IMALIRIJIIT

Monitoring George River Water Quality

2016 Science Land Camp – Scientific report

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1. Introduction

Adjusting to global climate and socio-environmental change has become a major issue for northern communities and for researchers. The Arctic is one of the most rapidly changing regions on the planet and Inuit communities are thus facing many challenges (Arctic Human Development Report, 2015). Scientists and northern residents are witnessing accelerated warming in this region (Pearce et al., 2009). In addition, there is significant pressure to exploit northern natural resources at the same time as there are calls for sustainable development by governments and local populations. Arctic communities are concerned about their future and wish to better understand the social, environmental and economic changes related to ongoing industrial development and climate change (Rodon, et al., 2014). They are concerned about the effects of climate change, mining and non-traditional lifestyles on their health, well-being and quality of life (Pearce et al, 2015). They also worry about the future and the education of youth, the widening generation gap, the preservation of traditional hunting, fishing and gathering techniques, as well as threats to Inuit culture and language (Laugrand and Oosten, 2009).

A group of researchers affiliated with Université du Québec à Trois-Rivières (UQTR), the Centre d'études nordiques (CEN), and OHMi Nunavik launched a project call to the Nunavik Inuit communities in summer 2015 to evaluate their interest in doing a Science Land Camp. This initiative was aiming to build a community-based environmental monitoring (CbEM) project expressly involving the local youth while promoting environmental sciences. The notion of CbEM refers to the direct involvement of local community members in monitoring/measuring the environmental quality of the ecosystems in their community, either through their participation in collaborative monitoring efforts, or by training local members to carry out monitoring projects. Community Based Environmental Monitoring (CbEM) is part of the field of Citizen Science. Whitelaw et al. (2003) first defined CbEM as "a process where concerned citizens, government agencies, industry, academia, community groups and local institutions collaborate to monitor, track and respond to issues of common community concern". There are numerous advantages to CbEM: it can build bridges between indigenous and scientific knowledge, favour trust between communities and institutionalized science, engage community members in the scientific process, and generate community-oriented data for management decisions (Lefler 2010). Therefore, it can lead to community empowerment, especially at the youth level. Nevertheless, there are also difficulties associated with CbEM, such as non-systematic data collection, volunteers losing interest and defining ownership of the data. Being conscious of these challenges from the start, they will be assessed and addressed with the community in a true partnership.

The community of Kangiqsualujjuaq answered the call and submited a resolution from the Municipal Council to confirm their will to participate in such a project. Researchers then traveled to Kangiqsualujjuaq from October 26th to 30th 2015 to consult with representatives from four groups separately: the Municipal Council, the Landholding Committee, the Culture Committee and the Youth Committee. After brainstorming about environmental interests and concerns in the perspective of a weeklong Science Land Camp involving youth, the researchers proposed three different scenarios: 1) Monitoring the George River Water Quality; 2) Studying Vegetation and Landscape Evolution in the Koroc River area; and 3) Inventorying the Edible Marine Resources in a location to be determined. The first scenario was unanimously chosen in the context of a rare earth element (REE) mining project planning to start its operations in the coming years in the upper watershed of the George River. Kangiqsualujjuamiut are concerned because the river is crucial to their traditional activities of fishing, hunting and gathering. The community therefore insisted they wanted their own independent and long- term environmental survey, baseline data and a strong youth training component for local capacity-building.

Partnerships were developed to complete the expertise of the team: University of Montreal in collaboration with Environment Canada for the field sampling and water samples analysis; Nunavik Research Centre for contaminant analysis in fish specimens; Nunavik Parks for accommodation, material and human resources; and Education and Water Monitoring Action Group (G3E/EWAG) for training sessions, support and pedagogical tools. Diverse disciplines and expertise are involved including human and physical geography, remote sensing, plant ecology, hydrology and ecotoxicology.

The IMALIRIJIIT project has three main objectives:

- To put in place a long-term community-based environmental monitoring program of the George River and its watershed;
- To foster local capacity in biological sampling, data management and analysis, and interactive mapping;
- To create interest for environmental sciences among youth and other community members while addressing local environmental issues.

2. Study site

Kangiqsualujjuaq is located at the mouth of George River, in Nunavik, the northern part of Quebec, 25 km from Ungava Bay (N 58.69°, W 65.94°) (Figure 1). It is part of the Low Arctic near the treeline, in the low shrub subzone, with discontinuous permafrost lying under valleys and continuous permafrost found beneath plateaus and mountains. The George River flows northerly for 505 km towards Ungava Bay and its watershed spreads over 41 700 km². Kangiqsualujjuaq was established in 1962 and its population was estimated at 874 people in the 2011 Statistics Canada Census.

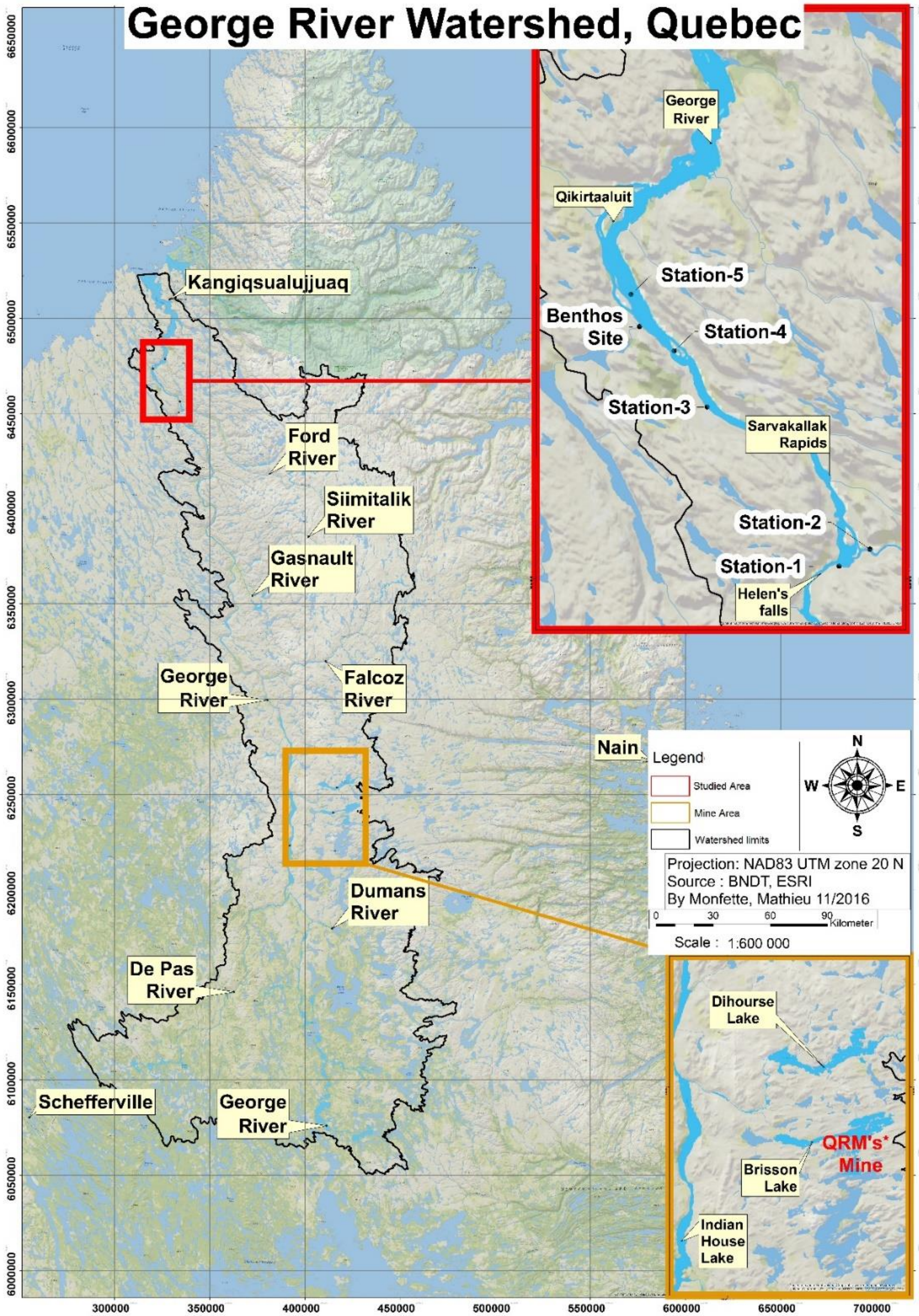


Figure 1. George River watershed and location of the 2016 Science Land Camp five sampling stations.

