Tłı̨chǫ Aquatic Ecosystem Monitoring Program (TAEMP)

Final Report, Whatì 2018

June 27, 2019

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Cover Photo: Laura Meinert, WRRB

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Acknowledgements

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Summary

The purpose of the Tłı̨chǫ Aquatic Ecosystem Monitoring Program (TAEMP) is to continue to build and maintain a successful community-based monitoring program that meets the needs of the Tłı̨chǫ 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 Tłı̨chǫ communities so that every community has samples collected and analysed 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 Tłı̨chǫ and scientific knowledge to address the question: “Are the fish safe to eat and is the water safe to drink?”

In 2018, community members in Whatì were informed of the TAEMP through face-to-face community meetings, where support staff and community members discussed the TAEMP camp near Whatì in 2014, and re-visited concepts related to Tłı̨chǫ and scientific knowledge relevant to water, sediment and fish, and concerns regarding potential contaminants. A key outcome of the workshops was advanced planning of a 5-day on-the-land monitoring camp on Lac la Martre at a location selected by community members from Whatì. At the planning meetings, and at the on-the land camp, elders and community members had opportunities to describe fish health near Whatì, as well as their concerns about aquatic ecosystem health and the need for adequate monitoring near the community. At the on-the-land camp in September 2018, biologists and community members collected fish tissue samples for analysis of a variety of metals, including mercury. Elders and community members ensured safe camp operations and transport by boats and provided direction on where fish nets were set and where water samples were collected. Sites sampled in 2014 were revisited, and three new water/sediment sampling locations were added further west of the camp as per community members’ request. However, due inclement weather, the additional sites were not sampled in 2018. Youth were provided basic hands-on training in science-based sampling methods. Water and sediment samples were analysed for metals, as well as chemical and physical properties.

A results meeting open to the public was held in Whatì in April 2019, and a presentation providing a comparison of the 2014 to 2018 results for fish, water and sediment was given. Fish tissue analysis indicated mercury levels were low in both łiwezǫ̀ǫ̀ (Lake Trout) and łih (Lake Whitefish), with łiwezǫ̀ǫ̀ samples having the highest concentrations overall. None of the species’ tissue samples showed levels of mercury that were considered abnormal for northern lakes. Comparison of 2018 results to 2014 results showed no appreciable change in mercury concentration. Water and sediment results supported the expectation that water and sediment quality is “good” (i.e. not abnormal) in Lac la Martre.

Introduction

The purpose of the Tłı̨chǫ 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 Tłı̨chǫ 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 Tłı̨chǫ communities. There are historic, currently operating, and proposed developments in Wek’èezhìı, and there is concern in Tłı̨chǫ 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 2016, 2015), 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 Tłı̨chǫ 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 Tłı̨chǫ 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 Tłı̨chǫ communities once every four years. With the conclusion of the 2014 camp near Whatì, the TAEMP completed its initial baseline sampling phase. In 2018, the final round of comparative sampling was completed with the return of the TAEMP to the community of Whatì. The comparative sampling phase has built on work carried out since 2010 and allows for comparative analysis of sampling results collected in each of the four communities. The comparative sampling provides 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 Tłı̨chǫ Government (TG), the Wek’èezhìı Land and Water Board (WLWB), the Department of Fisheries and Oceans (DFO), the Government of the Northwest Territories Department of Environment and Natural Resources Water Resources Division (GNWT ENR) and Department Health and Social Services (GNWT HSS), and Environment and Climate Change Canada (ECCC), Crown-Indigenous Relations and Northern Affairs Canada, Golder Associates.

Methods

The 2018 TAEMP consisted of three main phases:

1. Introductory and planning workshops in Whatì;
2. On-the land camp near Whatì on Lac la Martre where samples were collected; and,
3. Results workshop in Whatì.

