

Tłıchọ Aquatic Ecosystem Monitoring Program (TAEMP)

Final Report, Behchokò, 2015



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Summary

The purpose of the Tłıchq Aquatic Ecosystem Monitoring Program (TAEMP) is to continue to build and maintain a successful community-based monitoring program that meets the needs of the Tłıchq people in determining whether fish, water, and sediment quality are changing over time, and whether fish and water remain safe to consume. The TAEMP rotates science-based fish, water and sediment sampling through each of the four Tłıchq communities so that every community has samples collected and analyzed once every four years. The TAEMP continues to provide a means of addressing community concerns related to observed changes in the environment, and builds on work carried out since 2010. As a successful community-driven program, it meaningfully involves community members in conducting contaminants-related research, including the collection of samples and observations using both Tłıchq and scientific knowledge to address the question: “Are the fish safe to eat and is the water safe to drink?”

In late August and early September 2015, community elders and youth in Behchokò were informed of the TAEMP through introductory and planning workshops, where program support staff and community members discussed concepts such as: monitoring, indicators of change, and Tłıchq and scientific knowledge relevant to water, sediments, fish, and potential contaminants. Given that the 2015 TAEMP would re-visit the sampling locations visited in 2011, for a number of community members, the meetings served as a re-introduction to many of the concepts and planning needs. A key outcome of the workshops was advance planning of a 5-day on-the-land monitoring camp. The location, which supports an aboriginal subsistence fishery, was the same as the one utilized in 2011, though the campsite had been improved upon. At the workshops and at the on-the land camp, elders and community members had opportunities to provide assessments of current fish and aquatic ecosystem health on Russell and Slemon Lakes. From September 14-18, 2015, the on-the-land monitoring camp occurred, revisiting sampling locations as much as low water levels would allow. Elders and community members provided direction on safe access to where fish and water samples were collected, and youth were provided basic training on how samples are collected in a standardized manner. Support staff and community members collected fish in order to have tissue samples for analysis of a variety of metals, including mercury. Water and sediment samples were also collected and analyzed for metals, as well as chemical and physical properties. Results were brought back to Behchokò, in April 2015, after analyses were completed. Overall, results indicated that fish, water, and sediment quality are good, and that there were no health concerns as no results were considered abnormal. Community members had an opportunity ask questions at the public results meeting and have open discussion with the visiting support staff.

Introduction

The purpose of the Tłıchq Aquatic Ecosystem Monitoring Program (TAEMP), or “fish camp” as it is known, is to continue to successfully implement an aquatic ecosystem monitoring program based on Tłıchq Knowledge (i.e. traditional knowledge, or TK) and scientific knowledge in order to determine whether fish health, water, and sediment quality are changing over time at locations near Tłıchq communities. There are historic, currently operating, and proposed developments in Wek’èezhìı, and there is concern in Tłıchq communities that contamination of nearby aquatic ecosystems may occur, or has already occurred. As a result of these concerns and a general lack of information (WWF 2014), there is a need to collect information and have ongoing monitoring of the aquatic ecosystems in Wek’èezhìı in anticipation of continuing pressures on watersheds.

It is important to have Tłıchq community members (including elders and youth) directly involved in monitoring, and provide a genuine opportunity for community members to exchange knowledge with research scientists in appropriate community and on-the-land settings. By meaningfully involving community members in conducting science-based contaminants-related research, including the collection of samples and observations using both Tłıchq and scientific knowledge, the TAEMP provides a means to help to address the question: “Are the fish safe to eat and is the water safe to drink?”

The TAEMP rotates sampling through each of the four Tłıchq communities once every four years. With the conclusion of the 2014 camp near Whatı, the TAEMP completed its initial baseline sampling phase. In 2015, the first round of comparative sampling began with the return of the TAEMP to the community of Behchokq. The next phase of sampling (2015-2018) will continue to build on work carried out since 2010 and allow for comparative analysis of sampling results collected in each of the four communities. The comparative sampling will provide a way to continue to address community concerns related to changes in the environment.

TAEMP partners include: community members (e.g. elders, fishers and youth), the Wek’èezhìı Renewable Resources Board (WRRB), the Tłıchq Government (TG), the Wek’èezhìı Land and Water Board (WLWB), the Department of Fisheries and Oceans (DFO), the Government of the Northwest Territories (GNWT) Department of Environment and Natural Resources Water Resources Division (GNWT ENR) and the Department Health and Social Services (GNWT HSS), and Environment and Climate Change Canada (ECCC).

Methods

The 2015 TAEMP consisted of three main phases:

1. Introductory and planning workshops in Behchokq;
2. On-the land camp near Behchokq on Russell Lake where samples were collected; and,
3. Results workshop in Behchokq.

Translation was provided during all project activities by Jonas Lafferty and James Rabesca. See Appendix 1 for lists of participants in each phase.

1. Introductory / Planning Workshops

Prior to the on-the-land camp, workshops were held in late August and early September of 2015 to discuss the TAEMP with community members in Behchokò. The meetings provided a means to reacquaint community members with objectives and the approach of the TAEMP (i.e. the TAEMP had last taken place near Behchokò in 2011), and begin planning for the on-the-land camp. Community members discussed the concept of indicators and their perspectives on the health of the ecosystem with visiting researchers. During the planning meetings, selection of participants was also discussed and preliminary selection was determined based on relevant expertise/need/availability.

2. On-the-land Monitoring Camp – Russell Lake

a. Overall

To assess fish, water, and sediment quality, samples were collected using standard science-based techniques during a 5-day on-the-land “fish camp” where elders, youth, and research scientists cooperated in the implementation of an aquatic ecosystem-based monitoring program. The camp (and associated planning meetings previously mentioned) allowed for continued sharing of science and traditional knowledge-based approaches to monitoring, and built relationships and mutual respect.

The camp provided an opportunity for researchers and community members to work collaboratively to combine aspects of Tłıchq knowledge with scientific-based monitoring methods. It provided teaching opportunities in Tłıchq ways of understanding the aquatic ecosystem, assessing the health of the ecosystem, and catching, preparing, and preserving fish. The camp also provided an opportunity to “de-mystify” scientific monitoring methods by having community members directly involved in sample collection, and through on-shore demonstrations of sampling methods. The camp also provided youth with hands-on experience with science-based sampling methods and approaches to aquatic ecosystem monitoring, and provided youth with opportunities to ask visiting researchers / support staff questions about science and about possibilities for training and employment in the environmental monitoring field.

b. Water Quality

Surface water samples were taken as “grab samples”. Field Staff used fresh disposable vinyl gloves at each sample site to minimize the potential for contamination from the sampler’s hands. Different sample bottles were used for each laboratory analysis group including: physicals, nutrients, total and dissolved metals, and microbiological analysis. All bottles (except sterile bottles) were rinsed three times with sample water before filling.

Standard physical and chemical parameters were used as water quality indicators, including: temperature, pH, conductivity, clarity, turbidity, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), alkalinity, dissolved Oxygen, major nutrients, ions, and trace metals. These parameters are comparable to Aboriginal Affairs and Northern Development Canada (AANDC; now Indigenous and Northern Affairs Canada) Water Resources’ datasets for the Frank Channel on Great Slave Lake, the closest water quality monitoring station. Water sampling was led by the TG Wildlife Coordinator and the WLWB Regulatory Technician; procedures were followed to minimize contamination, such as implementation of appropriate Quality Assurance/

Quality Control (QA/QC) procedures, in accordance with instructions from the GNWT Taiga Environmental Laboratory (Taiga) located in Yellowknife.

Samples were placed in an electric cooler to preserve the integrity of the water samples. Microbiological analysis is particularly time-sensitive and samples for this analysis were delivered to the lab after support staff returned to Yellowknife. Taiga performed all analyses, and Taiga is a member of the Canadian Association of Environmental Analytical Laboratories (CAEAL), a national organization established to ensure consistent laboratory quality assurance.

c. Sediment Quality

Sediment sampling used methods outlined in Metal Mining Technical Guidance for Environmental Effects Monitoring (Environment Canada, 2012), and samples were analyzed for standard physical and chemical properties as well as trace metals. Lake sediments were sampled using an Ekman grab sampler (dredge) suitable for collecting soft, fine grained sediments typically observed in the area.

Sediment samples were collected using an Ekman, transferred to a stainless steel tray, then placed into sterile glass jars/ziplock bags. Sediment samples were stored in an electric cooler along with the water samples and provided to Taiga for analysis after support staff returned to Yellowknife. If two distinct layers of sediment were captured by the Ekman, they were sampled and submitted for analysis separately.

All appropriate QA/QC procedures were followed according to Taiga instructions, including the analysis of travel and field blanks. Field Staff used fresh disposable vinyl gloves at each sample site to minimize the potential for contamination from the sampler's hands. Different sample bottles were used for each laboratory analysis group including: physicals, nutrients, total metals, mercury, and microbiological analysis. All bottles (except sterile bottles) were rinsed three times with sample water before filling. Water sampling was led by the TG Wildlife Coordinator and the WLWB Regulatory Technician.

d. Fish Sampling

Fish were collected through the use of gillnets set at different locations as determined by community members; nets provided fish for sample collection as well as for consumption at camp. Four gillnet sets were conducted over the course of the camp on Russell Lake (Figure 1, Table 1). The 3.0-inch nets were used to target larger fish such as *Lih* (Lake Whitefish), *Ehts'ëë* / *Ehch'ëë* (Walleye or Pickerel), and *Jhdaa* (Northern Pike) which are the fish primarily caught for food. The number and duration of gillnet sets were subject to safety considerations.

The fish caught were identified to species, were measured to total and fork length (TL and FL) to the nearest millimeter (mm), and weighed (g). Additional data collected included: gender, stage of maturity, and a general description of the contents of the stomach, any parasites and/or deformities. The sample size targets for tissue (for contaminants) and otoliths and clethria (for aging) were, at minimum, in order to replicate sample sizes from 2011: 10 *lih*, 10 *ehts'ëë* / *ehch'ëë*, and 13 *jhdaa*; sample sizes of 20 / species were the maximum. The species sampled also represented those typically consumed by community members, and sampling of the three species also provided a way to account for differences between benthic (bottom feeding) and predatory (feeding on smaller fish) strategies.