3. 2016 Science Land Camp

3.1 General description

The Science Land Camp took place on the George River from July 22nd to July 29th 2016 and brought together 23 people. The participants included:

- Eight students from 12 to 17 years old: Eli Annanack, Morgan Annanack, Rupert Annanack, Lise Morgan, Vanessa Snowball, Clara Unatweenuk, Sarah Unatweenuk, Vanita Weetaltuk;
- Two elders: Mary Elisabeth Annanack, Minnie Mae Annanack;
- Three guides and one assistant: Paulosie Jararuse, Alex Noah Morgan, Joe Etok, Joshua Annanack;
- Three cooks: Mary Annanack, Louisa Minnie Etok with her daughter Qippita, Julianne Imbeault;
- Five researchers: José Gérin-Lajoie (coordinator, UQTR), Émilie Hébert-Houle (MSc student, UQTR), Mathieu Monfette (MSc student, UdeM), Justine-Anne Rowell (MSc student, UdeM), Tim Anaviapik Soucie (independent Inuk researcher in water quality monitoring from Pond Inlet, Nunavut) (Figure 3).

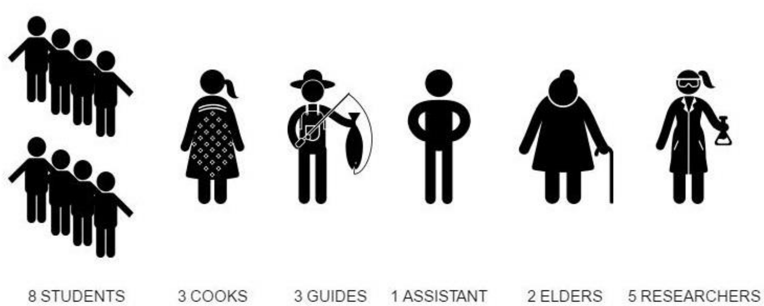


Figure 2. 2016 Science Land Camp participants

A reconnaissance trip on the river took place in early July in collaboration with Parks Nunavik. Camp logistics were finalized the week prior to the camp as well as an introduction meeting with the youth. Three boats stayed with the crew for the whole trip but four more boats, guides, and assistants were needed to get the people, material and camping gear to the campsite and back.

Several pre-sampling training workshops were organized at the beginning of the camp and five stations were established along a 35 km stretch of the river, between Helen Falls and Qikirtaaluit Islands (Figure 1). In this segment, the river's width is approximately 0.7 km to 1.7 km. Each station was visited and sampled twice. Water quality was measured *in situ* with manual kits and an electronic probe (temperature, pH, conductivity, dissolved oxygen, turbidity, hardness, temperature, color) and water samples were collected (unfiltered and filtered) for laboratory analyzes of nutrients, major ions, chlorophyll-*a*, trace metals and rare earth elements. (Environment Canada and University of Montreal).

Figure 3. Tim Anaviapik Soucie, an independent Inuk researcher in water quality from Pond Inlet (Nunavut), acted as a mentor for the youth and other local participants and was a great reference for all.

Transects across the river were done at strategic places to explore water depth. In addition, a macro-invertebrate station was sampled in a tributary brook; subsampling and identification was done at the camp. Macro-invertebrates are water creatures (insects and non-insects like snails) that live in streams, rivers and lakes under rocks and can inform us of the health of the water body. Some species require good water quality to survive and are sensitive to pollution, while others are more tolerant. Water sampling is a snapshot of water quality at one specific moment in time, whereas macro-invertebrate populations reflect water quality over the longer-term.

Interviews and discussions with the elders and guides took place several times to encourage intergenerational knowledge transfer, and to document Inuit knowledge related to the George River and observations of hydrological changes, thus linking Inuit knowledge and science. Various recreational activities were conducted between scientific workshops and sampling periods (Figure 4). Evening recognition and initiation events, as well as "Scientist of the day" nominations were used as a tool to boost the motivation of the youth.

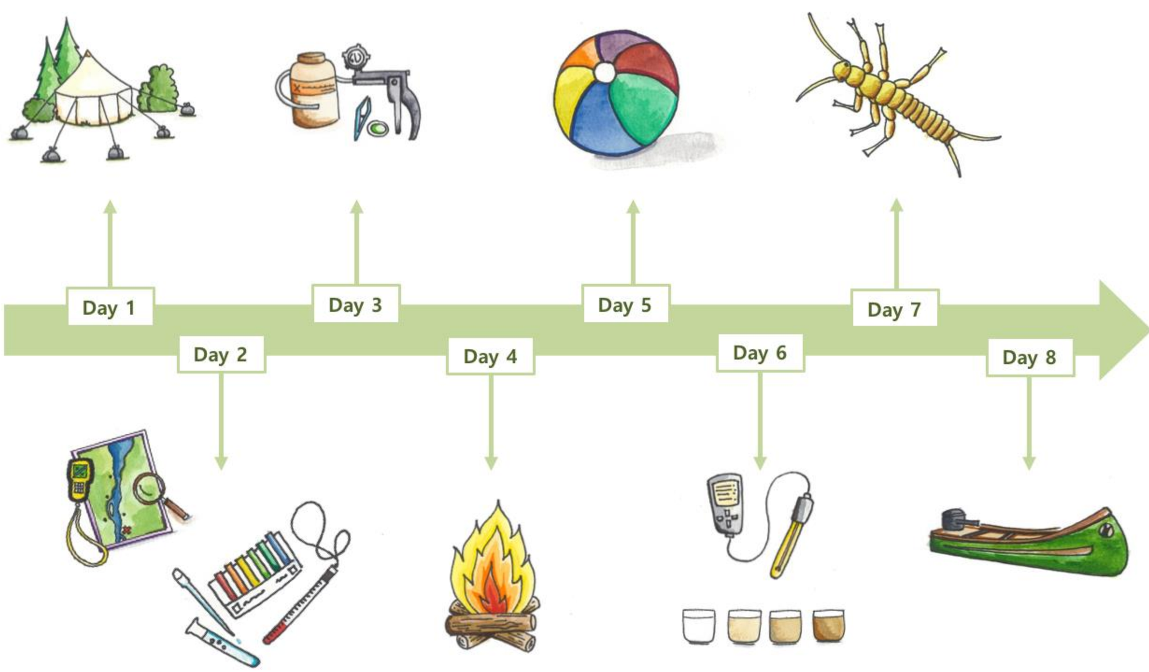


Figure 4. Science Land Camp time line

3.2 Methodology: Training workshops, sampling activities and collected data

3.2.1 Reconnaissance trip

The research coordinator visited the community prior to the Science Land Camp on July 4th to 8th to help with the logistics and to do a reconnaissance trip on the river (July 6th). This trip was realized in collaboration with Élise Rioux-Paquette from Nunavik Parks and local guides, Joshua and Don Annanack. Exploration for the location of basecamp and sampling stations (water and macro-invertebrates) took place and basic water quality parameters were measured at nine stations.

Maps, scientific sampling material and protocols were prepared and the whole team of researchers arrived in the community one week prior to the camp. A coordination meeting was organized with the Municipal Council and the Youth Committee to finalize the organization and select the participants. The students were met personally, with the help of the Youth Committee, to invite them to a Pre-Camp activity at the Community Centre and to distribute consent forms to be signed by their parents or tutors. During this activity, an ice breaker game was organized to know better each other. All the scientific material and instruments were displayed to allow participants to familiarize themselves with the equipment and ask questions. Instructions for departure were also given on this occasion. All the preparation for the camp was done in collaboration with members of the Youth Committee.

3.2.2 Selection and description of sampling sites

According to local knowledge, the tidal influence ends around the Qikirtaaluit Islands. The sampling zone was therefore selected between this area and Helen Falls, 3 km long rapids requiring a portage. Remote sensing was used as a complementary tool to identify active sedimentation zones, thus influencing the location of some stations.