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 2018 to discuss the TAEMP with community members in Whatì. The meetings provided a means to reacquaint community members with objectives and the approach of the TAEMP, as the TAEMP had last taken place near Whatì in 2014, 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 WRRB staff, as well as potential additional sampling locations. 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 – Lac la Martre

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 building/maintenance of relationships and mutual respect.

The camp provided an opportunity for researchers and community members to work collaboratively to combine aspects of Tłı̨chǫ knowledge with scientific-based monitoring methods. It provided teaching opportunities in Tłı̨chǫ 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 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 Crown-Indigenous Relations 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 WLWB Regulatory Manager; 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 taken on the day of departure delivered to the lab in Yellowknife on the same day. 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; now Environment and Climate Change Canada), and samples were analysed 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 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 as top and bottom.

Appropriate QA/QC procedures were followed according to Taiga instructions. Field Staff used fresh disposable vinyl gloves at each sample site to minimize the potential for contamination from the sampler's hands. Sediment sampling was led by the WLWB Regulatory Manager.

d. Fish Sampling

Fish were collected through gillnets set at locations as determined by community members given the knowledge of where fish species can be caught; 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 Lac La Martre (Figure 1, Table 1). The 4.0-inch, 4.5-inch and 5-inch nets were used to target larger fish such as łiwezǫ̀ǫ̀ (Lake Trout; LKTR) *łih* (Lake Whitefish; LKWH). The number and duration of gillnet sets were subject to safety considerations and occurred close to camp.

The fish caught were identified to species, measured for total length 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 (for aging) were 20 łiwezǫ̀ǫ̀ (LKTR) and 20 łih (LKWH) to replicate samples sizes from 2014. The species sampled also represented those typically consumed by community members, and sampling of the two species also provided a way to account for differences between benthic (bottom feeding) and predatory (feeding on smaller fish) strategies.