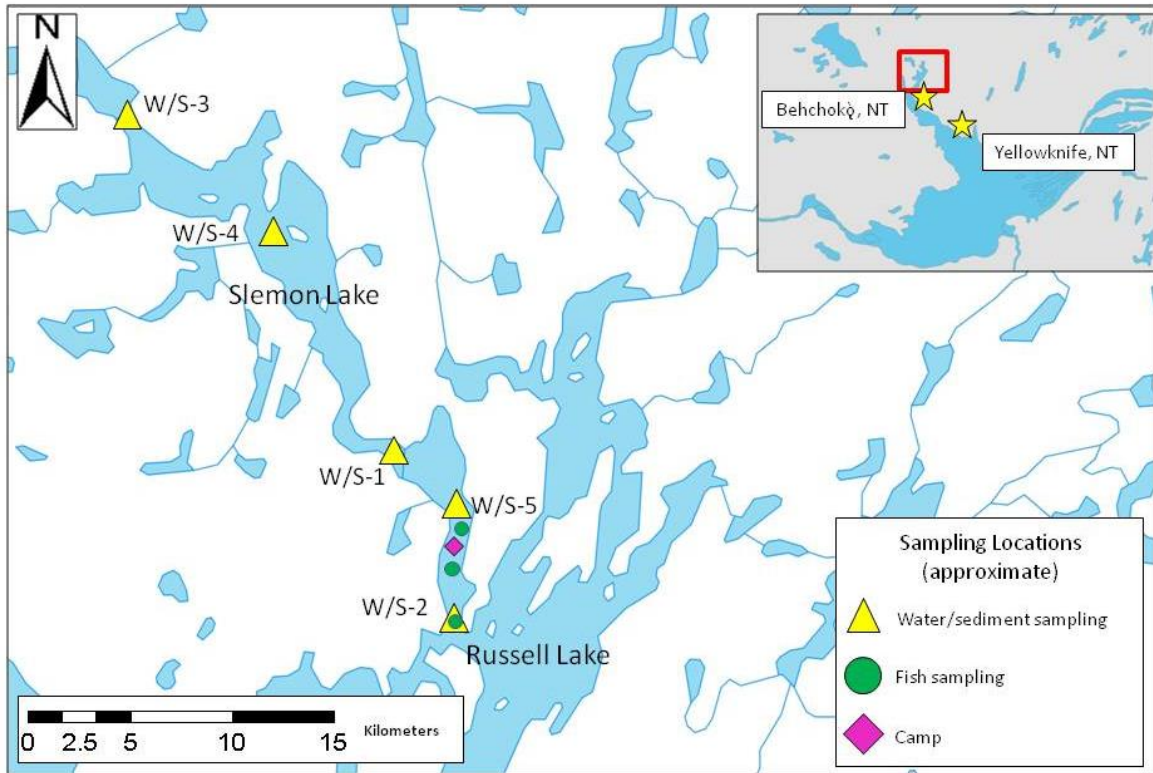


Figure 1 Locations of the on-the-land camp, and locations where samples of fish, water, and sediment were collected on Russell Lake and Slemon Lake during the on-the-land component of the Tłıchǝ Aquatic Ecosystem Monitoring Program (TAEMP) near the community of Behchokò, September 14-18, 2015. Sampling locations were placed as near as possible to where samples were collected during the 2011 TAEMP (see also Tables 1 and 2 for coordinates of 2011 and 2015 sampling locations).

Table 1. Details for gillnet sets used to collect all fish samples at the TAEMP on Russell Lake near the community of Behchokò, September 14-18, 2015.

Net set / pull date	Set Length (hh:min)	Location (Lat/Long; deg., min., sec.)	Net Length / Width (m)	Mesh size (inches)
Sept. 14 / Sept. 15	20:00	N 63°05'08.2" W-115°49'48.1"	100 /1.8	3.0
Sept. 15 / Sept. 16	19:30	N 63°02'56.7" W -115°49'07.8"	100 /1.8	3.0
Sept. 15 / Sept. 16	19:40	N 63°05'09.3" W -115°49'37.3"	100 /1.8	3.0
Sept. 16 / Sept. 17	20:00	N 63°05'09.3" W -115°49'37.3"	100 /1.8	3.0

Note: Lat/Long are NAD 83

Fish age was estimated by taking otolith samples, and having North/South Consultants Ltd. (Winnipeg) cut and mount them on slides, with the annual growth rings counted by experts. Figure 1 shows examples of sagittal cross-sections of otoliths and how the annual growth rings (annuli) may be counted to estimate age; a red dot is positioned between each individual growth ring. A clethrium (a large bone above the gills) can also be used to age fish such as jhdaa, and does not require a cross section as the growth rings are visible without using a microscope. Figure 1 shows a lih (LKWF) estimated at 10 years on the left, an ehts'èè / ehch'èè (WALL) estimated at 10 years in the middle, and an jhdaa (LKWF) estimated at 8 years on the right.

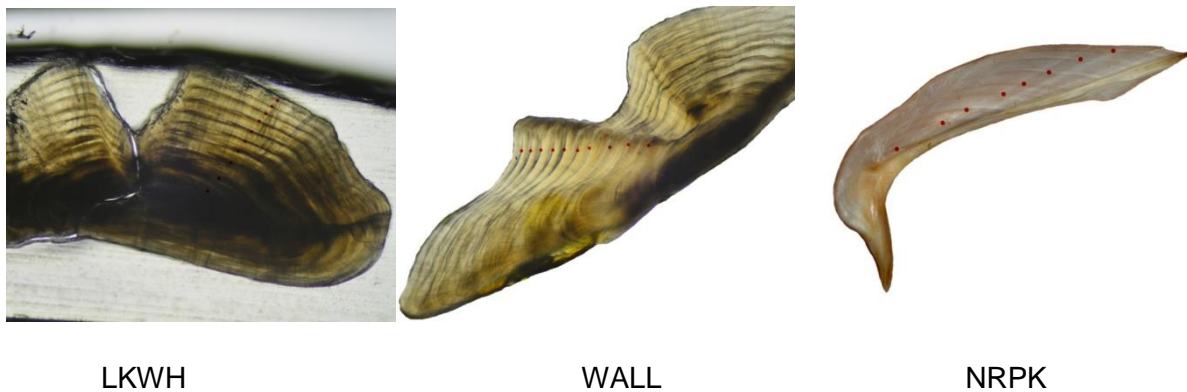


Figure 2 Two examples of otolith cross-sections, and one example of a clethrium obtained from samples collected on Russell Lake, September 2015 (not to scale); a lih (LKWH) estimated at 10 years is shown on the left, an ehts'èè / ehch'èè (WALL) estimated at 10 years in the middle and an jhdaa (NRPK) estimated at 8 years on the right. Photos and interpretation provided by North/South Consultants Inc., and Golder Associated Ltd.

e. Fish Tissue Analysis

To determine current levels of contaminants in fishes consumed regularly by the community members in Behchokò, fish tissue samples were collected from lih, ehts'èè / ehch'èè, jhdaa, the fish species regularly. Fish processing was led by Golder Associates Ltd. and ENR biologists, and samples were collected under the guidelines established by Environment Canada for sampling for metals (Environment Canada 2012) and the Golder Associates Ltd. technical protocol "Fish Health Assessment-Metals".

3. Results Workshop

After analyses of fish, water and sediment samples were completed and support staff had an opportunity to review the results, a public meeting was held in Behchokò to review the goals and objectives of the program, as well as present the results of the analyses, including a comparison to the 2011 results to see if any changes had occurred. Importantly, the results workshop provided an opportunity for participants and community members to ask questions and get clarification. An open format proved to be an effective and appropriate way to present results to participants and interested community members. Collaboration with GNWT HSS, along with other TAEMP partners, aided in the development of appropriate messaging and communication strategies prior to presentation of results. This collaboration ensured community members are informed and educated on the status of contaminants, if any, in the fish they may be eating and that nutritional guidance is provided to ensure these foods continue to remain healthy choices (AMAP 2011, GNWT HSS 2014, 2016,).

Results

1. Introductory / Planning Workshops

On August 19, 2015, a one-day workshop was held with community members from Behchokò to introduce, revisit, and discuss the TAEMP. Participants expressed interest in fish camp and having the opportunity to build on the fish camp in 2011. Participants agreed that monitoring fish, water, and sediment quality continues to be important in order to monitor changes near Behchokò and agreed that elders, youth and scientists can take the opportunity to work together again. There was agreement on safety as priority and that some community members should go out to the camp site a day early to prepare. Meeting participants suggested a potential list of elders for fish camp, recognizing that a number of elders who had participated in the 2011 camp had since passed away. Participants provided input on repeat sampling, as well as re-use of the 2011 location for the camp, with concerns being voiced about the low water levels and the need for capable boat captains. Additional concerns were voiced over the possibility of the camp location being used in September by other community groups, and participants agreed to look into any possible conflicts. It was understood that September was the available window for the camp, and that community support would be required, including the selection of engaged youth.

On September 4, 2015, a second workshop was held in Behchokò to finalize planning for the fish camp and to deal with logistical issues. Concepts related to monitoring were re-visited, as well as the primary tasks which needed to be achieved at camp. Some community members initially considered as participants were not available, and alternatives were discussed. A representative from the school made it clear that the school had requirements with regards to

boat captain training and insurance for the boats that would be used to transport the students, and without proper training and insurance, students could not be allowed in the boats. The camp location selected was the same location used in 2011, as community members confirmed that there would not be a conflict with other groups. Workshop participants agreed that the dates for the camp were Monday, September 14 to Friday, September 18. It was agreed that community members would examine and prepare the camp location on Sunday, September 13 (e.g. general inspection of site, set up of cook / meeting tents, gather firewood).

Workshop participants developed a list of elders who could potentially participate in the fish camp. The hope was to have equal representation of men and women elders, with couples preferred. Participants also clarified the need for elders without health concerns that may cause challenges while out-on-the land. It was also agreed that TG staff in Behchokò, in conjunction with WRRB staff, would discuss selection of youth with the principal and science teacher at Chief Jimmy Bruneau Regional High School, with the hope that 3 young men and 3 young women with an interest in the environment would be selected to participate. It was also discussed that students could also receive credit for their participation, given the time they would spend at the camp and the information relevant to the science curriculum.

2. On-the-land Monitoring Camp – Russell Lake

a. Overall

The on-the-land phase of the TAEMP occurred from September 14 to 18, 2015. Travel to the camp occurred on September 14, sampling and other activities occurred September 15-17, and participants returned to Behchokò on September 18th. The camp foreman and assistants visited the camp on Sunday the 13 in order to prepare the camp for participants

As previously mentioned, involvement of the youth required both training for the boat captains and insurance for the boats which transported students. A few days before the start of the camp there were uncertainties regarding the availability of boats and captains to transport students, which led to serious concerns about the possibility of any student participation. Fortunately, through quick cooperation among the program partners and school, a fully insured boat was provided by the school, along with a captain with the required training. It was recognized that miscommunication and assumptions had led to the possibility that students would not attend, and it was made clear to camp participants that the school requirements are there for safety, and that proper training and insurance are a must for future activities. In the future, earlier communications with community schools and potential boat captains will help to ensure uncertainties and delays are minimized.

At camp, there were regular morning and evening sessions in the cabin. These planning meetings at the beginning and end of each day provided an effective means to discuss activities and voice concerns. For example, during morning meetings, roles and responsibilities for the day were clarified, safety concerns discussed, and the best approaches to the day's activities selected based on local expertise and sampling requirements. In the evening meetings, the day's activities were discussed, possibilities for improvement(s) voiced, and plans for the following day suggested.