The stations were characterized directly on the site with the help of the youth and other participants. Sketches were also realized to complete the description.

Station 1-Helen Falls (N 58° 14' 28.7" W 65° 53' 25.8") was located just downstream from Helen Falls, where the river widens and forms a calm bay and sandy beaches with boulders, on the eastern side of the river and in front of a sand island.

Station 2-Ford River (N 58° 10' 42.4" W 65° 46' 21.1") was located in the middle of the Ford River, up to where a boat can navigate safely. The Ford River is a major affluent of the George River and acts as a reference site. The water was very transparent, appearing green, with erosion signs on the north shore.

Station 3-Small Beach (N 58° 15' 28.5" W 65° 57' 45") was located on a sandy beach with some stones on the western side of the river, just upstream from a little stream joining the river. The water was shallow in this area. There were few grasses but shrubs and conifers were abundant.

Station 4-Big Beach (N 58° 17' 26.3" W 66° 0' 4.8") was located on the western side of a sandy island in the middle of the George River, which is part of a group of islands. The shore was steep on this side and dense bushes with conifers were colonizing the middle of the island.

Station 5-Urpilik (N 58° 19' 21.3" W 66° 03' 08.1") was located in the middle of the George River, between a big island colonized by shrubs and tamaracks on the western side and the eastern shore. The river starts to widen at this place and the river was quite shallow in this area, with boulders.

Station 6-Benthos (N 58° 18' 14.9" W 66° 02' 29.6") was located on the west side of the river, between stations 4 and 5, in a small stream ending in a protected inlet of the river. The bed was mostly rocky with big boulders, turning into mud before joining the river inlet. The banks were densely vegetated with grasses, alders, willows, some birch trees and conifers.

The water flow was generally moderate and deep water holes of more than 60 meters (m) were measured downstream from Sarvakallak rapids.

3.2.3 Pre-sampling training workshops

Cartography, GPS and remote sensing

Initiation to maps, satellite imagery, aerial photograph interpretation and GPS technology was done with the youth. A treasure hunt using GPS was organized to introduce or to consolidate the use of this tool for each student (Figure 5). When correctly used, GPS is a very important tool providing spatial context to any monitoring project. Each student had to find a treasure, which was a little scientist kit with notebook, pencils, magnifying glass, etc. and treasures were hidden near basecamp in the forest. To find them, students were asked to enter specific coordinates on the GPS and follow them around the camp to find their kit.

Figure 5. Front left to right: GPS workshop with Lise, Émilie and Justine; site characterization with Joshua, Louisa and Alex; treasure hunt with Clara, José and Vanita; and territory exploration with Morgan, Mathieu and Rupert.

Site characterization

An initial site characterization was realized at the basecamp's beach as a practice site. The youth learned how to describe and sketch the vegetation, waterway, riverbed, and weather conditions, as well as how to measure water temperature, colour, and current speed.

Water quality parameters

To assess the water quality of a waterbody, several physical and chemical parameters can be measured directly on the field (*in situ*). The students learned how to measure temperature, pH, dissolved oxygen, colour, water hardness and turbidity. Detailed explanations about these parameters are given in section 4.1.

At the camp, students were introduced to water quality parameters and how to use the manual measurement kits and the YSI Pro electronic probe. They sampled water on the beach near the camp and measured its physico-chemical properties. The students learned to handle the equipment with care, and understood the importance of wearing gloves while sampling water and manipulating chemicals. They finally learned to record and compile the data correctly, an essential skill for a scientist, as the noted values need to be easily associated with the sampling station when compiling the results.

3.2.4 Data collection and sampling activities

Each station was visited and sampled twice *in situ* (Table 1). Work at one station included:

- Site characterization, including GPS coordinates;
- Field measurements with manual kits: pH, dissolved oxygen, turbidity, hardness, temperature
- Colour with Forel-Ule scale;
- Field measurements with a YSI Pro electronic probe: temperature, pH, conductivity, dissolved oxygen;
- Collection of water samples (filtered and unfiltered) for further laboratory analyzes.
- Water depth (Humminbird Fishin' Buddy Sonar) and speed (Global Flow Probe, FP101) at specific locations.

A laboratory tent was set on the camp to facilitate scientific activities and allow the storage of equipment.

Table 1. Sampling stations description

	Stations	Name	Latitude	Longitude	Date	Time
Sampling #1	Station 1	Helen Falls	58° 14' 28.7"	65° 53' 25.8"	July 24 2016	14:15
	Station 2	Ford River	58° 10' 42.4"	65° 46' 21.1"	July 24 2016	16:15
	Station 3	Small Beach	58° 15' 28.5"	65° 57' 45.0"	July 25 2016	11:54
	Station 4	Big Beach	58° 17' 26.3"	66° 0' 4.8"	July 25 2016	17:20
	Station 5	Urpilik	58° 19' 21.3"	66° 03' 08.1"	July 25 2016	16:11
Sampling #2	Station 1	Helen Falls	58° 14' 28.7"	65° 53' 25.8"	July 27 2016	12:40
	Station 2	Ford River	58° 10' 42.6"	65° 46' 23.3"	July 27 2016	10:45
	Station 3	Small Beach	58° 15' 29.4"	65° 57' 42.2"	July 27 2016	15:55
	Station 4	Big Beach	58° 17' 26.8"	66° 0' 05.3"	July 28 2016	13:40
	Station 5	Urpilik	58° 19' 22.5"	66° 03' 09.4"	July 28 2016	11:29

In situ measurements and water physico-chemistry

Following this training, students began sampling at each station with the site characterization by observing the environment, taking notes about physical characteristics of the water, the shoreline, the vegetation and more generally, the landscape. The students also had to note the GPS coordinates.

The students were then in charge of water sampling and physicochemical measurements with the manual kits. They were supervised by the researchers, but had to carry out the measurements on their own (Figure 6). At each sampling station, the students also assisted Tim during probe measurements. Guides and cooks also actively participated in the measurements.

Figure 6. From left to right: water sample collection with Justine and Joshua; water color determination with Lise; water sampling for laboratory analyses; and manual measurements of turbidity with Morgan.

Collection of water samples

In addition to the *in situ* measurements, water samples were also taken for laboratory analyses to be completed in southern laboratories (University of Montreal and Environment Canada). Some water quality parameters, such as metal analysis, cannot be measured in the field as they require sample filtration, conservation and complex analytical instruments. This type of sampling also requires more in-depth training and strict adherence to clean sampling protocols.

Plastic bottles used for trace metal analyses must be thoroughly cleaned and packed in double bags prior to sampling. As a precaution, most bottles were acid-washed before being sent into the field. As mentioned in the *Future work* section, special attention will be paid to the cleaning of sampling equipment for the 2017 sampling campaign.

Bottles and tubes were identified in advance with station and sample number. Date and time were added directly in the field. Collected volumes were also noted. Sampling equipment, including glassware and plasticware, filtration units, filters, tweezers and a manual pump, was packed and transported every day from the laboratory tent to each of the sampling stations. Students and researchers used a detailed protocol for sampling preparation (MDDELCC, 2014, Figure 7).