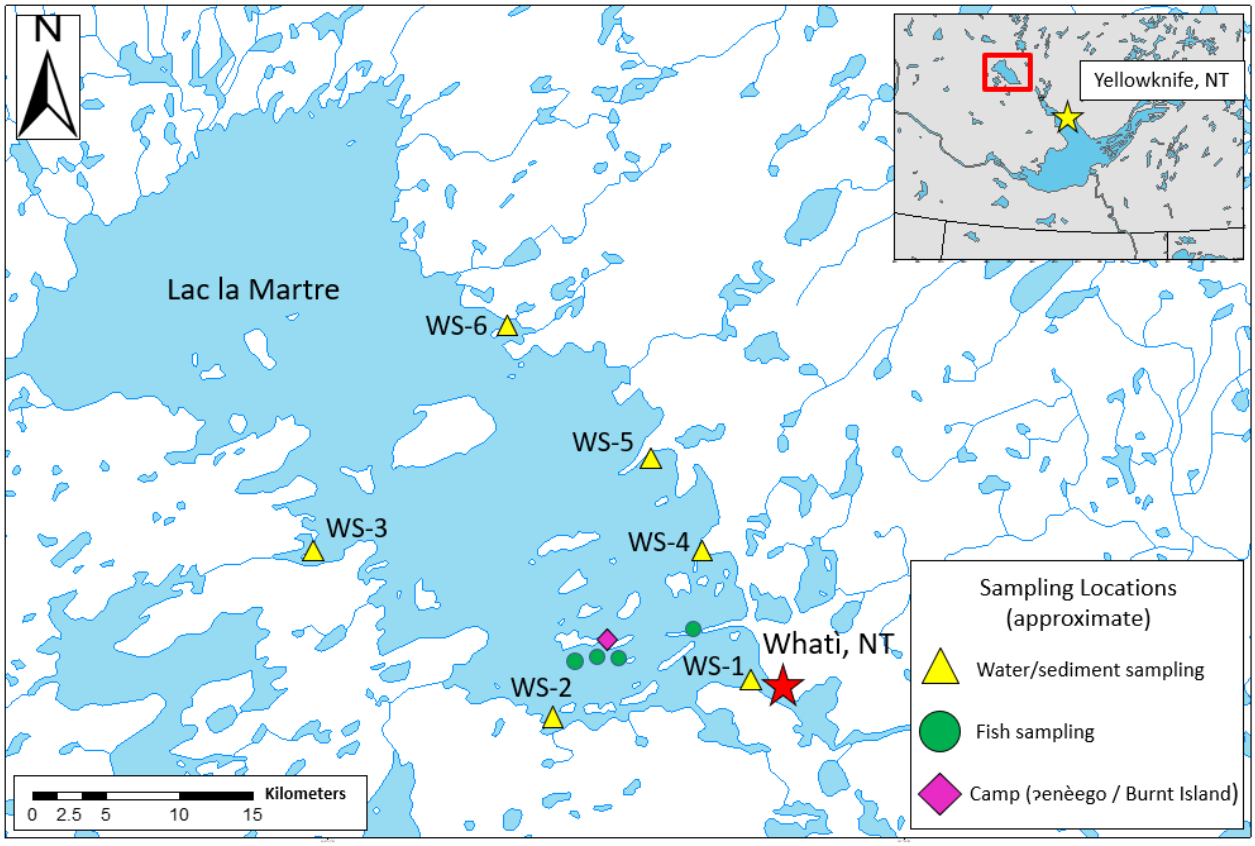


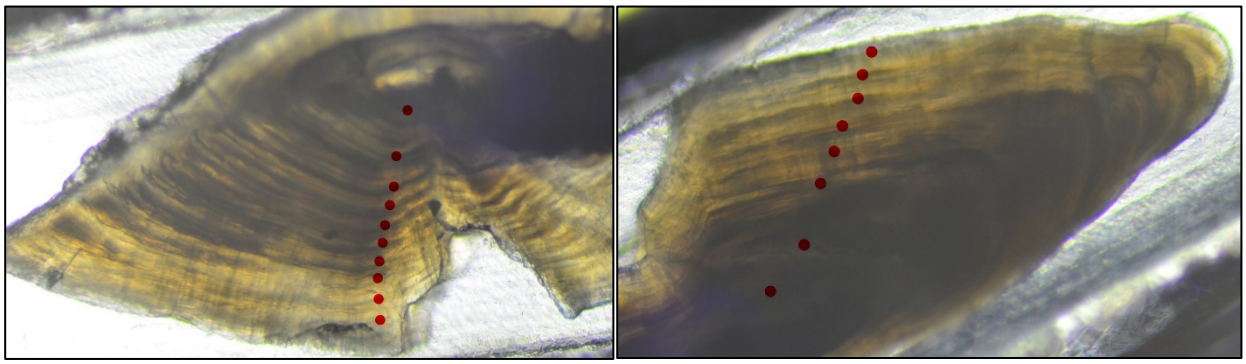
Figure 1 Location of the on-the-land camp, and locations where samples of fish, water, and sediment were collected on Lac la Martre during the on-the-land component of the Tłı̨chǫ Aquatic Ecosystem Monitoring Program (TAEMP) near the community of Whatì, September 2018. Water/sediment and fish locations overlapped with locations sampled in 2014.

Table 1 Details for gillnet sets used to collect all fish samples at the TAEMP on Lac la Martre near the community of Whatì, September 11-14, 2018

Net set / pull date	Set Length (hrs)	Start Coordinates (11V)		End Coordinates (11V)		Net Length / Width (m)	Mesh size (in)
		Easting	Northing	Easting	Northing		
Sept. 11/ Sept. 12	19.10	472853	7001972	472848	7001929	30 / 2	5
Sept. 11 / Sept. 12	19.25	472383	7001974	472432	7001860	100 / 2	4
Sept. 12 / Sept. 13	23.38	470941	7002013	470945	7001974	30 / 2	5
Sept. 12 / Sept. 13	23.75	470952	7001966	470941	7001760	100 / 2	4
Pulled Sept. 13	N/A	480067	7003957	-	-	100 / 2	4.5

Note: A community net that had already been set was used on September 13 to retrieve the final 20th LKWH as there was limited time to set a final net.