The minimum objective to sample 10 lih, 10 ehts'èè / ehch'èè, and 13 jhdaa was achieved and surpassed (see section e. Fish Tissue Analysis, p 14). The desired number of water and sediment samples were also collected, with sampling locations located as close as possible to 2011 locations by using 2011 GPS coordinates (see Figure 2 for 2015 location, Table 2 for 2015 and 2011 GPS coordinates). However, windy conditions, low water levels and thick aquatic vegetation led to difficulties in placing the comparative sampling exactly where 2011 sampling locations were located. Safety was the primary concern at camp, and challenges were addressed through the capable community members and support staff at camp. Community members and visiting researchers all had years of experience in field-based situations, and community members were instrumental in ensuring safe transport for all participants given their knowledge of the area near their community.

The 5-day camp provided various educational opportunities focused on ways of understanding aquatic ecosystems and assessing the health of the ecosystems through a variety of methods. Participants worked collaboratively, and shared Tłıchǰ knowledge with science-based monitoring approaches. Experiences shared at the camp included youth gaining hands-on experience with sampling methods, elders providing a demonstration of a variety of dry-fish preparation techniques, and a visit to gravesites near the camp location.

b. Water Quality

Final locations for all water and sediment samples collected in 2015 and 2011 are provided in Table 2 (see also Figure 1). Nutrient and physical parameters were found to be similar at all sites. Calcium and magnesium were both low (1.4-1.5mg/L and 3.95-4.3mg/L, respectively), reflecting the softness of the water.

The pH results showed very little difference between sampling sites. The pH in 2015 was similar to the pH in 2011; pH in 2015 ranged from 7.32 to 7.37 and the pH in 2011 ranged from 7.18 to 7.37. The water flowing into Slemon Lake from Snare River (W/S-3) had the same pH as the water flowing through the channel into Russell Lake (W/S-2) and the results fell within Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life (FAL) guidelines (6.5-9.0) (CCME 2014).

Conductivity of the water ranged from 39.85 to 43.9 microsiemens per centimeter (μ sie/cm) in 2015, and in 2011 the conductivity was similar with a range of 36.8 to 38 μ sie/cm.

Total Dissolved Solids (TDS) at each 2015 site had low measurable amounts ranging from 29 mg/L to 34mg/L. In 2011 all sites were less than minimum detection levels (MDL).

Total Suspended Solids (TSS) in 2015 had measurable amounts of TSS ranging from 4 to 8mg/L. In 2011 TSS were consistently below MDL of 3 mg/L with the exception of W/S-1 with 6mg/L.

Water sample results indicated that most metal concentrations in Russell Lake and Slemon Lake were very low. Many results were found to be below MDL, with only Aluminium and Iron found to be outside the guidelines (Figure 3). Aluminium was outside the CCME FAL guidelines (100 μ g/L) in all of the sampling locations in 2015, ranging from 107 μ g/L to 597 μ g/L (Figure 3a), and aluminium exceeded guidelines in all but one location in 2011 (W/S-3), ranging from 93-307 μ g/L. Similar to results in 2011, the 2015 total aluminium concentration was the lowest

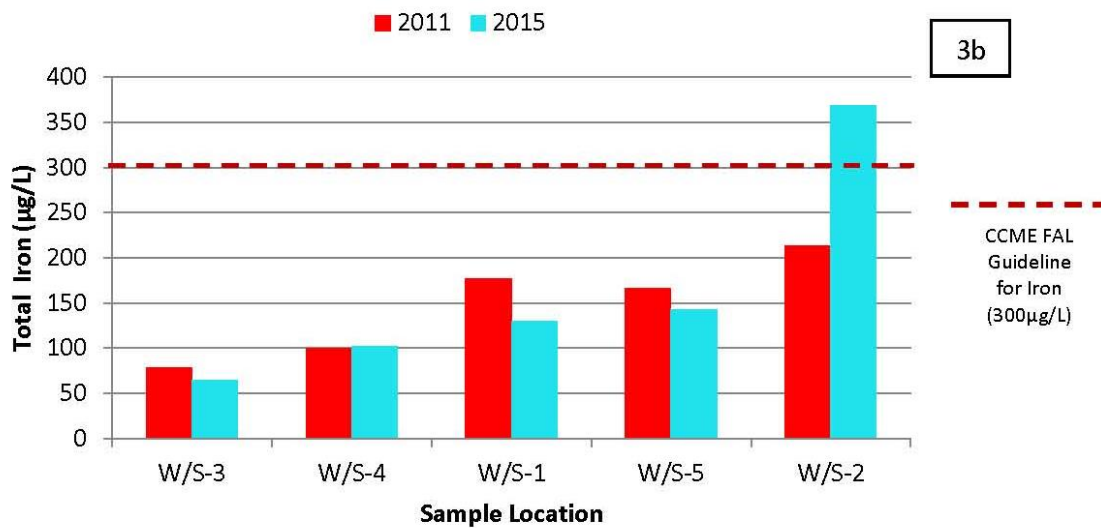
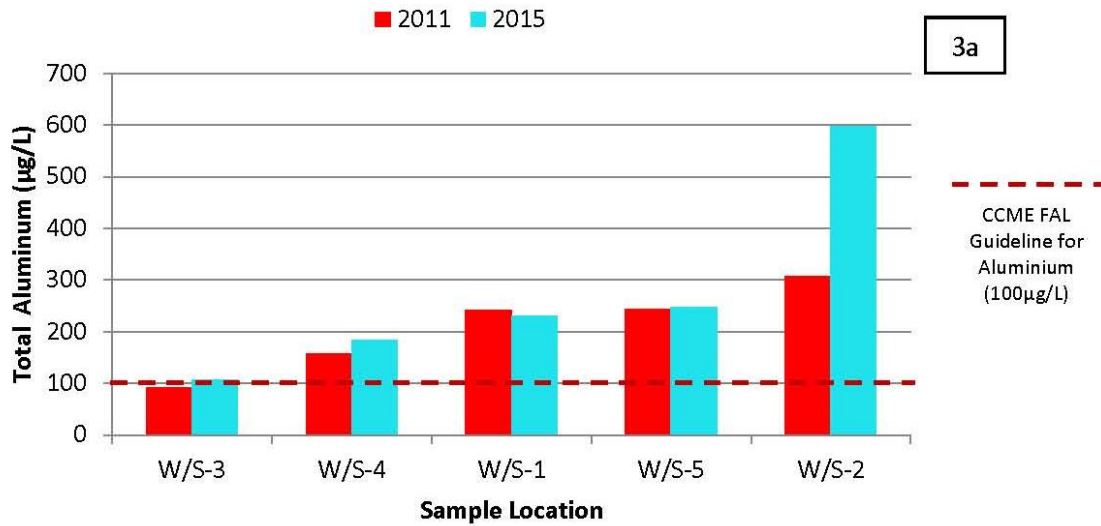


Figure 3 Comparison of the total concentrations of Aluminium (3a) and Iron (3b) surface water samples collected during the on-the-land component of the TAEMP near Behchokò, September 2015 and September 2011. Sample locations are arranged from those more upstream (Slemon Lake, W/S-3) to downstream (Russell Lake, W/S-2); refer to Figure 1. Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life (FAL) provided for Aluminium (100µg/L) and Iron (300 µg/L) provided.

where the water flows into Slemon Lake (W/S-3), and concentration increased downstream with the highest level found at the site furthest downstream (W/S-2).

The iron concentration at site W/S-3 (369µg/L) was the only sampling location which exceeded the guideline (300µg/L). Iron concentrations in 2015 ranged from 65-369µg/L, and in 2011 sample ranged from 79-213µg/L (Figure 3b). Similar to the pattern observed with aluminium, results in 2011 and 2015 showed total iron concentration was the lowest at site W/S-3 (upstream) and highest at W/S-2 (downstream).

Comparison of percent dissolved fraction of the metals indicated that aluminium, iron, manganese, titanium and zinc had a majority of the metal present in particulate form (<10% in dissolved form). Arsenic, barium, copper, lithium, nickel, rubidium and strontium had more of the metal present in dissolved form, with greater than 60 percent in the dissolved form. Most metals showed a decrease in the percent of dissolved metal downstream (more of the total metal was in particulate form).

Table 2 Details for water and sediment sampling locations at the TAEMP on Russell and Slemon Lakes near the community of Behchokò, September 14-18, 2015.

ID	Description	2011 Location (Lat/Long; deg. min. sec.)	2015 Location (Lat/Long; deg. min. sec.)
W/S-1	Mouth of channel flowing from Slemon to Russell Lake	N63° 07' 07.6" W115° 53' 03.1"	N63° 07' 07.6" W115° 53' 03.1"
W/S-2A	Mouth of channel flowing into Russell Lake (lower grey layer)	N63° 02' 43.8" W115° 48' 45.2"	N63° 02' 43.8" W115° 48' 45.2"
W/S-2B	Mouth of channel flowing into Russell Lake (upper brown layer)	N63° 02' 43.8" W115° 48' 45.2"	N63° 02' 43.8" W115° 48' 45.2"
W/S-3	Mouth of Snare River flowing into Slemon Lake	N63° 14' 29.1" W116° 07' 48.1"	N63° 14' 29.8" W116° 07' 43.5"
W/S-4	Slemon Lake	N63° 12' 37.7" W116° 01' 17.3" (water sample only)	N63° 12' 37.0" W116° 01' 17.0" (water and sediment samples)
W/S-5A	Mouth of channel north of camp (grey lower layer)	N63° 05' 03.3" W115° 49' 38.8"	N63° 05' 03.4" W115° 49' 38.4"
W/S-5B	Mouth of channel north of camp (upper brown layer)	N63° 05' 03.3" W115° 49' 38.8"	N63° 05' 03.4" W115° 49' 38.4"

Note: Lat/Long are NAD 83

c. Sediment Quality

The sediments collected from Russell Lake and Slemon Lake had relatively high amounts of aluminium, iron, and titanium. There are currently no CCME sediment guidelines for these metals. Most metals concentrations found in the 2015 sediment samples were similar to the results seen in 2011 samples (Figure 4). All metal concentrations in 2015, except for chromium concentration at one location (W/S-1), were below the CCME Probable Effect Levels (PEL) criteria, and all 2011 samples were below PEL criteria (CCME 2014). However, a number of samples in both years exceeded the Interim Freshwater Sediment Quality Guidelines (ISQG) for the Protection of Aquatic Life (CCME 2014).

Arsenic concentrations exceeded the CCME ISQG of 5.9µg/g at all sites sampled except W/S-3 in 2015 and 2011. The concentrations ranged from 5-12µg/g in 2015, and 6.3-9.5µg/g in 2011 (Figure 4a).

Chromium concentrations exceeded the CCME ISQG of 37.3µg/g at all sites sampled in 2015 and 2011. The concentrations ranged from 45-92µg/g in 2015 and 51.3-80.4µg/g in 2011 (Figure 4b).

Copper concentrations exceeded the CCME ISQG (35.7µg/g) at one location in 2015 (W/S-1), while all the samples in 2011 exceeded the guideline. The copper concentrations ranged from 16 to 38µg/g in 2015, and from 45.1-67.7µg/g in 2011 (Figure 4c).

In 2015, none of the samples collected were above guidelines for lead, and concentrations ranged from 7 to 14µg/g. Lead concentrations exceeded the CCME ISQG (35µg/g) at one site in 2011 (W/S-5). The sample that exceeded the guideline was found in the upper section of the sediment (40.8µg/g; W/S-5A) and in the lower section of the sediment collected (36.9µg/g; W/S-5B) (Figure 5a).