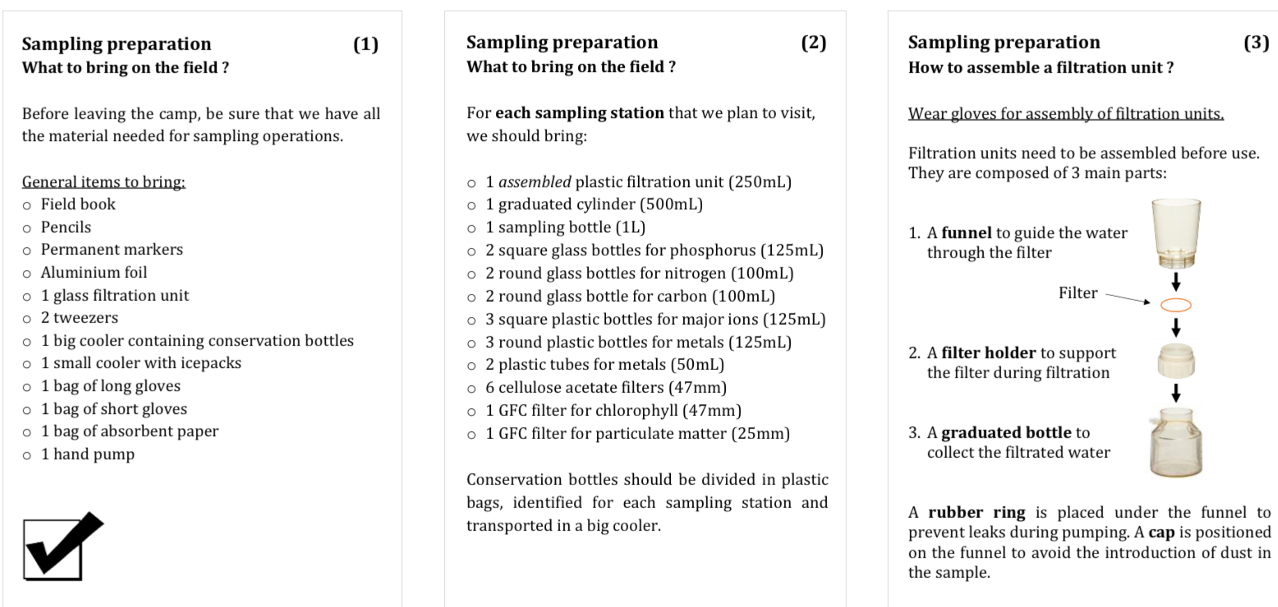
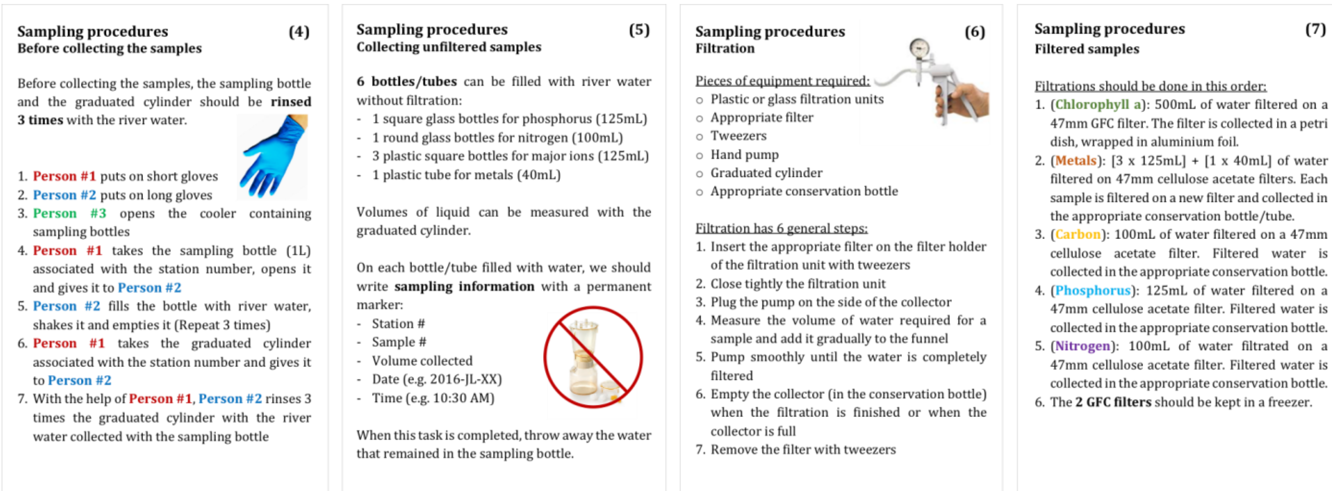


Figure 7. List of sampling material and preparation protocols: (1) General items to bring on the field; (2) Items to bring at each sampling station; (3) How to assemble filtration units?

To separate dissolved and suspended fractions, some samples were filtered using a filtration unit and a manual pump (Figure 8). According to the type of samples, different filter sizes were used. Guides, cooks and students participated in the water collection and its filtration.


Sampling procedures (4)
Before collecting the samples

Before collecting the samples, the sampling bottle and the graduated cylinder should be **rinsed 3 times** with the river water.

1. Person #1 puts on short gloves
2. Person #2 puts on long gloves
3. Person #3 opens the cooler containing sampling bottles
4. Person #1 takes the sampling bottle (1L) associated with the station number, opens it and gives it to Person #2
5. Person #2 fills the bottle with river water, shakes it and empties it (Repeat 3 times)
6. Person #1 takes the graduated cylinder associated with the station number and gives it to Person #2
7. With the help of Person #1, Person #2 rinses 3 times the graduated cylinder with the river water collected with the sampling bottle

Sampling procedures (5)
Collecting unfiltered samples

6 bottles/tubes can be filled with river water without filtration:
- 1 square glass bottles for phosphorus (125mL)
- 1 round glass bottles for nitrogen (100mL)
- 3 plastic square bottles for major ions (125mL)
- 1 plastic tube for metals (40mL)

Volumes of liquid can be measured with the graduated cylinder.

On each bottle/tube filled with water, we should write **sampling information** with a permanent marker:
- Station #
- Sample #
- Volume collected
- Date (e.g. 2016-JL-XX)
- Time (e.g. 10:30 AM)

When this task is completed, throw away the water that remained in the sampling bottle.

Sampling procedures (6)
Filtration

Pieces of equipment required:
- Plastic or glass filtration units
- Appropriate filter
- Tweezers
- Hand pump
- Graduated cylinder
- Appropriate conservation bottle

Filtration has 6 general steps:
1. Insert the appropriate filter on the filter holder of the filtration unit with tweezers
2. Close tightly the filtration unit
3. Plug the pump on the side of the collector
4. Measure the volume of water required for a sample and add it gradually to the funnel
5. Pump smoothly until the water is completely filtered
6. Empty the collector (in the conservation bottle) when the filtration is finished or when the collector is full
7. Remove the filter with tweezers

Sampling procedures (7)
Filtered samples

Filtrations should be done in this order:
1. (Chlorophyll a): 500mL of water filtered on a 47mm GFC filter. The filter is collected in a petri dish, wrapped in aluminium foil.
2. (Metals): [3 x 125mL] + [1 x 40mL] of water filtered on 47mm cellulose acetate filters. Each sample is filtered on a new filter and collected in the appropriate conservation bottle/tube.
3. (Carbon): 100mL of water filtered on a 47mm cellulose acetate filter. Filtered water is collected in the appropriate conservation bottle.
4. (Phosphorus): 125mL of water filtered on a 47mm cellulose acetate filter. Filtered water is collected in the appropriate conservation bottle.
5. (Nitrogen): 100mL of water filtrated on a 47mm cellulose acetate filter. Filtered water is collected in the appropriate conservation bottle.
6. The **2 GFC filters** should be kept in a freezer.

Figure 8. Sampling procedures protocols: (4) Before collecting the samples; (5) Collecting unfiltered samples; (6) Filtration; (7) Filtered samples.

Difficulties were encountered when applying non-contamination protocols such as wearing gloves and stopping boats engines 50 meters from sampling stations. Special caution will have to be paid to this aspect in 2017.

Samples for trace metal analyses were preserved with ultra-trace acid within 24 hours after sampling. Milli-Q water blanks were collected and acidified at stations 1, 2 and 4 and blank values were subtracted from sample values.

Filters used for chlorophyll collection and measurement were wrapped in plastic petri dishes and aluminum foil. However, as it was not possible to freeze them in the field, filters were placed in plastic bags and bags were immersed in river water to keep them cool. This change to the standard protocol should be considered when examining the chlorophyll results presented in Section 4.

Laboratory analyses

Nutrients, major ions and chlorophyll analyses were conducted in Environment Canada's labs in Burlington, Ontario. Trace metal analyses were completed at University of Montreal in Montreal, Quebec. The major nutrients nitrogen (N) and phosphorus (P) concentrations were measured whereas for the major ions calcium (Ca), magnesium (Mg), potassium (K), and sodium (Na) were quantified.