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 2 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. Examples in Figure 2 show a łiwezǫ̀ǫ̀ (LKTR) estimated at 10 years on the left and a łih (LKWH) estimated at 8 years shown on the right.



LKTR LKWF

Figure 2 Two examples of otolith cross-sections, obtained from samples collected on Snare Lake, September 2016 (not to scale); a łiwezǫ̀ǫ̀ (LKTR) estimated at 10 years on the left and a łih (LKWH) estimated at 8 years shown 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 Whatì, fish tissue samples were collected from 20 łiwezǫ̀ǫ̀ (LKTR) and 20 łih (LKWH), the fish species regularly consumed by Whatì residents. Fish processing was led by Golder Associates Ltd. and DFO biologists, and samples were collected under the guidelines established by Environment Canada for sampling for metals (Environment Canada 2012; now Environment and Climate Change Canada) 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 Whatì, to review the goals and objectives of the program, as well as present the results of the analyses, including a comparison to the 2014 results to see if any changes had occurred. Importantly, the results workshop provided an opportunity for community members to ask questions and gain clarification(s). 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 appropriate messaging and communication strategies regarding the 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 17, 2018, a half-day workshop was held with community members from Whatì to introduce, revisit, and discuss the TAEMP. Participants expressed interest in the TEAMP camp and having the opportunity to build on the fish camp in 2014. Participants agreed that monitoring fish, water, and sediment quality continues to be important to monitor changes near Whatì and agreed that elders, youth and scientists can take the opportunity to work together again. Participants clarified that cultural activities need to occur (e.g. grave site visits, fish demonstrations) and that time will be allocated accordingly. There was a strong desire to ensure as much youth participation as possible occurred. Discussion continued on how best to coordinate with school, TSCA, community members and support staff, and to find options for ensuring safety and meeting safety requirements. It was clarified that camp participants from Whatì would consist of 6-8 elders (male and female), 6 students, as well as cook/cook's helper, foreman/foreman's helper, and likely a chaperone. It was thought that some community members should go out to the camp site a day early to prepare. Participants provided input on repeat sampling, as well as re-use of the 2014 location for the camp, as it would enable elders to safely return to Whatì easily if it was medically required. Visiting staff clarified that community members want water/sediment sampling sites added further to the West of Lac la Martre in order to capture locations that are important. It was understood that September was the available window for the camp, though community members voiced concerns about the weather in

September and desired an earlier start date. Support staff clarified there were various commitments in September and difficulties coordinating schedules led to the middle two weeks in September being proposed. There was agreement that camp should occur September 10-14th (Monday- Friday). It was agreed that next planning meeting should occur on September 5th in Whatì.

On September 5, 2018, a second workshop was held in Whatì, 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. The camp location selected was on the same island as in 2014, as it offered better options for camp set up and boat landing/launch given that either side of the island could be used in response to changes in wind.

Participants at workshops 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 Whatì, in conjunction with community members would discuss selection of youth with staff at Mezi Community School in Whatì, with the hope that 3 young men and 3 young women with an interest in the environment would be selected to participate. It was clarified that the TAEMP camp could benefit youth by providing them the opportunity to learn on-the-land skills; a chaperone for the youth would be present at camp.

2. On-the-land Monitoring Camp – Lac la Martre

a. Overall

The on-the-land phase of the TAEMP occurred from September 10 to 14, 2018. Travel to Whatì occurred on September 10, however, due to high winds, participants were not able to reach the camp until the morning of September 11th. Sampling and other activities occurred September 11-14, and participants returned to Whatì on September 14. The camp foreman and assistants visited the camp on Sunday September 9th to prepare the camp for participants. Local camp participants also remained at the camp location on September 14th to complete tear-down of the camp.