Zinc concentrations exceeded the CCME ISQ Guideline (123µg/g) at all sites sampled in 2015 with the exception of W/S-3. However, in 2011 none of the samples collected were above guidelines. In 2015, the concentrations ranged from 109 to 179µg/g, and 69-111µg/g in 2011 (Figure 5b).

Sediment samples had similar proportions of clay to sand to silt. Clay made up the larger percentage and then silt with a small fraction of sand. The exception was the sample site near the mouth of the Snare River in Slemon lake (W/S-3), which had a larger percentage of sand then clay then silt in 2015. The sediment samples from the mouth of the channel flowing into Russell Lake (W/S-2) and the site near the second fish net location (W/S-5) had a distinctive top layer which was reddish brown, more organic and less packed. This upper layer was sampled separately (labelled W/S-5B), and had less clay and more silt than the lower portion of the sediment (labelled W/S-5A).

It should be noted that sediment samples were not collected at location W/S-4 in 2011.

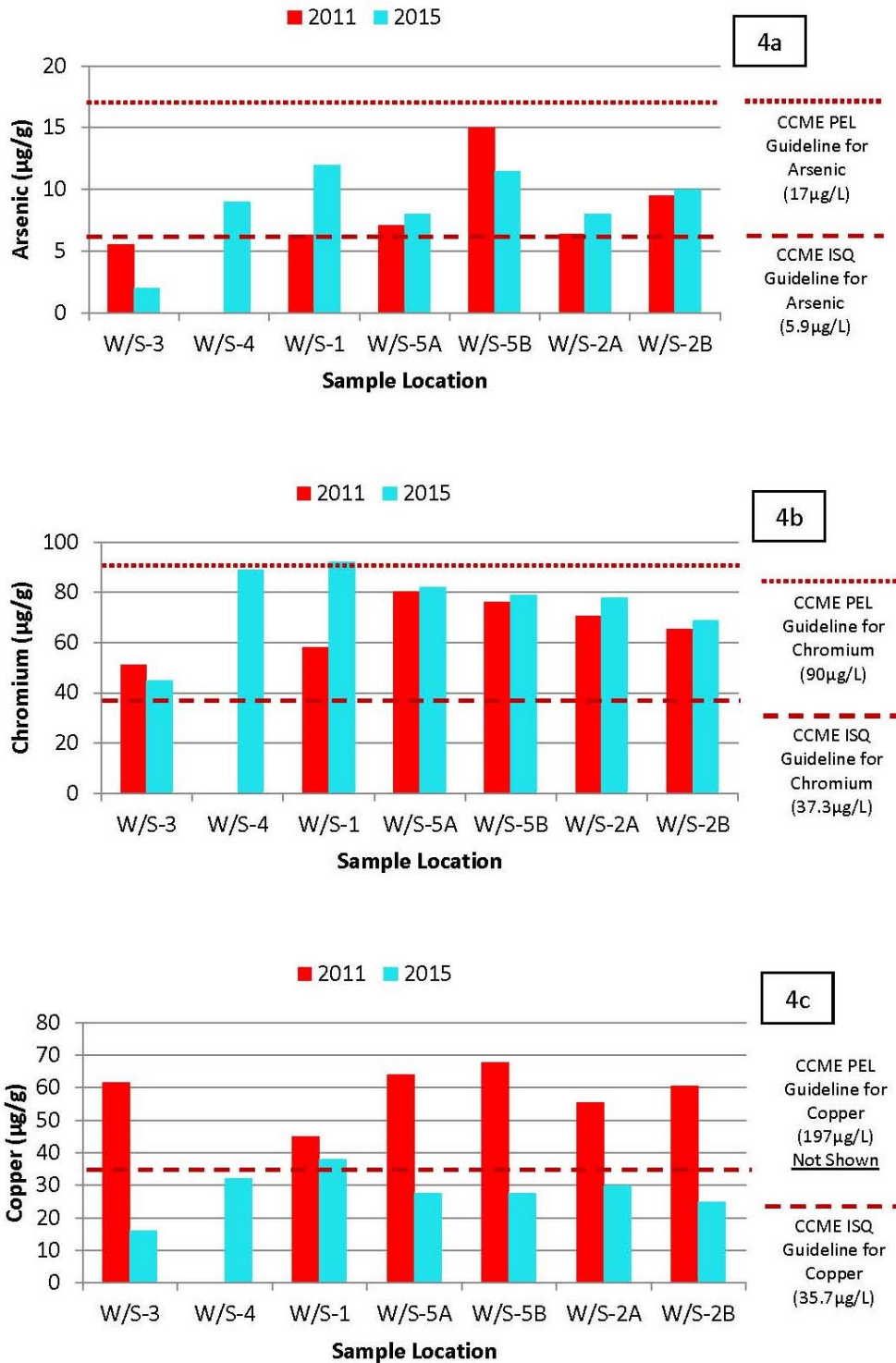


Figure 4 Comparison of the concentrations of Arsenic (4a), Chromium (4b) and Copper (4c) in sediment samples collected during the TAEMP near Behchokò, September 2015 and September 2011. Sample locations are arranged from those more upstream (Stemon Lake, W/S-3) to downstream (Russell Lake, W/S-2); refer to Figure 1. Canadian Council of Ministers of the Environment (CCME) Interim Freshwater Sediment Quality (ISQ) Guidelines for the Protection of Aquatic Life and Probable Effects Levels (PEL) provided for Arsenic, Chromium and Copper. Note: samples not collected at W/S-4 in 2011, and CCME PEL for Copper not shown on figure as it is beyond the scale provided.

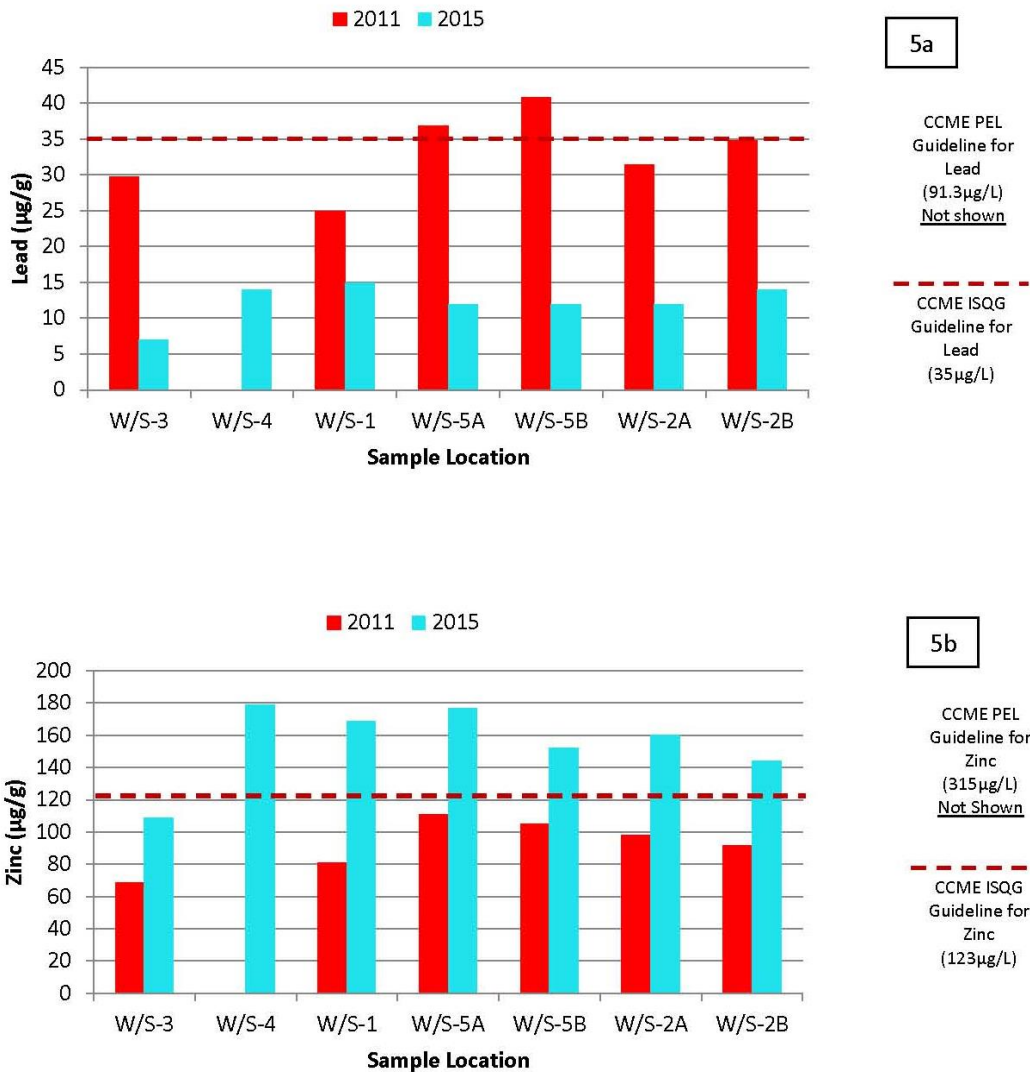


Figure 5 Comparison of the concentrations of Lead (5a) and Zinc (5b) in sediment samples collected during the TAEMP near Behchokò, September 2015 and September 2011. Sample locations are arranged from those more upstream (Slemon Lake, W/S-3) to downstream (Russell Lake, W/S-2); refer to Figure 1. Canadian Council of Ministers of the Environment (CCME) Interim Freshwater Sediment Quality Guidelines (ISQ) for the Protection of Aquatic Life and Probable Effects Levels (PEL) provided for Lead and Zinc. Note samples not collected at W/S-4 in 2011, and CCME PEL for Lead and Zinc not shown on figures as they are both beyond the scales provided.

d. Fish Species Diversity

Five species of fish were caught on Russell Lake (Table 3); 4 wille (INCO; Coney), 43 lih, 11 ehts'èè / ehch'èè, 1 kwiezhìi (WHSC; White Sucker), and 19 jhdaa, for an overall total of 78 fish caught over a combined total of 57.55 hours of net sets. The ehts'èè / ehch'èè (WALL) and jhdaa (NRPK) represented the common top predators, and lih (LKWH) represented benthic invertebrate feeders. Smaller fish fauna could not be effectively sampled with the mesh size in the gillnets used.

e. Fish Tissue Analysis

The three fish species which had tissues collected for contaminant analyses were lih, ehts'èè / ehch'èè, and jhdaa. These three species are species used for consumption, and the three were the same species for which analyses occurred in 2011.