The trace metal analyses included the measurements of 16 metals and 15 lanthanides elements, more commonly known as rare earth elements (REE). Analysed trace metals included: aluminum (Al), copper (Cu), nickel (Ni), lead (Pb), chromium (Cr), zinc (Zn), arsenic (As), cadmium (Cd), vanadium (V), manganese (Mn), cobalt (Co), selenium (Se), barium (Ba), iron (Fe), uranium (U), and thorium (Th). Analysed rare earth elements included: yttrium (Y), lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), and lutetium (Lu). Metal analyses were conducted with Inductively Coupled Plasma Mass Spectrometry (ICP-MS), using a 7-points calibration curve. Semi-quantitative analysis was first conducted to identify metals of interest. A quantitative analysis was then completed to precisely measure metal concentration. Results and detailed parameters description are provided in Section 4.

Macro-invertebrate inventory

Macro-invertebrates are good indicators of the water quality as these organisms spend at least part of their lifecycles on the riverbed. Each species has different needs and is thus more or less sensitive to the physical and chemical qualities of the habitat. Disruptions in the habitat will affect macro-invertebrate numbers and diversity, which can affect animals further up the food chain such as fish and amphibians.

A preliminary macro-invertebrate inventory was done at the mouth of a tributary brook, between stations 4 and 5, following the MDDEFP (2013) sampling protocol for rocky riverbeds (Figure 9). Twenty samplings of 30 seconds each were done by brushing the stones of the riverbed 50cm in front and upstream of a D-frame net (600 microns) to dislodge free-living and burrowing aquatic macro-invertebrates. Samplings were done in various habitats and currents. After each sampling, the net was rinsed and emptied into a mesh bucket (600 microns). The collected organisms were put into tubs to be sorted (10 minutes), then subsampled (5 minutes), identified and counted.

Figure 9. From left to right: Macro-invertebrate inventory with Rupert; Joshua, Eli and Mathieu capturing macro-invertebrates; collected macro-invertebrates; and collective work a benthos station.

3.2.5 Educational assessment

The land camp framework and environmental science training can help create better understanding of how youth relate to science in different contexts. A qualitative documentation method was used as an educational assessment during the 2016 land camp. The two main methodologies used were observation of participants and researcher's journals from the four Qallunaat researchers (Laperrière, 2009; Noiseux, 2010).

4. Results and discussion

4.1 *In situ* measurements and water physico-chemistry

This section presents the results of water physico-chemistry parameters measured manually by the students. The units used are defined in Table 2 and a compilation of manual kits and electronic probe measurements for temperature, pH, dissolved oxygen, conductivity, hardness and turbidity presented in Table 3. Each parameter is then described in detail and comparisons drawn with values from the Koroc River, Nunavik obtained by Rioux-Paquette (2016).

Table 2. Definition of employed units

Units	Definition
°C	Celsius degree
µS/cm	Microsiemens per centimetre
JTU	Jackson Turbidity Units
mg/L	Milligrams per liter (1mg = 0,001g)
µg/L	Micrograms per liter (1µg = 0,000001g)

Table 3. *In situ* measurements and water physico-chemistry results.

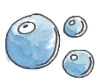
	Temperature		pH		Dissolved oxygen		Conductivity		Hardness		Turbidity	
Units	*°C*		*-*		*mg O_2/L*		*µS/cm*		*mg $CaCO_3$/L*		*JTU*	
Sampling #	#1	#2	#1	#2	#1	#2	#1	#2	#1	#2	#1	#2
Station 1	18.3	17.2	6.20	7.30	9.99	10.2	13.2	13.4	4.43	4.73	18	10
Station 2	13.6	12.7	7.00	7.11	11.43	11.58	13.2	13.4	3.05	3.10	15	5
Station 3	17.2	18.1	7.16	7.15	10.12	10.00	13.4	15.6	4.09	4.88	12	8
Station 4	16.8	15.1	7.25	6.97	10.45	10.34	13.2	13.8	4.10	4.25	7	5
Station 5	16.7	15.5	7.36	7.00	10.93	10.67	12.9	13.2	3.98	4.24	7	5
Mean	16.5	15.7	6.99	7.11	10.58	10.56	13.2	13.9	3.93	4.24	12	7

 *Temperature*

Temperature was measured with a thermometer and was a highly variable parameter, changing from day and night and over weeks, months and seasons. Temperature variations can affect physical, chemical and biological processes in aquatic environments. The average temperature of our water samples, collected in July, was 16 degrees Celsius (°C).

 *pH*

Measuring pH allows us to determine if the water sample is acid (like a lemon), basic (like bleach) or neutral (like distilled water). pH is measured on a scale of 0 to 14 thus 7 is the neutral value. Each increase by one unit in pH indicates a 10-fold increase in acidity. The pH of river water is usually between 6 and 8.5. The pH can have various effects on aquatic environments, including effects on nutrient availability and on the toxicity of different metals. The average pH of our water samples was neutral at 7.05. To compare, the average pH value of the Koroc River (Nunavik) was 6.60 in 2015.

 *Dissolved oxygen*

As oxygen is an essential gas for most living organisms, the measurement of dissolved oxygen is a crucial parameter. A concentration of oxygen between 7 and 11 milligrams per liter (mg/L) is ideal for most fish species. The average dissolved oxygen concentration in our water samples was 10.57 mg/L. The average concentration of dissolved oxygen in the surface water of the Koroc River (Nunavik) was 8.62 mg/L in 2015.

 *Conductivity*

Conductivity is defined as the water's capacity to conduct electricity and depends on its concentration in mineral salts and temperature. Mineral salts, known as ions, can be divided in two categories: cations and anions, respectively positively charged (calcium, magnesium, potassium, sodium, etc.) and negatively charged (bicarbonate, chloride, fluoride, sulphate, nitrate, phosphate, etc.). Conductivity is linked to the local geology and the values we measure should be relatively stable for a given environment. The average conductivity of our water samples was 13.5 micro-Siemens per centimeter (μS/cm). The average value of conductivity for the Koroc River (Nunavik) was 28.8 μS/cm in 2015.

Water hardness

Water hardness is linked to conductivity and the concentration of mineral salts, calcium and magnesium. Very soft water contains between 0 and 30 milligrams per liter (mg/L) of mineral salts and very hard water contains over 160 mg/L of mineral salts. Water hardness can influence the availability and/or toxicity of other elements, such as metals. Hard water is often correlated with a decrease in the toxicity of some metals. The competition between mineral salts and metals for transport sites on cells will reduce the uptake of metals by aquatic organisms. Inversely, metal ions will be more available in soft waters (See Section 4.3 for details). The average water hardness in our samples was low with 4 mg/L of calcium carbonate (mg $CaCO_3$ /L). The average value of hardness for the Koroc River (Nunavik) was 14 mg $CaCO_3$ /L in 2014.

Turbidity

Turbidity is a measure of the water cloudiness, or of how much light can pass through the suspended matter in the water. Some waters are completely clear while others are full of particles and cloudy. Natural turbidity levels can vary greatly, from less than 1 Jackson Turbidity Unit (JTU) to 50 JTU. Variations are mainly due to the erosion of the river's shoreline and heavy rainfall. The average turbidity value of our water samples was 8 JTU and the average turbidity value for the Koroc River (Nunavik) was 0.2 JTU in 2014.

4.2 Nutrients and production quantification

Nutrients and chlorophyll concentrations for the five sampling stations are shown in Table 4. Figure 10 illustrates the important difference between the average nitrogen and the phosphorus concentrations in George River. Each parameter is then detailed.

Table 4. Nutrients (mg/L) and chlorophyll (μg/L) concentrations in the George River water during the sampling period (July 22nd and July 29th 2016).