At camp, there were regular morning and evening briefing and debriefing meetings. These meetings 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.

Water and sediment sampling locations were located as close as possible to 2014 sampling locations, with 3 new locations added further west of the camp at the request of community members (Figure 1). The weather was calm enough to sample the 2014 sites which were closer to camp, however weather (and safety) considerations did not allow safe access to the three new water and sediment sampling locations. Through cooperation among participants, fish were caught in nets to provide food for the traditional camp, and to provide samples for analyses. Tissue samples were successfully collected from 20 łiwezǫǫ̀ (LKTR) and 20 łih (LKWH) (see Results Section E. Fish Tissue Analysis, p 15). Elders at the camp preferred to make their tea

with melted snow water that had been stored in plastic jugs since the most recent winter. Elders were curious about the water quality of their “snow water.” A sample of snow water was collected and named “Whatì-Snow”. This sample was analysed for nutrients and physical parameters along with the Lac la Martre water samples. Water samples were also collected near the community dock and analysed for bacteria, total coliforms and faecal coliforms.

The 4-day camp provided educational opportunities focused on ways of understanding aquatic ecosystems and assessing the health of the ecosystems (see also Results section g. Cultural / Educational Activities, p. 23). Participants worked collaboratively, and Tłı̨chǫ knowledge and science-based monitoring approaches were shared. For example, visiting support staff demonstrated how fish are processed in order to collect information. Including how tissue samples are used to determine concentrations of mercury and other contaminants in the fish; otoliths, or “ear bones”, are used to determine the age of each fish; and body measurements including weight and length help to better understand fish health and growth rates. Youth from Mezi Community School also collected water and sediment samples using scientific equipment and techniques. On-shore demonstrations were given on how to properly take water and sediment samples using standard procedures, including how to lower the Ekman dredge into the water to pull up mud and sediment from the bottom of the lake.

Elders from Whatì led visits to grave sites in the area, sharing their Tłı̨chǫ knowledge and cultural practices with the youth and other participants. Elders also demonstrated how to repair nets and process fish, with youth assisting with cleaning and preparation of fish.

b. Water Quality

Final locations for all water and sediment samples collected in 2018 are provided in Table 2, which are the same locations sampled in 2014 (see also Figure 1). Nutrient and physical parameters were measured at all sample sites in 2014 and 2018 sampling programs and no noticeable difference was noted between the two sampling years. Nutrient and physical parameters were found to be similar at all sites.

Analysis of water samples indicated no noticeable difference between 2018 and 2014 with regards to nutrient and physical parameters measured at all sample sites; all nutrients and physical parameters were found to be similar at all sites. For example, water samples in 2018 indicated pH ranged from 8.38 to 8.47, and results showed very little difference between sampling sites (n=6); 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). By comparison pH ranged from 8.35 to 8.39 in 2014 (n=6).

Conductivity of the water ranged from 302 to 333 microsiemens per centimeter (µS/cm) in 2018, and in 2014 the conductivity was similar with a range of 297 to 304 µS/cm.

Total Dissolved Solids (TDS) at each 2018 site had amounts ranging from 166 mg/L to 184 mg/L, with 2014 results similarly ranging from 156 mg/L to 182 mg/L.

Total Suspended Solids (TSS) in 2018 for all locations were below the detection limit of 3 mg/L. Similarly, in 2014 TSS for the majority of locations were under the detection limit of 3 mg/L, with only one location (WS-5) at 4 mg/L.

Most metal concentrations in Lac la Martre were very low with many measuring below method detection limits (MDL). The 2018 water samples were all better than FAL guidelines, while 2014 water samples had a few metal concentrations greater than FAL guidelines (copper and silver; Figure 3). Overall, there was minimal difference between 2014 and 2018. No samples exceeded the FAL guidelines for mercury in either 2018 or 2014.