Jhdaa 2015 results

The average mercury concentration for the jhdaa sampled in 2015 (n=17) was 0.4412mg/kg (95% CI+/-0.1081, $\alpha=0.05$) and ranged from 0.105 to 0.849mg/kg. Approximately half of the fish sampled (9 of 17) were below the mercury concentration guideline of 0.5 mg/kg, (wet weight, (wwt); Health Canada, 2016, 2011), and ranged from 0.105 to 0.435mg/kg (Figures 6a, 6b and 6c). The fish tissue samples found to be above the guideline (8 of 17) ranged from 0.524 to 0.849mg/kg (wwt); tissue samples above the guideline included some of the largest (e.g. 1041 and 1016mm), heaviest (e.g. 8210.0 and 7983.2g) and oldest fish sampled (e.g. estimated at 14 and 15 years). Review of mercury concentrations in muscle tissue in relation to age, fork length, and weight show positive relationships (Figures 6a, 6b and 6c; no regression analyses performed). Mercury concentrations in jhdaa were the highest out of the three fish species sampled.

Jhdaa comparison between 2015 and 2011

The average mercury concentration jhdaa sampled in 2011(n=13) was 0.4603mg/kg (95% CI+/-0.1732, $\alpha=0.05$) and ranged from 0.0221 to 1.01 (with the min/max values representing a very small very young individual, and one of the larger older individuals sampled, respectively). Overall, the mercury concentrations found in jhdaa tissues sampled in 2015 appear to be similar to the concentrations found in 2011 (Table 4), and visual comparison of scatter plots suggests similar positive relationships between mercury concentrations in tissue relative to length, weight and age (Figures 6a, 6b and 6c; no statistical comparisons were conducted).

Table 3 Date and duration of net sets, and number of wile (INCO), ìih (LKWH), ehts'èè / ehch'èè (WALL), kwiezhìi (WHSC), and ìhdaa (NRPK) caught on Russell Lake near the community of Behchokò during the TAEMP, September 14-18, 2015.

Net set / pull date	Location (Lat/long)	INCO	LKWH	WALL	WHSC	NRPK
Sept 14 / Sept 15	N 63°05' 08.2" W-115°49'48.1"	0	12	0	0	2
Sept 15 / Sept 16	N 63°02'56.7" W -115°49'07.8"	0	8	0	0	5
Sept 15 / Sept 16	N 63°05'09.3" W-115°49'27.3"	2	8	5	1	6
Sept 16 / Sept 17	N 63°05'09.3" W-115°49'27.3"	2	15	6	0	6
Totals		4	43	11	1	19

Note: Lat/Long are NAD 83

Table 4 Comparison of 2011 and 2015 average mercury concentrations in tissue samples (mg/kg +/- 95% CI, $\alpha=0.05$) collected from ìhdaa (Northern Pike) ehts'èè / ehch'èè (Walleye) and ìih (Lake Whitefish) caught on Russell Lake near the community of Behchokò during the TAEMP, September 14-18, 2015.

Fish species	2011 Average Mercury concentration (+/- 95% CI)	2015 Average Mercury concentration (+/- 95% CI)
ìhdaa (Northern Pike)	0.4603mg/kg (+/-0.1732); n=13	0.4412mg/kg (+/-0.1081); n=17
ehts'èè / ehch'èè (Walleye)	0.2714mg/kg (+/-0.0838); n=11	0.1962mg/kg (+/-0.0137); n=11
ìih (Lake Whitefish)	0.0675mg/kg (+/-0.0226); n=10	0.0471mg/kg (+/-0.0087); n=20

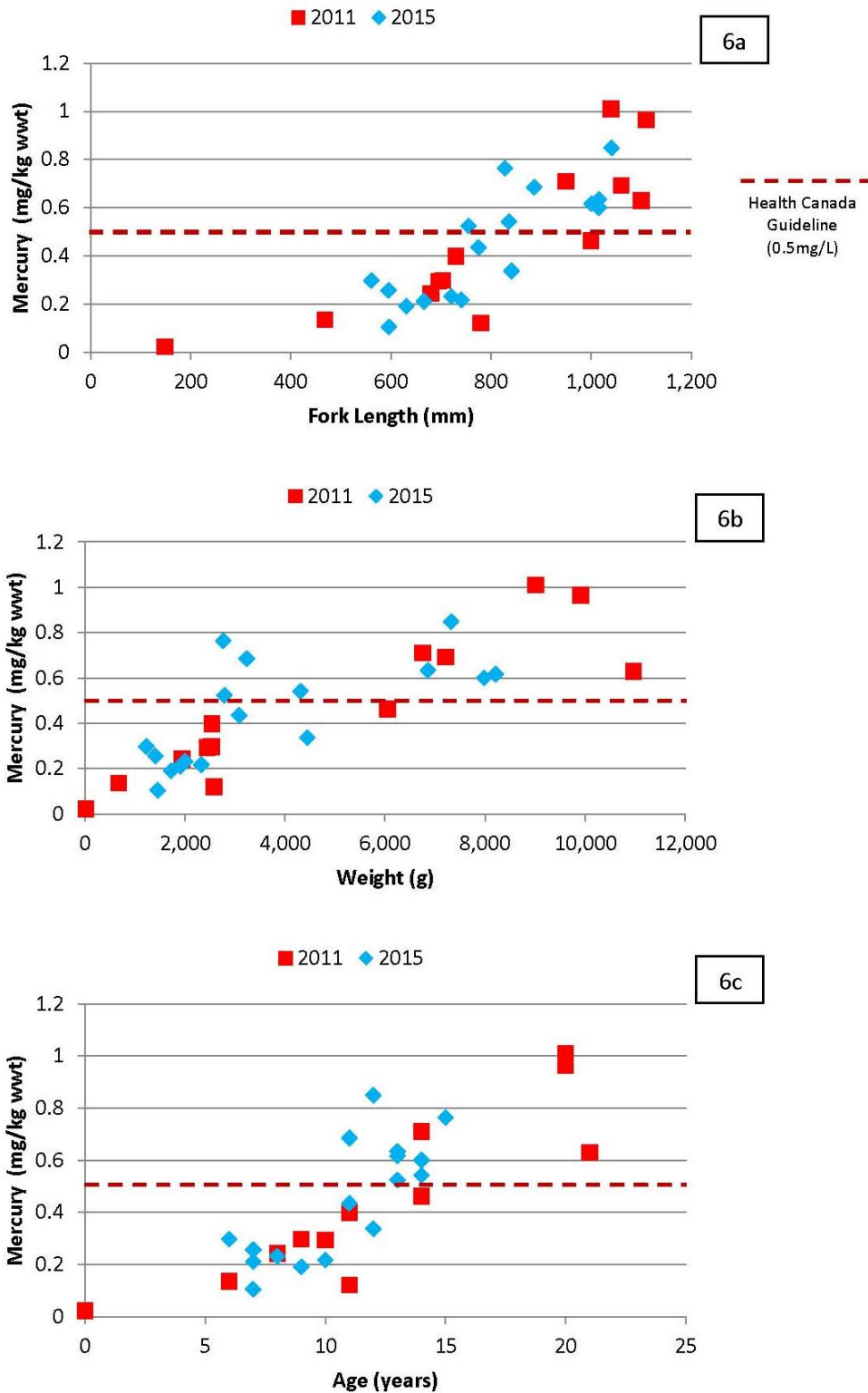


Figure 6 Comparison of the relationships between mercury concentration in tissues (mg/kg; wet weight) fork length (mm) (6a), body weight (g)(6b), and age (years; estimated via clethria aging) (6c) of ɰhdaa (Northern Pike) collected during the TAEMP near Behchokø, September 2015 and September 2011. Health Canada Canadian Standard for mercury concentration in commercial fish 0.5mg/L) provided.

Ehts'èë / ehch'èë 2015 results

The average mercury concentration in ehts'èë / ehch'èë sampled in 2015 (n=11) was 0.1962 mg/kg (95% CI±/0.0137, $\alpha=0.05$; Table 4) and ranged from 0.160-0.228mg/kg (wwt) (Figures 7a, 7b and 7c). All of the ehts'èë / ehch'èë sampled fell below the mercury concentration guideline of 0.5 mg/kg, (wet weight, wwt; Health Canada, 2012). In 2015, mercury concentrations in ehts'èë / ehch'èë tissue were lower than concentrations found in jhdaa and higher than concentrations found in ìih.

Ehts'èë / ehch'èë comparison between 2015 and 2011

The average mercury concentration in ehts'èë / ehch'èë sampled in 2011 (n=11) was 0.2714 mg/kg (95% CI±/0.0838, $\alpha=0.05$) and ranged from 0.103 to 0.532mg/kg (wwt), a wider range of concentrations than observed in 2015. The tissues with the highest concentrations in 2011 were from the older (e.g. 15 and 20 years), larger (e.g. 462 464mm FL) and heavier (e.g. 946 and 982g) fish. Overall, the mercury concentrations found in ehts'èë / ehch'èë tissues sampled in 2015 were slightly lower than the concentrations found in 2011 (Table 4), and visual comparison of scatter plots suggest a stronger positive relationships between mercury concentrations in tissue relative to length, weight and age in 2011 results versus the 2015 results, with 2015 results being more clustered relative to the 2011 results (Figures 7a, 7b and 7c).

ìih 2015 results

The average mercury concentration in ìih sampled in 2015 (n=20) was 0.0471mg/kg (95% CI±/0.0087, $\alpha=0.05$) and ranged from 0.0204-0.0878mg/kg (wwt). All of the ìih sampled fell well below the guideline for mercury. Review of mercury concentrations in muscle tissue in relation to age, fork length, and weight suggest positive relationships (Figure 8a, 8b and 8c; no regression analyses performed).

ìih comparison between 2015 and 2011

The average mercury concentration in ìih sampled in 2011 (n=10) was 0.0675mg/kg (95% CI±/0.0226, $\alpha=0.05$) and ranged from 0.0359 to 0.157mg/kg (wwt). Overall, the mercury concentrations found in ìih tissues sampled in 2015 were similar to the concentrations found in 2011 (Table 4), and visual comparison of scatter plots suggest similar positive relationships between mercury concentrations in tissue relative to length, weight and age for both 2011 and 2015 (Figure 8a, 8b and 8c).

Overall, no deformities/abnormalities were noted in any of jhdaa, ìih, or ehts'èë / ehch'èë sampled; parasites (e.g. worms) were found, though not at levels considered to be abnormal.

It should also be noted that the Health Canada Guidelines provided are for retail fish (Health Canada 2016). There are no Health Canada Guidelines for fish caught for recreational or subsistence purposes.