	Total nitrogen		**Total phosphorus**		**Chlorophyll**	
Units	*mg N/L*		*mg P/L*		*μg/L*	
Sampling #	#1	#2	#1	#2	#1	#2
Station 1	0.127	0.163	0.0086	0.0202	0.2	0.8
Station 2	0.088	0.081	0.0039	0.0057	<0.1	0.3
Station 3	0.107	0.128	0.0215	0.0109	0.3	0.5
Station 4	0.122	0.122	0.0073	0.0088	<0.1	0.5
Station 5	0.134	0.127	0.0090	0.0043	<0.1	0.5
Mean	0.115	0.124	0.0100	0.0100	0.23	0.5

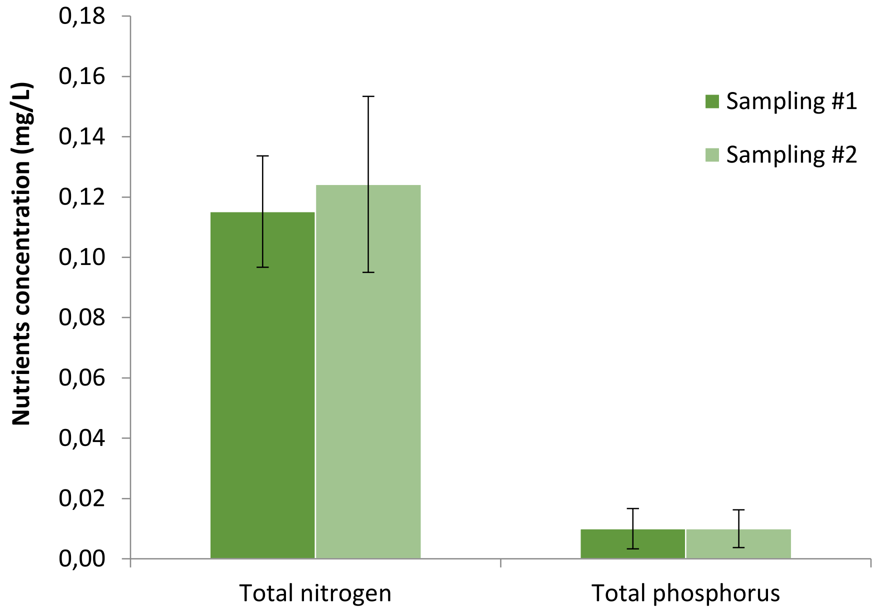


Figure 10. Average concentrations of nitrogen and phosphorus (mg/L) in the George River water at the five sampling stations (average of 3 replicate samples on 2 sampling dates) during the sampling period (July 22nd and July 29th 2016).

Nutrients

The nutrient analyses included the measurement of nitrogen (N) and phosphorus (P) concentrations. Those elements can be measured in many different chemical forms such as nitrite/nitrate, ammonia, particulate and dissolved N and P. Total concentrations of N and P are presented to give an overview of the nutrient concentration, but details of the different chemical species will be measured and provided for the 2017 sampling campaign. Nutrient levels in George River are expected to be low because the river is not surrounded by agricultural areas with inputs of nutrients by fertilizers. The average concentrations of N and P in our water samples were respectively 0.12 milligrams per liter (mg/L) and 0.01 mg/L. Total phosphorus concentration in water bodies not affected by human activities are generally less than 0.01 mg/L, as seen in our George River samples. Low total phosphorus (<0.01 mg/L) also indicates that George River is oligotrophic, meaning having low nutrient levels and plant growth.

Chlorophyll

Essential for capturing the energy of the sun during photosynthesis, chlorophyll is a green pigment found in plants and algae. Chlorophyll concentration can be related to the abundance of phytoplankton and micro-algae living in water and if concentrations are lower than 3 micrograms per liter (μg/L), the productivity of the water body is low. A highly productive water will have high plant growth and a chlorophyll concentration exceeding 15 μg/L. The average concentration of chlorophyll in our water samples was 0.32 (μg/L). No comparison value is available for chlorophyll in the Koroc River (Nunavik). However, since the preservation of the filters used for chlorophyll measurements was not optimal in the field, the values presented may not be accurate. Samples must be frozen quickly after sampling to preserve the pigments.

Major ions

Presented in the conductivity section, major ions play an important role in aquatic ecosystems. They are present in the water in concentrations between 1 and 10 000 mg/L. For example, the average calcium (Ca) concentration in our water samples was 1.23 mg/L, comparing to 3.47 mg/L in the Koroc River water; and the average magnesium (Mg) concentration in our water samples was 0.39 mg/L, compared to 1.21 mg/L in the Koroc River (Nunavik) water. These concentrations remain very low and may contribute to an increase in the river sensitivity to acidification. Calcium and carbonates are known to have a large buffering effect in waters.

Major ions concentrations measured for the five sampling stations did not vary much between sampling (Table 5) and calcium had higher concentrations compared to the other major ions (Figure 11).

Table 5. Calcium, magnesium, sodium and potassium concentrations (mg/L) in George River water during the sampling period (July 22nd and July 29th 2016).

	Calcium		**Magnesium**		**Sodium**		**Potassium**	
Units	*mg/L*		*mg/L*		*mg/L*		*mg/L*	
Sampling #	#1	#2	#1	#2	#1	#2	#1	#2
Station 1	1.25	1.36	0.36	0.38	0.57	0.60	0.29	0.32
Station 2	1.08	1.10	0.42	0.43	0.48	0.49	0.23	0.24
Station 3	1.21	1.36	0.37	0.44	0.54	0.70	0.27	0.34
Station 4	1.22	1.29	0.37	0.39	0.52	0.54	0.27	0.29
Station 5	1.20	1.29	0.36	0.39	0.52	0.54	0.27	0.29
Mean	1.19	1.28	0.37	0.40	0.52	0.57	0.27	0.29

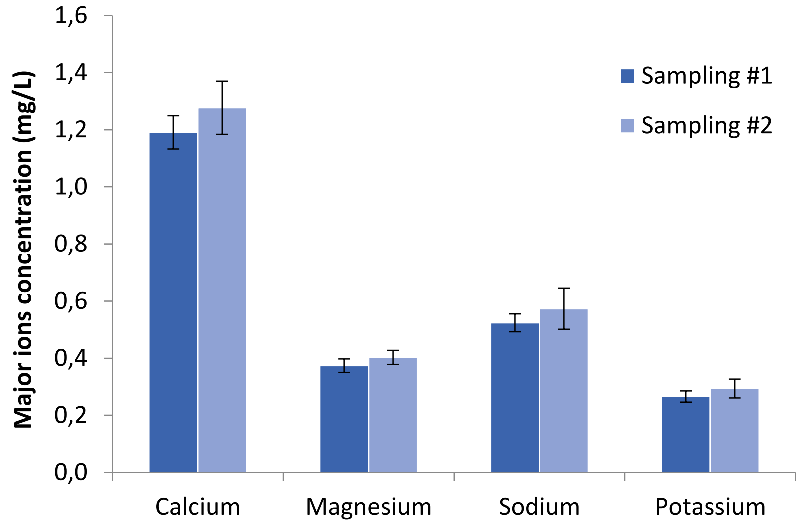


Figure 11. Average concentrations of calcium, magnesium, sodium and potassium (mg/L) in the George River water at the five sampling stations (average of 3 replicate samples on 2 sampling dates) during the sampling period (July 22nd and July 29th 2016).

4.3 Trace metals and rare earth elements

Trace metals

Trace metals are naturally present in the environment at low concentrations, varying between nanograms (0.000000001 g/L) and micrograms per liter (0.000001 g/L), depending on local geology and volcanic inputs (MDDELCC, 2014). Human activities, including transportation and mining, have been responsible for an increase in trace metal concentrations in many ecosystems. These metals show variable toxicity influenced by many factors such as the physico-chemical characteristics of the aquatic environment. For example, pH, water hardness and the presence of suspended particles both influence the chemical form of metals. The chemical form can affect the metal's availability to plants and animals (Worms, 2008).

Some metals are essential for living organisms in low concentrations, but may become toxic at higher concentrations, for example zinc. Other metals such as arsenic, cadmium and lead show high toxicity even at very low concentrations. For this reason, water quality guidelines are established by federal and provincial governments with different criteria for drinking water and for the protection of aquatic life.

All concentrations of trace metals measured in the George River are presented in Table 6 and meet water quality guidelines for surface waters, where guidelines exist. Some trace metals are not associated with any criteria, manganese for example. It is important to note that water quality guidelines for metals have several major limitations and should only be used for regulatory or screening purposes. No single measurement can measure good water quality and guidelines should be considered broad targets to be used in combination with other tools for environmental protection.

Table 6. Trace metal concentrations (µg/L) in the George River water at the five sampling stations (average of 3 replicate samples on 2 sampling dates) during the sampling period (July 22nd and July 29th 2016).