Samples were also collected near the community dock in 2018 to assess bacteria (e.g. *Escherichia coli*, total Coliforms, and Faecal Coliforms). Faecal coliforms, *Escherichia coli* and hydrocarbon results were all below detection limit. Total coliforms detected at 27.5 MPN/100ml.

The Whatì-Snow sample pH result of 6.92 falls within the 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 snow water was 8.3 µS/cm, and there was low measurable TDS at 10 mg/L. Analysis indicated that the Whatì snow water for tea sampled can be considered “soft,” whereas all Lac la Martre sites sampled in 2018 would be considered “hard.” Total and dissolved copper concentrations (8.6 and 7.2 µg/L, repetitively) exceeded the guideline (CCME 2014) for copper (2 µg/L).

Table 2 Details for water and sediment sampling locations at the TAEMP on Lac la Martre near the community of Whatì, September, 2018.

ID	Description	Northing
WS-1	Lac la Martre Lake outflow	N 63°07.492 / W-117°15.593
WS-2	Near sucker spawning area	N 63°05.653 / W -117°37.803
WS-3	Near area of boreal wood caribou activity (*ʔedèezhìì* / Horn Plateau)	N 63°11.917 / W -117°06.557
WS-4	Near area of traditional net sets	N 63°13.093 / W -117°23.365
WS-5	Near area of traditional net sets / near old Lac la Martre Lodge (the one that burnt down)	N 63°18.407 / W -117°29.325
WS-6	Near current Lac la Martre Lodge	N 63°23.231 / W -117°47.408
Community Dock	Near community dock	N 63°08.650 / W-117°16.868
Snow	Snow harvested in Whatì in the summer and brought to camp in plastic jugs	

Note: Lat/Long are NAD 83;