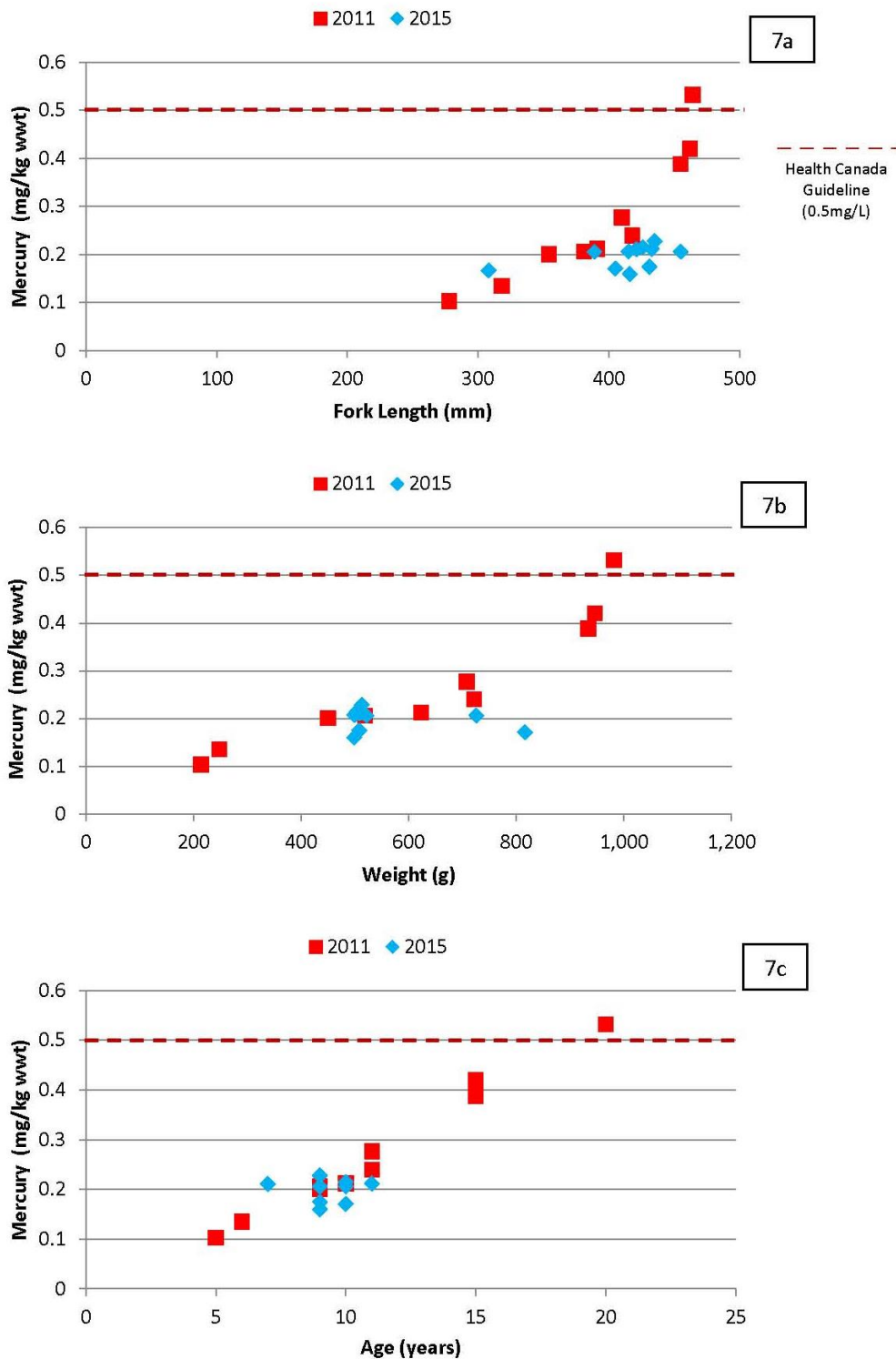


Figure 7 Comparison of the relationships between mercury concentration in tissues (mg/kg; wet weight) and fork length (mm) (7a), body weight (g)(7b), and age (years; estimated via otolith aging) (7c) of ehts'èë / ehch'èë (Pickerel or Walleye) collected during the TAEMP near Behchokò, September 2015 and September 2011. Health Canada Canadian Standard for mercury concentration in commercial fish (0.5mg/L) provided.

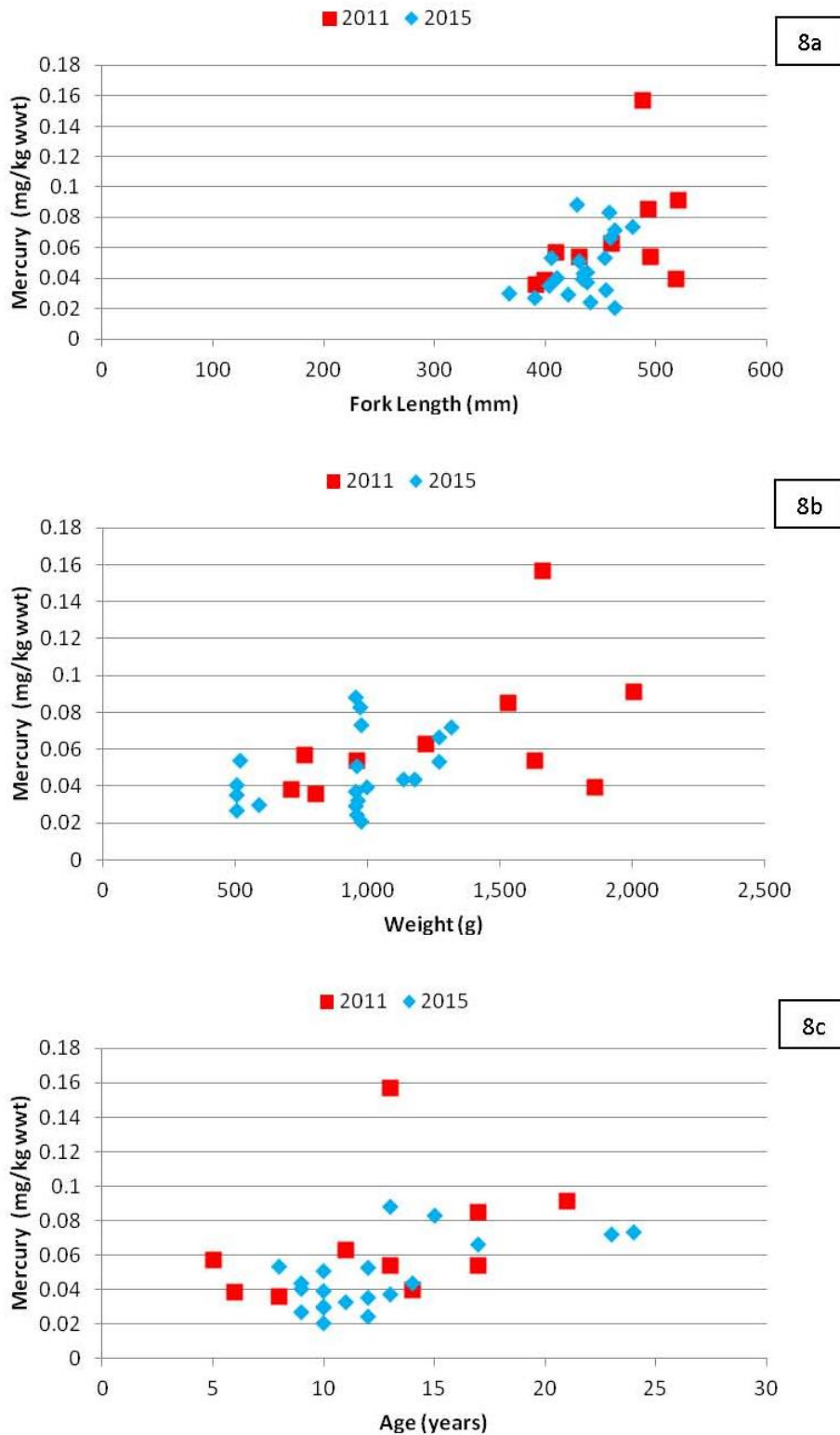


Figure 8 Comparison of the relationships between mercury concentration in tissues (mg/kg; wet weight) and fork length (mm) (8a), body weight (g)(8b), and age (years; estimated via otolith aging) (8c) of fish (Lake Whitefish) collected during the TAEMP near Behchokò, September 2015 and September 2011. Health Canada Canadian Standard for mercury concentration in commercial fish (0.5mg/L) not shown.

Other fish species

No łwezoq̄ (Lake Trout) were caught, which was not unexpected given that only two łwezoq̄ were caught in 2011 and that community members mentioned that the likelihood of catching łwezoq̄ was low; łwezoq̄ tissue samples were not collected for analyses. One kwiezhì was caught, tissue samples were not collected for analyses. There were four wile caught; tissue samples were not collected for analyses.

f. Fish Growth

Overall, review of age in relation to length for the jhdaa caught in Russell Lake suggest a positive relationship (Figure 9). The relationship of age in relation to length was less obvious for lih, and ehts'èq̄ / ehch'èq̄, though slightly positive relationships are suggested (Figure 9); no regression analyses were performed.

Jhdaa

Jhdaa sampled in 2015 (n=17) were on average 794.41mm in length (FL) (95% CI+/-75.32, $\alpha=0.05$) ranged from 561-1041mm, were on average 3707.72g in weight (95% CI+/-1148.29, $\alpha=0.05$) and ranged between 1224.7-8210.0g and were estimated to be on average 10.71 years of age (95% CI+/-1.37, $\alpha=0.05$) ranging from 6-15 years.

By comparison, jhdaa sampled in 2011 (n=13) were on average 805.00mm (95% CI+/-152.85, $\alpha=0.05$) in length (FL) and ranged from 148-1140mm, were on average 4817.54g (95% CI+/-1996.69, $\alpha=0.05$) in weight and ranged from 20-10970g, and were on average estimated to be 12 (95% CI+/-3.52, $\alpha=0.05$) years of age with a range of 0-21 years of age. For age sample size was 12 as age was available for one of the 13 fish sampled, as the jhdaa was small and the otolith was not collected.

Ehts'èq̄ / ehch'èq̄

The ehts'èq̄ / ehch'èq̄, sampled in 2015 (n=11) were on average 412.18mm (95% CI+/-22.79, $\alpha=0.05$) in length (FL) and ranged from 308 to 455mm, were an average of 513.80g (95% CI+/-111.60, $\alpha=0.05$) in weight and ranged from 45.4-816.5g, and were estimated to be on average 8.91 years in age (95% CI+/-0.96, $\alpha=0.05$) with a range of 7-11 years.

By comparison, ehts'èq̄ / ehch'èq̄, sampled in 2011 (n=10) were on average 393.1mm (95% CI+/-38.69, $\alpha=0.05$) in length (FL) and ranged from 278-464mm, were on average 634.6 (95% CI+/-172.14, $\alpha=0.05$) in weight and ranged from 214-982g, and were estimated to be on average 11.1 (95% CI+/-2.79, $\alpha=0.05$) years in age with a range of 5-20 years.