Element	Detection limit	Station 1	Station 2	Station 3	Station 4	Station 5	Average
Aluminum (Al)	0.2	16.3 ± 1.1	12.6 ± 0.4	25.5 ± 4.2	15.9 ± 5.5	11.6 ± 1.0	16.4 ± 5.485
Arsenic (As)	0.03	<0.03	<0.03	<0.03	0.04 ± 0.02	0.04 ± 0.01	0.04 ± 0.00
Barium (Ba)	0.002	3.367 ± 0.337	1.994 ± 0.067	5.422 ± 1.849	3.421 ± 0.777	2.812 ± 0.139	3.403 ± 1.266
Cadmium (Cd)	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Chromium (Cr)	0.07	0.21 ± 0.03	0.14 ± 0.04	0.83 ± 0.21	0.30 ± 0.39	0.04 ± 0.02	0.30 ± 0.31
Cobalt (Co)	0.001	0.036 ± 0.004	0.031 ± 0.002	0.065 ± 0.025	0.031 ± 0.007	0.014 ± 0.002	0.035 ± 0.019
Copper (Cu)	0.02	0.46 ± 0.05	0.60 ± 0.50	0.75 ± 0.11	0.46 ± 0.14	0.45 ± 0.13	0.54 ± 0.13
Iron (Fe)	0.5	28.4 ± 1.7	10.8 ± 1.0	86.4 ± 50.1	22.1 ± 6.8	16.5 ± 1.6	32.8 ± 30.6
Lead (Pb)	0.003	0.026 ± 0.009	0.027 ± 0.018	0.056 ± 0.011	0.024 ± 0.016	0.014 ± 0.002	0.029 ± 0.016
Manganese (Mn)	0.004	8.617 ± 2.419	0.915 ± 0.041	10.762 ± 6.831	3.268 ± 0.618	0.596 ± 0.122	4.832 ± 4.616
Nickel (Ni)	0.1	0.3 ± 0.1	0.8 ± 0.0	0.7 ± 0.1	0.4 ± 0.1	0.3 ± 0.0	0.5 ± 0.2
Selenium (Se)	0.08	<0.08	<0.08	0.15 ± 0.04	<0.08	<0.08	0.06 ± 0.05
Thorium (Th)	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Uranium (U)	0.004	0.049 ± 0.001	0.019 ± 0.001	0.077 ± 0.010	0.051 ± 0.018	0.039 ± 0.002	0.047 ± 0.021
Vanadium (V)	0.004	0.067 ± 0.007	0.043 ± 0.003	0.116 ± 0.035	0.056 ± 0.017	0.040 ± 0.002	0.065 ± 0.031
Zinc (Zn)	0.2	0.8 ± 0.3	0.8 ± 0.4	3.1 ± 3.0	1.3 ± 1.0	0.5 ± 0.2	1.3 ± 1.0

Rare earth elements (REE)

Rare earth elements (REEs) were measured as the Strange Lake mining project will be extracting these elements. The REE series is composed of 17 metallic elements (scandium, yttrium, lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium) (Kogel, 2006). All were analyzed in George River water except scandium and promethium because they are respectively difficult to measure accurately and not naturally occurring. REE concentrations in George River are presented in Table 7.

Despite their name, REEs are not particularly rare. They are indeed as abundant as many other elements in the earth's crust, for example cerium is as abundant as copper. REE have very similar physico-chemical properties which make them difficult to extract and isolate from each other.

Known for their unique optical, magnetic and catalytic properties, REE make good magnets and are used in many high-tech products such as solar panels, wind turbines, electric vehicles, mobile phones and computers (Bauer et al. 2010; Tse, 2011). As demand and use of REE is growing, it is becoming important to assess their potential risk to the environment. No water quality criteria exist in Canada for REEs as there is a lack of scientific data on their behaviour, fate and toxicity in natural ecosystems. Many research projects are currently underway trying to understand their mobility in ecosystems and their toxicity for living organisms. The IMALIRIJIIT project is helping to create knowledge on the behaviour of REE in northern river ecosystems.

REE are mostly attached to soils, consequently they have low mobility in water. This may explain why they are found in low concentrations in the George River except for yttrium which is naturally more abundant in the environment. As REE are more likely to accumulate in sediments and living organisms, the analysis of REE in sediments, macro-invertebrates, plants and fish should be considered for the 2017 sampling campaign.

Table 7. Rare earth elements concentrations (μg/L) in the George River water at the five sampling stations (average of 3 replicate samples on 2 sampling dates) during the sampling period (July 22nd and July 29th 2016).

Element	Detection limit	Station 1	Station 2	Station 3	Station 4	Station 5	Average
Yttrium (Y)	1.330	275.364 ± 159.896	191.127 ± 7.698	401.316 ± 48.880	286.919 ± 84.902	220.499 ± 12.354	275.045 ± 80.782
Lanthanum (La)	0.001	0.163 ± 0.033	0.110 ± 0.005	0.217 ± 0.010	0.158 ± 0.060	0.112 ± 0.006	0.152 ± 0.044
Cerium (Ce)	0.001	0.230 ± 0.101	0.113 ± 0.005	0.257 ± 0.043	0.176 ± 0.069	0.117 ± 0.007	0.178 ± 0.065
Praseodymium (Pr)	0.001	0.039 ± 0.015	0.024 ± 0.001	0.047 ± 0.005	0.036 ± 0.016	0.025 ± 0.001	0.034 ± 0.010
Neodymium (Nd)	0.001	0.150 ± 0.071	0.085 ± 0.003	0.172 ± 0.018	0.132 ± 0.051	0.094 ± 0.005	0.127 ± 0.037
Samarium (Sm)	0.002	0.022 ± 0.013	0.011 ± 0.001	0.025 ± 0.003	0.019 ± 0.008	0.014 ± 0.001	0.018 ± 0.006
Europium (Eu)	0.001	0.003 ± 0.001	0.002 ± 0.000	0.004 ± 0.001	0.003 ± 0.001	0.002 ± 0.000	0.003 ± 0.001
Gadolinium (Gd)	0.001	0.029 ± 0.016	0.015 ± 0.001	0.034 ± 0.005	0.025 ± 0.009	0.017 ± 0.001	0.024 ± 0.008
Terbium (Tb)	0.014	0.525 ± 0.390	0.331 ± 0.030	0.740 ± 0.099	0.541 ± 0.180	0.399 ± 0.029	0.507 ± 0.157
Dysprosium (Dy)	0.001	0.008 ± 0.005	0.004 ± 0.000	0.010 ± 0.002	0.007 ± 0.002	0.006 ± 0.000	0.007 ± 0.002
Holmium (Ho)	0.001	<0.001	<0.001	0.002 ± 0.000	<0.001	<0.001	0.001 ± 0.001
Erbium (Er)	0.001	0.005 ± 0.002	0.002 ± 0.001	0.006 ± 0.001	0.004 ± 0.001	0.003 ± 0.000	0.004 ± 0.001
Thulium (Tm)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ytterbium (Yb)	0.001	0.004 ± 0.001	0.002 ± 0.000	0.005 ± 0.001	0.003 ± 0.001	0.002 ± 0.000	0.003 ± 0.001
Lutetium (Lu)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

4.4 Macro-invertebrates

Results for macro-invertebrates are only preliminary indicators of the water quality as this first macro-invertebrate sampling was not extensive. The three Insect Orders most intolerant to pollution, *Ephemeroptera* (C), *Plecoptera* (R) and *Trichoptera* (C), were rated common (C) or rare (R) while the *Diptera* (A) more pollution tolerant, was rated Abundant (A). The abundance of black flies and mosquitoes at this time of year in this area may explain the prevalence of *Diptera*. Future sampling will enable us to calculate a biotic index as a simple biological measure of the river's state of health.

4.5 Participants' experience

The students rapidly learned the sampling protocols and conducted them with great care. As they better understood their own abilities, they gained confidence in their capacity to conduct science, which was a prospect that initially seemed foreign. At the end of the camp, they were able to do the set-up, conduct tests and record the data on their own (Figure 12). Participating in scientific measurements with committed local adults and elders, as well as researchers, had a significant positive impact on the youth. By the end of the week, the youth felt that the structured and safe camp setting, as well as conducting meaningful work for the community and being on the land every day, had been important for them. Their attitude towards the researchers had changed, becoming more friendly and trustful. They were more committed to the project and displayed a sense of pride in their work.