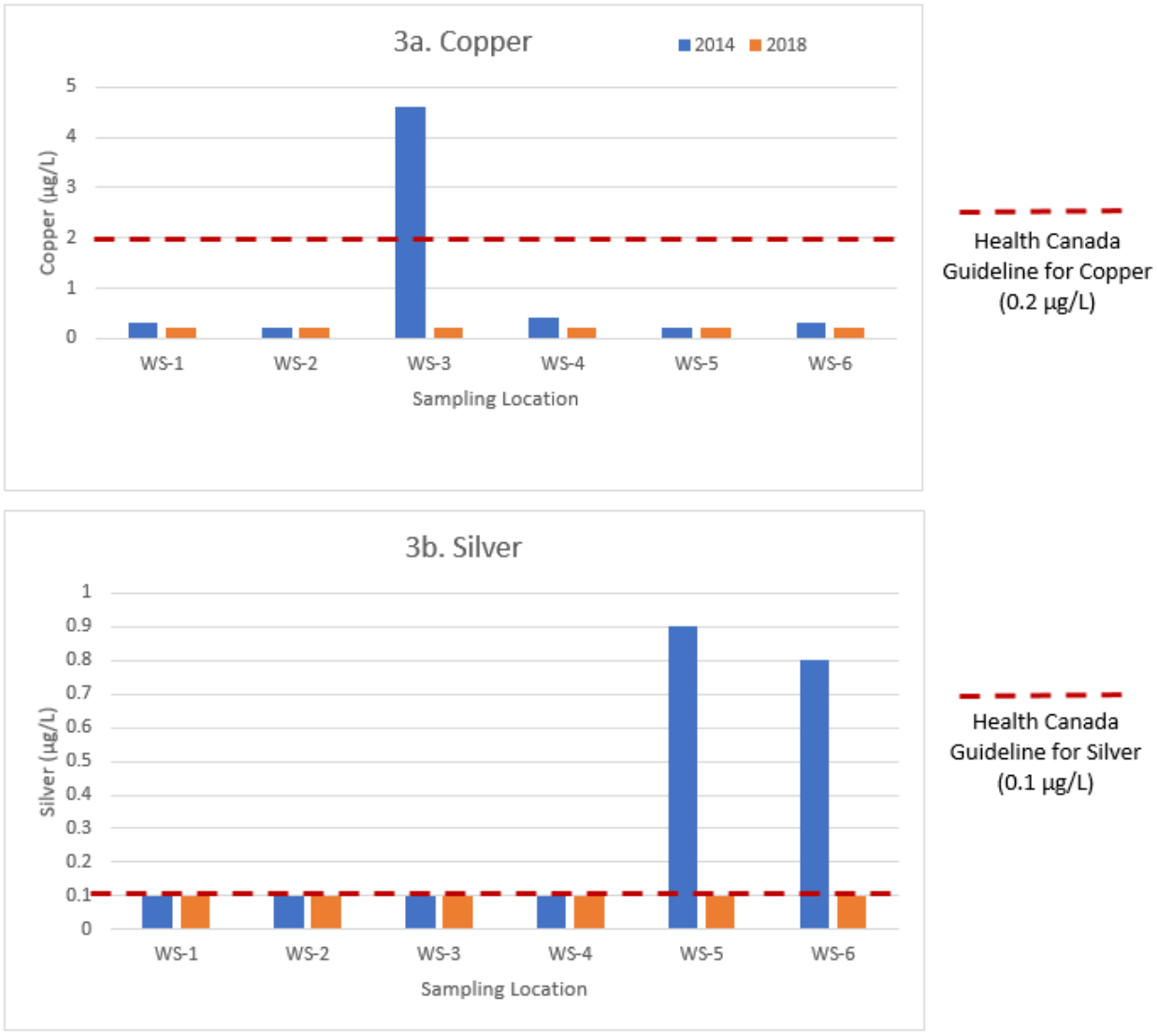


Figure 3 Comparison of the total concentrations of copper (3a) and silver (3b) in surface water samples collected during the on-the-land component of the Tłı̨chǫ Aquatic Ecosystem Monitoring Program (TAEMP) near Whatì, September 2018 and September 2014. Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life (FAL) provided for copper (0.2 µg/L) and copper (0.1 µg/L). All 2018 silver samples tested below the detection limit of 0.1 µg/L.

c. Sediment Quality

Sediment samples collected in 2018 from all locations had arsenic concentrations below the CCME Sediment Quality Guidelines for the Protection of Aquatic Life interim Sediment quality guidelines (SQG) of 5.9 µg/g (CCME 2014).

The 2018 cadmium method detection limit was 1 µg/g which is higher than the SQG for cadmium of 0.6 µg/L. All of the 2018 sediment sample results for cadmium showed a “less than” detection result, but because “less than” values were treated as results equal to the detection limit, the results may represent a false exceedance. This is identical to the 2014 cadmium results.

The 2018 mercury method detection limit was 0.1 µg/g. The SQG was 0.17 µg/g, and the PEL guideline was 0.486 µg/g (CCME, 2014). All of the 2018 sediment sample results for copper showed a result less than the detection limit of 0.1 µg/g, however one sample (WS-1) showed a result of 0.2 µg/g, which exceeded the SQG guideline but not the but PEL guideline. In 2018, one sample was collected per sampling location, except for sites WS-2 and WS-6 where a top and bottom sediment sample was collected as the samples had visible stratified layers. For both WS-1 and WS-6 the top and bottom sample results for mercury were below detection limit (<0.1 µg/g) (Figure 4). In 2014, two locations (WS-1 and WS-3) exceeded the SQG but no the PEL guideline.

In 2018, none of the copper results exceeded SQG. The WS-2 top and bottom results for copper were 7 and 10 µg/g respectively, while the WS-6 top and bottoms results for copper were 10 and 12 µg/g respectively. For WS-2, the copper results were averaged to 8.5 µg/g while WS-6 was averaged to 12 µg/g (Figure 5). In 2014, copper concentrations exceeded ISQG of 35.7 µg/g, but not the Probable Effects Level (PEL) guidelines (CCME, 2014) at WS-3 (99 µg/g), WS-4 (41 µg/g), and WS-5 (41 µg/g). The PEL guideline for copper is 197 µg/g.

