize stream habitat and benthic macroinvertebrate community structure. At each site several habitat variables are measured, water samples are collected, benthic invertebrates are collected with a 3-minute kick-net sample, and periphyton (algae) is scraped from a sample of rocks.

Field activities:

- Sampling occurred in Saglek and Nachvak Fiords (2006 and 2007).
- Four Inuit (2 students and 2 crew of the What's Happening) were trained in CABIN sampling procedures and were integral contributors to the field collections.
- Fourteen sites in riffle-run habitats were visited, augmenting approximately 9 sites re-sampled by the Environment Canada/UNB team.
- A 3-minute kick-net sample of benthic invertebrates was collected.
- Stream characteristics measured at each site include lat/long, width, water velocity, shoreline vegetation, aquatic vegetation, canopy cover, distance above tideline, and primary productivity.
- Photographs were taken to characterize each site as well as identify stream substrate size.
- Water samples were collected at each site.

Laboratory activities:

- Invertebrate samples (2007,2008) to be sorted, sub-sampled and processed according to the CABIN protocol.
- Invertebrates will be identified to the lowest feasible level for 2007, 2008. Samples from 2006 will be reprocessed to the same level of identification.
- Invertebrate data will be entered into the Environment Canada CABIN database.
- Water chemistry is being analyzed by Environment Canada (results pending).
- Chlorophyll A levels will be measured in periphyton samples.

Elias Obed kicknet sampling benthic invertebrates in Nachvak Fiord

PARTNERS:

- Environment Canada
- Nunatsiavut Government
- University of New Brunswick

RESULTS:

***Preliminary Results from 2006**:*

- Mean of 10.2 families of benthic invertebrates per site (range: 6-15). For comparison, this is lower than is typical in insular Newfoundland.
- Statistical analyses suggest the habitats we sampled in the Torngats support a total of 35-60 families of benthic invertebrates.
- Estimated number of invertebrates ranged from 138-2925 per site (mean = 898).
- Invertebrate communities in Saglek and Nachvak were similar despite Nachvak's more northerly location.
- The sample taken below the PCB containment facility at the Saglek radar base (SRC0106) was similar to samples from un-contaminated sites.

Benthic invertebrates are an important food source for young that will be spawned by these Arctic char in Tinutyarvik Brook, Nachvak Fiord.

Proposed activities for 2009/2010:

- Re-sampling of coastal sites in Nachvak and Saglek Fiords. Two additional years of sampling (5 in total) should provide sufficient data to understand annual variation in benthic communities. This information will be critical for assessing our ability to detect ecosystem change with this monitoring measure.

***Proposed data uses**:*

- Develop a "reference condition" to be used when assessing stream community health in Northern Labrador (planned data sharing with Environment Canada/UNB will improve this product).
- Contribute to "Sea to Sky" sampling conducted by Environment Canada/UNB
- Assess statistical power of benthic invertebrate monitoring given the community structure observed in northern streams
- Combine with similar data sets from other national parks to describe variation in benthic invertebrate communities along the Atlantic coast from Nova Scotia through the high Arctic. Again, collaboration with Environment Canada/UNB is planned.

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RATIONALE

Some environmental changes are best understood by looking at entire landscapes. Parks Canada is monitoring changes in plant productivity using a normalized difference vegetation index (NDVI), which is acquired from images taken by AVHRR and MODIS satellite sensors. NDVI is used as a measure of plant productivity and to determine the timing of leaf emergence each year. The Satellite Monitoring of Northern Ecosystems project includes twelve national parks in the Canadian north, including: Aulavik, Auyuittuq, Ivvavik, Kluane, Nahanni, Sirmilik, Torngat Mountains, Tuktut Nogait, Ukkusiksalik, Vuntut, Wapusk and Wood Buffalo National Parks of Canada.

SATTELITE MONITORING OF NORTHERN ECOSYSTEMS

OBJECTIVES

- To monitor large-scale variation in plant productivity in Northern national parks.
- To monitor changes in the timing of leaf emergence (green-up) in Northern national parks.

METHODS AND INFORMATION COLLECTED

- The program has collected and compiled satellite images from AVHRR since 1985 and MODIS since 2000.
- We have also compiled climate station data (temperature and precipitation) for to relate to satellite images taken from April 1 to October 31 each year.
- To reduce cloud effects images taken over ten-day periods are combined into composites.
- Analysis of composite satellite images is conducted by the Parks Canada Western and Northern Canada Service Centre in Winnipeg.
- Ecodistricts are used as sampling units in order to best integrate satellite data with available landscape and biological information.