Figure 12. Students using manual kits to measure physico-chemical parameters by themselves on the last day.

Upon return to the community, the two elder participants (who had grown up in the George River area) went on the local radio to say that they had appreciated their experience. One guide also gave a 10-minute speech informing people about the camp's activities, including the importance of the involvement and training of the youth, the relevance of the environmental protection of the river and also his pride at seeing Inuit doing Science, referring to Anaviapik Soucie's work. After the camp, researchers were invited to give a local public presentation during the Youth Conference. In October 2016, the mayor, H. Snowball, and one student. V. Weetaltuk were invited to do a joint oral presentation with T. Anaviapik Soucie and J. Gérin-Lajoie about this whole experience at the 20th Biennial Inuit Studies Conference in St-Johns, Newfoundland.

Participants' expectations and perceptions before and after the Land Camp are described through quotes from the four groups: Youth, Guides/Assistants, Elders and Researchers (Table 8).

Table 8. Quotes illustrating the initial expectations as well as perceptions and impacts during or after the Science Land Camp for the four groups of participants.

	Youth	Guides/Assistants	Elders	Researchers
Expectations prior to the Science Land Camp	"We are not scientists." "The ones not participating, will they be allowed to go boating?"	"I don't understand why some kids don't like science." "What are we going to do?"	"Our oral knowledge was not valuable for governments because it was not on paper. They would just not listen to us."	"Will it work? Will the students find it interesting and get onboard?" "Will we be able to do all the work planned?"
Perception during/after the Science Land Camp	"I remember well because I am sober now." "I want to do all the tests." "Will there be another camp next year?"	"I really love what you guys are doing here. I am glad this study is going on now." "It is very important for the Youth to be trained in water quality monitoring."	"Thank you for bringing us here." "It's good for the kids to be here." "Things have changed so much in 50 years."	"It worked!" "You did it all alone!" "We did everything that was planned!"

5. Conclusions

5.1 Water quality conclusions

Preliminary results highlight the high water quality of the George River including neutral pH, soft water, and low nutrient and metal levels. This pilot study allowed us to create some data on the George River water quality, as well as test the protocols and training techniques required in order to establish a long-term water monitoring program driven by the community with the support of researchers. Great insights arose from this pilot study and will strengthen the next steps of the project in future years.

5.2 Project objectives

The Science Land Camp 2016 was a successful first edition of the IMALIRIJIIT project from the perspectives of the researchers, the guides, the elders, the students and the community; it was a favourable context to foster intergenerational and intercultural relationships. Being on the land, camping together, doing hands-on activities, mixing scientific work with other activities (Figure 13), sharing between generations and cultures, having less time constraints, all these factors contributed to:

- A different perception of science for the youth and local participants;
- A better link between the community and researchers;
- A greater local capacity and engagement in the protection and monitoring of their environment.

Figure 13. From left to right: initiation activity around a bonfire; lunch time at station 2; Lise and Vanessa at the introduction meeting; Elder's stories about the land.

Local and regional organizations invested a lot of effort, material and human resources that were essential to the success of the camp. These factors will surely contribute to its sustainability and help to increase engagement and capacity in the monitoring of environmental issues. Training, outreach and tools encompassed in IMALIRIJIIT project will contribute to empower Kangiqsualujjuamiut in leading this independent environmental monitoring program. This project helps to foster a next generation of Inuit researchers with interest and capacity in water quality monitoring, biological sampling, interactive mapping, data management and analysis.

6. Future work

2017 Science Land Camp

Next summer, the second phase will pursue the Science Camp experience and expand this study to the scale of the George River watershed, using tools such as remote sensing and indigenous cartography to evaluate water quality and environmental change. To complement this program, a study of contaminants in country food is proposed for species harvested and consumed in this area. Land-based activities such as hands-on workshops, real data collection and sharing between generations and cultures will contribute to make science practical and meaningful for Inuit Youth, and to foster local capacity in environmental monitoring.

First, as a complementary tool of *in-situ* measurements, remote sensing will be used to estimate three water quality parameters over the entire channel: turbidity (suspended sediments), chlorophyll and temperature. Two databases in optic remote sensing will be used from available and free archives: satellites Landsat-5, 7 and 8 since 1984 (NASA) (resolution 15m), satellite Sentinel-2 (ESA) since 2015 (resolution 10m). Ice onset and breakup, as well as snow melt, will be documented from the same dataset. These two parameters have a great influence on runoff, discharge and water quality. All parameters will first be estimated on available past and present images. Data extracted from the July 2016 Sentinel-2 image will be compared with (i) the 2016 field and lab data, (ii) the referenced values of literature. The same protocol will be reproduced during summer 2017, to increase the number of samples. At the watershed scale, NDVI analyses of Landsat time series will be used to assess environmental change including vegetation (greening or browning), landslides and sedimentation. For all parameters derived from optical satellite images, the work steps will include: selection of the processing approach, application of the algorithm on past and present images, validation, development of an automated procedure, application on future images, and training/transfer of the approach to the communities.

Local and traditional ecological knowledge (LTEK) will be used as another tool to document the George River watershed. The interactive map will integrate quantitative data, qualitative data, multimedia content and georeferenced data to Google Earth images, allowing interconnectivity between Inuit culture, land, and environmental and physical sciences for a multi-sensory experience. Pre-existing data will be reviewed and enriched by new interviews conducted with local knowledge holders in Kangiqsualujjuaq and in Kawawachikamach, an upstream Naskapi community. Semi-structured interviews will use a questionnaire about life stories, land uses, animal and plant species, local toponymy, changes in the river watershed, as well as stories and songs linked to the river. These interviews will use paper and digital map supports (Google Earth) when an Internet connection is available. With the interviewees' consent, interviews will be digitally recorded, filmed and then transcribed and integrated into the interactive map.

Training sessions in interactive mapping and LTEK collection will be organized for Northerners (Inuit, Naskapis) in Montréal. Inuit Youth from these two communities will be trained in interactive mapping, first at University of Montreal (Geography Dept.) and then through the Ethnographic Mapping Lab (University of Victoria) which provides training sessions for members of aboriginal communities. The content of the training will be based on the transfer of the knowledge and expertise related to the George River watershed and the technical and computer skills needed.

Water quality monitoring

In preparation of the 2017 sampling campaign, complete statistical analyzes will be carried out on the 2016 data. Since the concentrations of metals and rare earth elements measured in George River in 2016 were low, special attention will be paid to the cleaning of sampling equipment to prevent contamination. All glassware and plasticware will be acid-washed and double-bagged. On site, water samples will be collected with peristaltic pumps and samples will be preserved with ultra-trace acid.

The same physicochemical parameters (temperature, pH, dissolved oxygen, conductivity, hardness and turbidity) will be measured in 2017 to allow a temporal follow-up of the conditions. Environment Canada will again contribute to the nutrients (nitrogen and phosphorus), chlorophyll and major ions analyses. They will also supply the sampling bottles related to these analyses. University of Montreal will also participate in the analysis of trace metals and rare earth elements.

Contaminants

In the next phase, we plan to measure the contaminants in key country food species collected in the George River watershed (aquatic and terrestrial). It is aiming at fostering local capacity in environmental monitoring, biological sampling, and data management.

A meeting will be set in March 2017 with the community to decide which traditional food items should be investigated and where the water and sediment samples should be taken. Gwyneth MacMillan, a PhD student in Marc Amyot's lab will be present. After this meeting, a final experimental design will be established. We plan to measure 150 samples for total Hg (THg), methyl mercury (MeHg), trace metals and rare earth elements (REEs). The 150 analyses will be distributed approximately as presented in Table 9 (this distribution will be adjusted following further consultations with the community).

Table 9. Distribution of 150 samples for contaminants analysis

Sample	Description	Sites	Replicates	Number
Water	George River	10	3	30
Sediments	George River	10	3	30
Biota	3 freshwater species	5	2	30
	3 marine species	5	2	30
	3 terrestrial species	5	2	30
			Total	**150**

Samples will be collected during summers 2017 and 2018 using trace metal techniques. Educational kits will be prepared for the training of young people from the community in environmental contaminant sampling.

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