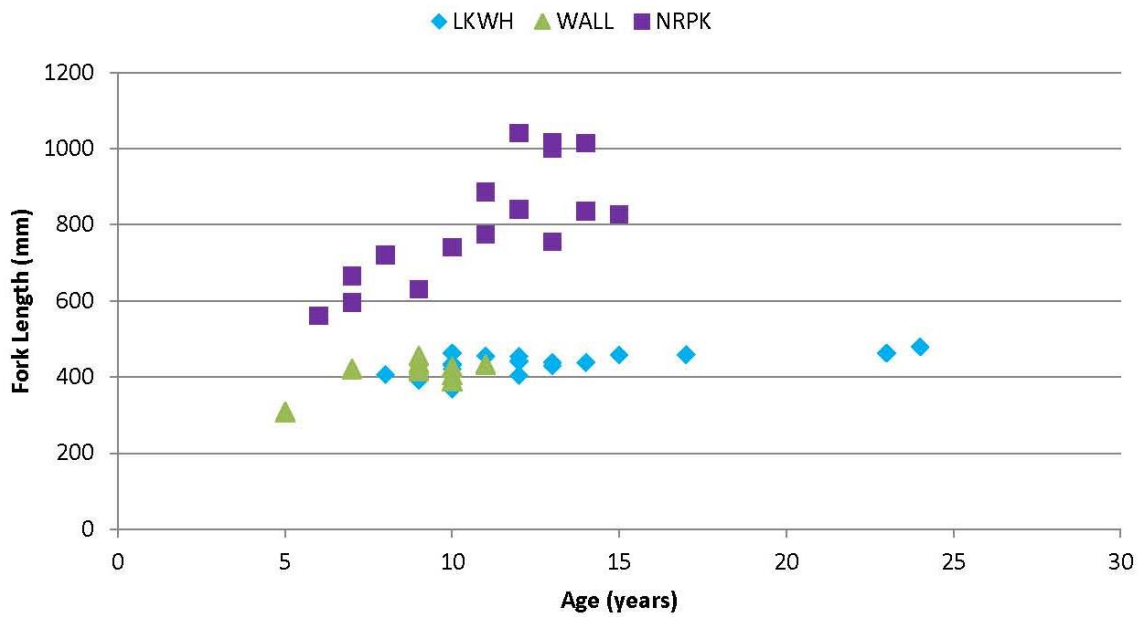


Figure 9 Relationships between fork length (mm) and age (years; estimated via otolith and clethria aging) in lih (LKWH), ehts'èè / ehch'èè (WALL) and jhdaa (NRPK) that were collected on Russell Lake during the TAEMP near Behchokò, September 2015.

łih

The łih sampled in 2015 (n=20) were on average 433.9mm (95% CI+/-12.09) in length (fl) and ranged from 363-479mm, were on average 921.93g in weight (95% CI+/-115.90) ranging from 503.5g-1315.4g, and were estimated to be on average 12.55 (95% CI+/-1.92) years of age, ranging from 8-24 years.

By comparison, łih sampled in 2011 (n=10) were on average 460.7mm in length (FL) (95% CI+/-30.38) ranging from 392-520mm, were on average of 1314g in weight (95% CI+/-299.87.90) with a range of 710-2005g, and were estimated to be on average 12.5 (95% CI+/-3.12) years of age with a range of 5-21 years.

Other fish species

One kwiezhìi (White Sucker) was caught, 434mm in length and 1179.0g in weight. There were four wiile (Inconnu, or Coney) caught averaging 560.8mm in length (FL) (95% CI+/-77.7) and ranging from 496 to 671mm, and averaging 1574.0g in weight (95% CI+/-691.3) ranging from 966.2 to 2313.3g.

g. Cultural / Educational Activities

Elders and youth were exposed to, and participated in, scientific sampling methods typically used to monitor aquatic ecosystems, including the following: sediment and water quality sampling as well as fish tissue sampling for contaminant analysis. On shore demonstrations and field-based activities built on knowledge transferred to community members in 2011, increased understanding of standard methods used to assess contaminants in aquatic environments, and allowed community members to have increased knowledge with regards to monitoring and research activities near Tłıchq communities.

On-shore demonstrations were given for fish sample processing, though time constraints led to water and sediment sampling being demonstrated in the field prior to actual samples being collected. Paul Vecsei (Golder Associates Ltd.), with assistance from Erin Goose, Field Technician Support, (GNWT ENR), demonstrated how to process a fish for sampling and how to obtain the required information from the fish (e.g. length, weight, sexual maturity, otolith/clethria extraction). Differences among the fish species caught were shown, with particular focus on the characteristics that show adaptations for different lifestyles (e.g. top predator vs. benthic feeders). Sean Richardson, Wildlife Coordinator (TG), along with Roberta Judas, Regulatory Technician, and Meghan Schnurr, Regulatory Specialist, both with the WLWB, led the field demonstration for water and sediment sample collection. Sampling in the field involved interested youth, and under supervision, the youth assisted with the collection of some of the water and sediment samples.

Importantly, youth were exposed to, and were provided basic training on standardized methods for the collection of samples. Under supervision and through direction by the TG and WLWB staff, youth were provided with hands-on opportunities to collect water and sediment samples. Though youth who participated in 2015 were not the same youth who were present in 2011, the possibility that youth may continue with more specific training is strengthened by the availability of the Marian Watershed Stewardship Program led by the TG and WLWB, and by training opportunities offered via the Tłıchq Government (e.g. boat captain training). In discussions with

support staff, youth participants voiced an interest in continuing training in environmental monitoring, notably including interest in the planning and analyses components of research, in addition to the field sampling components.

Through stories and commentary provided by elders, youth and visiting researchers were exposed to Tłıchq knowledge of the area, which promoted greater understanding of the local aquatic environment among participants, as well as a historical and cultural context to the area around the camp and sampling locations. A four-year rotation through Tłıchq communities allows for strong potential that community members will repeatedly participate in, contribute to, and learn from the TAEMP. Unfortunately, a number of the elders who participated in the 2011 camp had passed away, and other 2011 participants were not able to attend for other reasons. However, some of the participants from 2011 were still able to attend, and pass on their knowledge and memories from the 2011 TAEMP.

At camp, elders shared their knowledge and stories, and through their direction, youth assisted with camp chores and learned skills and behaviours appropriate at an on-the-land camp from both the elders and from support staff. Everyone enjoyed the traditional foods prepared by the camp cooks, and fish caught were used for both sampling and consumption. Elders provided an on-shore demonstration of a variety of dry-fish preparation techniques, with stories during the preparation indicating under what circumstances and for what reasons different techniques were used. Two elders, who had years of experience from teaching at the Daring Lake Field Station, answered questions from the youth and visiting support staff. The majority of camp participants (excluding those who stayed back at camp for maintenance safety reasons) also paid a visit to gravesites near the camp location. Two gravesites were visited, with one site being known only to a portion of the Tłıchq community members. As a result, local knowledge and history were passed on not just to the youth and visiting researchers, but to some of the community members as well.

The *Common Fish of the Tłıchq Region*, a basic field guide to fish found in Wek'èezhìı, was provided to participants at camp. Post-camp, the fish guide was updated to include information on fish habitat in addition to basic information on the characteristics of common fish species in Wek'èezhìı. The updated guide has since been printed, and will be provided to Tłıchq community schools in time for the start of the September 2016/17 school year. The guide will also be provided on the WRRB website and through links to TEAMP partner sites.

In addition to providing the updated fish guide, educational videos highlighting activities at the on-the-land camps specific to each Tłıchq community have been developed by NWT-based filmmakers with assistance from WRRB staff. All have been shown, and are currently available on the WRRB website (www.wrrb.ca). In addition, two new educational videos have been developed that provide demonstrations of fish, water and sediment sampling. The videos have been printed on DVD, and will be provided to the Tłıchq schools along with the updated fish guides. The sampling videos will also be available on the WRRB website.

3. Results Workshop

A workshop was held in Behchokò on April 15, 2016, to report results of lab analyses back to camp participants and interested community members. The implementation of the results meeting faced a number of unforeseen delays as all the sediment and some fish tissue samples needed to be reanalysed. As a result, the meeting occurred later than expected (i.e. results meeting was originally planned for February 2016). In spite of delays, the results meeting was attended by the majority of elders who participated in the 2015 camp, as well as a number of interested community members. Unfortunately, the youth participants did not attend, likely due to a half day of school and community celebration scheduled for the afternoon after the results meeting.

Paul Vecsei (Golder Associates Ltd.) presented the results related to fish, and Sean Richardson (TG) and Nicole Dion (GNWT ENR) presented the water and sediment results. Participants of the Results Workshop were interested in the results and asked questions of clarification. The issue of mercury contamination was discussed, and community members were relieved to hear that the *ih*, *ehts'èè* / *ehch'èè*, and *jhdaa* from Russell Lake continue to be healthy food choices and do not pose a risk. Additional information on healthy traditional food choices was provided via GNWT HSS Traditional Food Fact sheets (GNWT HSS 2014), and clarification was provided on the potential differences between consumption of the predatory fish (*ehts'èè* / *ehch'èè*, and *jhdaa*) and the benthic strategist (*ih*). Importantly, community members were also pleased to hear that there were no appreciable differences between the 2011 and 2015 results for mercury concentrations in fish tissues.

At the end of the presentation, community members expressed their support of the TAEMP and hearing the sampling results. Narcisse Chocolate said, *"I learned a lot from my grandfather. I learned from him and I sell fish. It's good to hear this."* Paul commented on the contributions that community members have made to the success of the TAEMP. He spoke about how the fish camps are a "good forum for the exchange of ideas and learning together". At each fish camp, elders have shared their traditional knowledge of fish and fish habitat, and showed youth various techniques for preparing fish. Their demonstrations show their "skill and precision gained over many years of practice," Paul said. Paul also looked forward to future fish camps: *"The communities are understanding the sampling procedures, so next year one of the younger kids will do up the fish around the processing table and show us how it's done."*

Discussion

Overall, results from the 2015 TAEMP near Behchokò indicated that fish are healthy and habitat is clean in Russell and Slemon Lakes. The message provided to the community was that water, fish and sediment quality are good, where "good" indicates that results were not abnormal and that there were no health concerns highlighted. Also, comparison between the 2011 and 2015 results suggested that there was no appreciable change in the fish, water or sediments.

Results from the 2015 monitoring program near Behchokò support the expectation that water quality and sediment quality are good in Russell Lake. Basic interpretation of the water and sediment quality results involves comparison of results to CCME Guidelines for the Protection of Aquatic Life, for water, and the CCME Sediment Quality Guidelines and Probable Effects Level,

for sediment (CCME 2014). The guidelines are based on a thorough review of information on the toxicity of different parameters (e.g. metals, nutrients, etc.) and indicate the concentration of a parameter below which no adverse effects are expected. CCME guidelines are not site-specific; they are meant to be applied as Canada-wide standards for freshwater to protect all forms of aquatic life, including the most sensitive life stage of the most sensitive species. If a guideline value is exceeded, that does not necessarily indicate that a particular parameter is having a negative effect on aquatic organisms; it suggests that there is potential for an effect, depending on the species present and the natural background characteristics of the water and sediment. These national guidelines are used in absence of baseline or control data to use as a comparison.

The main objective of the 2015 fish, water and sediment quality monitoring program was to repeat the sampling that was done in 2011 to see if any changes had occurred. There was no apparent change in the water quality and sediment quality between 2011 and 2015, with the understanding that some variation of parameters is to be expected with varying natural conditions and low frequency sampling.