YEARS OF DATA

- 1985-present

PARTNERS

- Parks Canada - Western and Northern Canada Service Centre
- University of Saskatchewan

FUNDING

- Parks Canada

NDVI is a method to track seasonal plant growth using satellite imagery, and over time can provide information on changes in growing season timing and length as well as landscape-scale plant biomass.

RESULTS

- Procedures for compiling and extracting NDVI and collecting climate data were developed, and a complete NDVI, LST, and climate database was

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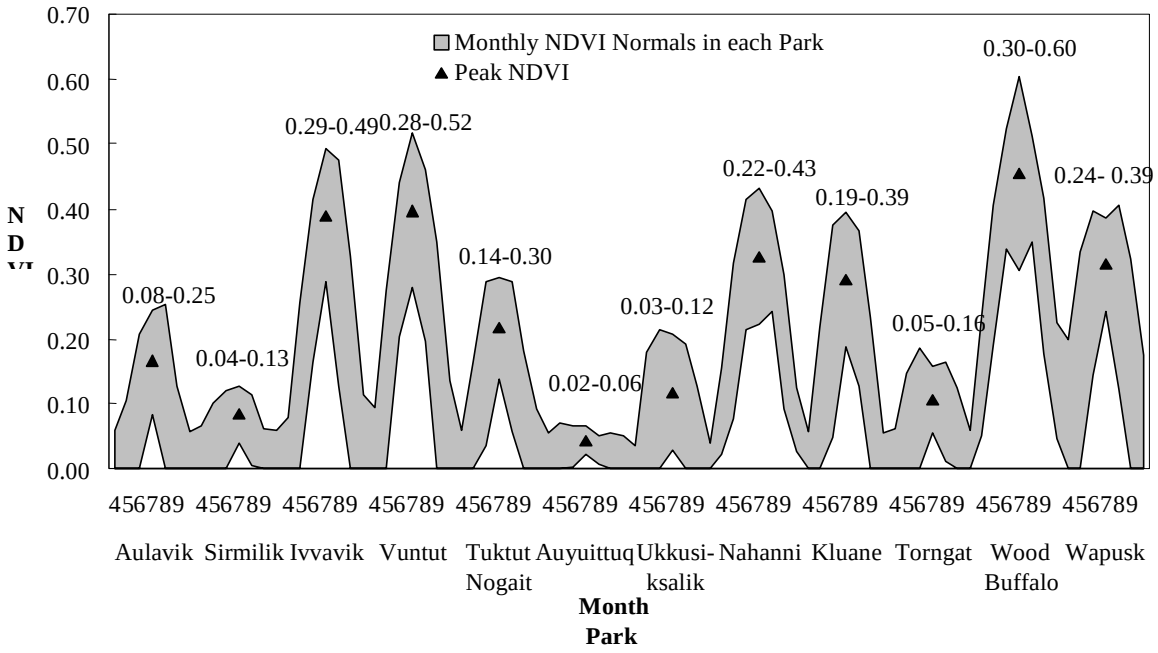
compiled for each northern park and ecoregion.

- Monthly and annual NDVI normals were measured within-park ecoregions and ecodistricts surrounding parks.
- NDVI observations were related to climate data; temperature explains more variation in NDVI than precipitation.
- Relations between temporal patterns in NDVI and climate indicate that NDVI may have been affected by weather in particular years from 1985–2007.
- The effect of temperature or precipitation on NDVI is not only spatial scale-dependent but also time-dependent, affecting plant growth at 2-4 year time scales. However not all climate variation resulted variation in vegetation growth and other factors affected productivity at certain scales.
- Annual NDVI change rates were spatially variable but all increased across ecozones during the study period. A corresponding increasing trend in growing-season temperature has also occurred in most ecozones.
- Weaker relationships between precipitation and NDVI indicated that water availability was not a major constraint on vegetation productivity in the North.
- Increases in NDVI typically occurred in years when El Niño brought warm weather, while NDVI decreased when La Niña events led to a cooler climate.
- MODIS-based NDVI estimates were higher than those estimated from AVHRR images, with the greatest differences occurring at the beginning and end of growing season. However there was still a strong relationship between the two datasets so it may be possible to combine these data sources for some analyses.



Monthly NDVI normals measured over 23 years (1985-2007) for 12 northern national parks. Values for Torngat Mountains National Park are relatively low, a reflection of the sparse vegetation typical of this and other Arctic parks such as Sirmilik and Auyuittuq.

ANNUAL REPORT OF RESEARCH AND MONITORING IN TORNGAT MOUNTAINS NATIONAL PARK 2008