The general water and sediment quality of Russell Lake and Slemon Lake can be considered to be good (i.e. not abnormal). Aluminium was the only metal in Russell and Slemon Lakes that exceeded CCME Protection of Freshwater Aquatic Life (FAL) guidelines. In both sample years, the total aluminium concentration was noted to increase downstream as the water flowed from Snare River, through Slemon and Russell Lake. The increased total aluminium concentration was in particulate form as was seen in the percent of dissolved versus total metals in Slemon and Russell Lakes. The increase in total aluminium in the water could be explained by the aluminium rich sediment in Slemon and Russell Lakes. The water flowing through the water system is most likely re-suspending the sediment and carrying it further downstream. The concentration of aluminium and iron in water found at each sample site was similar in both sample years with the exception of the sample site near the mouth of the channel flowing into Russell Lake (W/S-2) near the first fish net location. The concentration of aluminium collected in 2015 from W/S-2 was almost double that found in 2011, with the results for iron being similar. The higher concentration of aluminium and iron may be due to disturbance of the sediment as a result of the fish net activities (e.g. community members not associated with the camp setting nets in the area, with support poles placed in the sediment rotating and “churning” the sediment) and windy conditions resulting in further mixing. It should be noted that there is no consistent, convincing evidence that aluminium in drinking water causes adverse health effects in humans (Health Canada 2015). Sediment sample results showed that sediment collected from the mouth of the Snare River flowing into Slemon Lake (W/S-3), also the most upstream sample site, had lower concentrations of metals than all the other sample sites. 2015 sediment sample results showed that the sediment in Slemon and Russell Lakes exceed CCME Interim Freshwater Sediment Quality (ISQ) Guidelines for arsenic, chromium and zinc. By comparison, the 2011 results did not have zinc in exceedance of guidelines, though copper was in exceedance. Arsenic, chromium, copper, lead and zinc are metals of environmental concern as these metals exceeded CCME (FAL) guidelines. However, these metals were within CCME guidelines in the water samples.

Nutrients are the building blocks for productivity and growth of phytoplankton, algae and other aquatic plants. Lakes are often categorized according to their productivity as oligotrophic (low productivity), mesotrophic (moderate productivity) or eutrophic (high productivity). While many

nutrients are required for plant growth, nitrogen and phosphorus are frequently the controlling factors for productivity (Wetzel 2001). Nutrient and physical parameters were measured at all sample sites and were found to be similar at all sites. The results of Slemon and Russell Lake are typical of water originating on the Precambrian Shield and would be classified as an oligotrophic lake.

Overall, results indicated that fish are healthy and habitat is clean in Russell and Slemon Lakes; no contaminant levels observed in jhdaa, ehts'ëë / ehch'ëë or lih were considered to be abnormal. Though jhdaa and ehts'ëë / ehch'ëë were found to have higher mercury concentrations than lih, this was not unexpected given that they are predatory fish which commonly exhibit higher levels due to bioaccumulation and biomagnification, while lih primarily feed on small fish and arthropods and typically show lower levels of contaminants (GNWT 2014, 2016, Health Canada, 2016, 2011, Cabana et al. 1994). No statistical analyses of mercury concentrations in muscle tissue in relation to age, fork length, and weight were conducted, given that examination of the scatter plots suggest positive relationships (as expected). Statistical analyses are expected through collaboration with Environment and Climate Change Canada, examining data in the context of the TAEMP, as well as comparing TAEMP data to surrounding lakes in Wek'èezhìi which have not been sampled as part of the TAEMP.

Elders and other community members guided all aspects of the project, with Tłıchq knowledge incorporated throughout, by design. The application of Tłıchq knowledge included: selection of participants, selection of the camp location and establishment of the on-the-land camp, direction on where samples were collected, which culturally significant places are visited, and what behaviours/practices are appropriate and respectful while at the on-the-land camp. In addition, the on-the-land component of the TAEMP provided an opportunity for youth to engage with their elders, assisting in the youth's education in observing, monitoring and understanding the aquatic ecosystem from a Tłıchq perspective. Elders and community members passed on Tłıchq knowledge to youth fostering interest in monitoring near communities and assisting with the continuation of Tłıchq knowledge of aquatic ecosystems and the traditions associated with each community. The TAEMP also offered an opportunity for researchers to learn from traditional knowledge holders in a culturally appropriate on-the-land context. This form of engagement allowed for building of mutual respect and trust through exchange of TK and science-based information. Lastly, by bringing results back to Behchokò, findings were discussed in a public forum which helped build a shared appreciation of the similarities in perspectives provided by both Tłıchq knowledge and science.

Conclusions and Next Steps

The Tłıchq Aquatic Ecosystem Monitoring Program has been developed and modified continuously through a collaborative relationship among communities and agencies based in the NWT. By design, the TAEMP is based on consultation with communities near which sampling occurs. The TAEMP Partners will continue to use a collaborative approach in the future through face-to-face meetings, conference calls, and workshops, culminating in the on-the-land "fish camp" at which dialogue with community representatives occurs constantly to ensure the Program continues to meet its objectives.

The TAEMP provides an opportunity for youth and community members to conduct scientific fish monitoring at an on-the-land camp, and allows their experience(s) to be combined with their

Tłıchq knowledge of the environment near communities. This increases the capacity of Tłıchq people to understand the science-based methods used to assess the current and potential effects of contaminants within various ecosystems across their lands and how the results are interpreted, while simultaneously sharing Tłıchq knowledge and allowing for clarification of concepts in an on-the-land setting (e.g. similar to a field course-based approach). The TAEMP also offers an opportunity for researchers to learn from traditional knowledge holders in a culturally appropriate on-the-land context. This form of engagement allows for building of mutual respect and trust – as scientists and knowledge holders learn from one another while out on the land, recognizing each other’s capabilities through regular camp operations (e.g. net setting, fish collection, fish processing for samples and food).

The TAEMP also involves staff from organizations inherently linked to Tłıchq communities, including the WRRB, WLWB and the TG. Long-term capacity building occurs in these organizations through continued support by their trained staff, some of whom are also Tłıchq citizens living in communities. A four-year rotation through Tłıchq communities also allows for the potential that community members will repeatedly participate in, contribute to, and learn from the TAEMP – notably the youth. Youth are exposed to, and provided basic training on, the standardized collection of samples, and the possibility for youth continuing with more specific training is strengthened by the availability of the Marian Watershed Stewardship Program led by the TG and WLWB.

With the conclusion of the TAEMP near Whatì in 2014, baseline sampling was completed near all four Tłıchq communities. In 2015, when the TAEMP returned to Behchokq, a new phase began: the first round of comparative sampling. This next phase of comparative sampling will provide data that will continue to provide a means of addressing community concerns related to changes in the environment, and the TAEMP will continue to build on work carried out since 2010. The next four years (2015-2018) will provide data that may indicate changes and may provide relevant information to assist in cumulative effects analyses and informed decision-making. For example, the TAEMP will contribute to the implementation of the NWT Water Stewardship Strategy (WSS) and Action Plan, and the continuing assessment of contaminant levels in traditional foods through collaboration with Health and Social Services and the Northern Contaminants Program. TAEMP will also complement the Tłıchq Government’s ongoing Marian Watershed Stewardship Program in establishing baseline datasets and evaluating cumulative effects that may occur due to climate change, industrial activities (e.g. Fortune Mineral’s proposed NICO project), and/or natural disturbances such as fire (Baltzer 2015). Finally, TAEMP continues to assist in the promotion, understanding, and protection of source water for Tłıchq communities.

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Appendix 1 – Project Participants

Introductory Workshop (August 27, 2015)

Behchokò Community members:

- Jonas Football
- Joseph-Pierre Mantla
- Bernadette Rabesa
- Celine Wanazah

Support Staff:

- Susan Beaumont WRRB
- Sean Richardson TG
- Boyan Tracz WRRB

Translation:

- Jonas Lafferty
- James Rabesca)

Planning Workshop (September 10, 2015)

Behchokò Community members:

- Joseph-Pierre Mantla
- Jonas Football
- Bernadette Rabesa
- Celine Wanazah
- Eva Mantla
- Michel Louis Rabesca
- Charlie Apples
- Mary Mantla
- Samuel Lamouelle

Support Staff:

- Susan Beaumont WRRB
- Linsey Hope TSCA
- Sean Richardson TG
- Boyan Tracz WRRB

Translation:

- Jonas Lafferty
- James Rabesca

Fish Camp (September 14-18, 2015)

Behchokò Elders:

- Charlie Apples
- Jonas Football
- Louis Frankie
- Dora Migwi
- Michel Louie Rabesca
- Bernadette Rabesca

Behchokò Youth:

- Patrick Adzin
- Roman Lamouelle
- Vincent Naskin
- Tracy Nadary
- Teya Wetrade
- Jody Ann Zoe

Behchokò Community Support:

- Sam Lamouelle Foreman
- James Lafferty Foreman Assistants
- Joseph P. Mantla Foreman Assistants
- Peter Apples Camp Assistant:
- Eva Mantla Head Cook:
- Bertha Zoe Cooks Helper:

Partners:

- Erin Goose GNWT
- Roberta Judas WLWB
- Lucy Lafferty TCSA
- Sean Richardson TG
- Meghan Schnurr WLWB
- Boyan Tracz WRRB
- Paul Vecsei Golder

Translation

- Jonas Lafferty
- James Rabesca

Additional Support:

- Michael Birlea TG Behchokò
- Nicole Dion GNWT
- Janita Etsemba TG Behchokò
- Lindsey Hope TCSA
- Jessica Humm TG Behchokò
- Phoebe Rabesca TG Behchokò

Results Workshop (February 11. 2015)

Elders (and camp participants)

- Charlie Apples
- Joans Football
- Lucy Lafferty
- Dora Migwi
- Bernadette Rabesca
- Michel Louie Rabesca

Community Members

- William Apples
- Frank Beaulieu
- Narcisse Chocolate
- Noel Drybones
- Joe Erasmus
- Mary Koyina Richardson
- George. E. Lafferty
- Joe Mantla

TG Support staff:

- Micheal Birlea
- Jessica Hum

Partners:

- Susan Beaumont WRRB
- Nicole Dion ENR
- Sean Richardson TG
- Boyan Tracz WRRB
- Paul Vecsei Golder Associates Ltd.

Translation:

- Jonas Lafferty
- James Rabesca



Photo: S. Beaumont, WRRB

Appendix 2 – Results from Water Quality Travel and Field Blanks

Field quality assurance/quality control (QA/QC) measures carried out for this program consisted of a travel blank and a field blank. These QA/QC samples were incorporated into the study to ensure that no contamination was introduced through the collection, handling, shipping and analysis of the samples.

Travel blanks were prepared by Taiga Labs (Yellowknife) and field blanks were prepared on site, using Type 1 water provided by Taiga. The blanks were carried and analyzed the same as samples which were collected on site.

The presence of measureable total metals in the field blank samples, i.e., concentrations above the method detection limit, may indicate contamination during sample preparation in the field. Measurable total metals in the travel blank may indicate contamination in the lab.

Results available upon request.

Appendix 3 – Surface Water Physical and Nutrient Analysis Results

Results available upon request

Appendix 4 – Surface Water Metal Analysis Results

Results available upon request

Appendix 5 – Sediment Metals Analysis Results

Results available upon request

Appendix 6 – Fish species diversity, length and weight

Results available upon request

Appendix 7 – Metals analysis for fish tissue samples

Results available upon request

Appendix 8 – Age analysis for fish otolith samples

Results available upon request