No other parameters exceeded the CCME SQC or PEL in the sediments analysed.

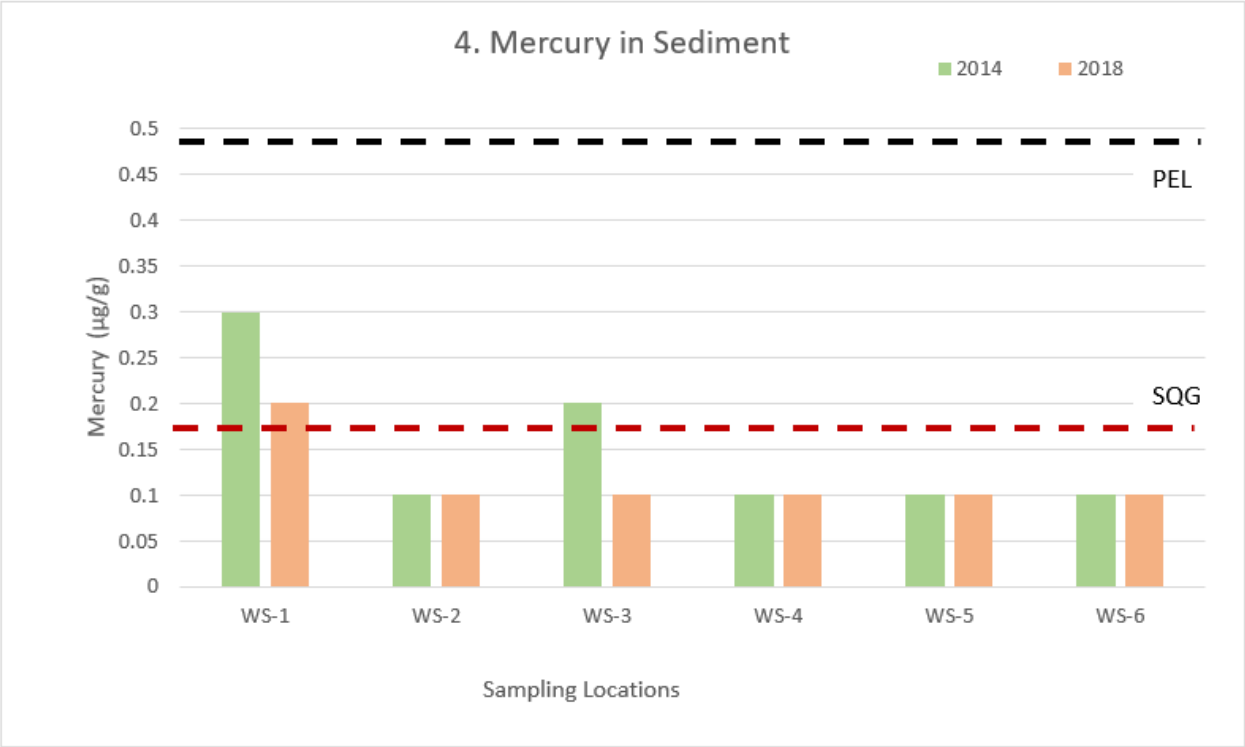


Figure 4 Comparison of the total concentrations of mercury for sediment samples collected during the on-the-land component of the Tłı̨chǫ Aquatic Ecosystem Monitoring Program (TAEMP) near Whatì, September 2018 and September 2014. Canadian Council of Ministers of the Environment (CCME) Sediment Quality Guidelines for the Protection of Aquatic Life sediment quality guidelines (SQG) provided for Copper (0.17 µg/g), and probable effects Levels (PEL) provided for Copper (0.486 µg/g).

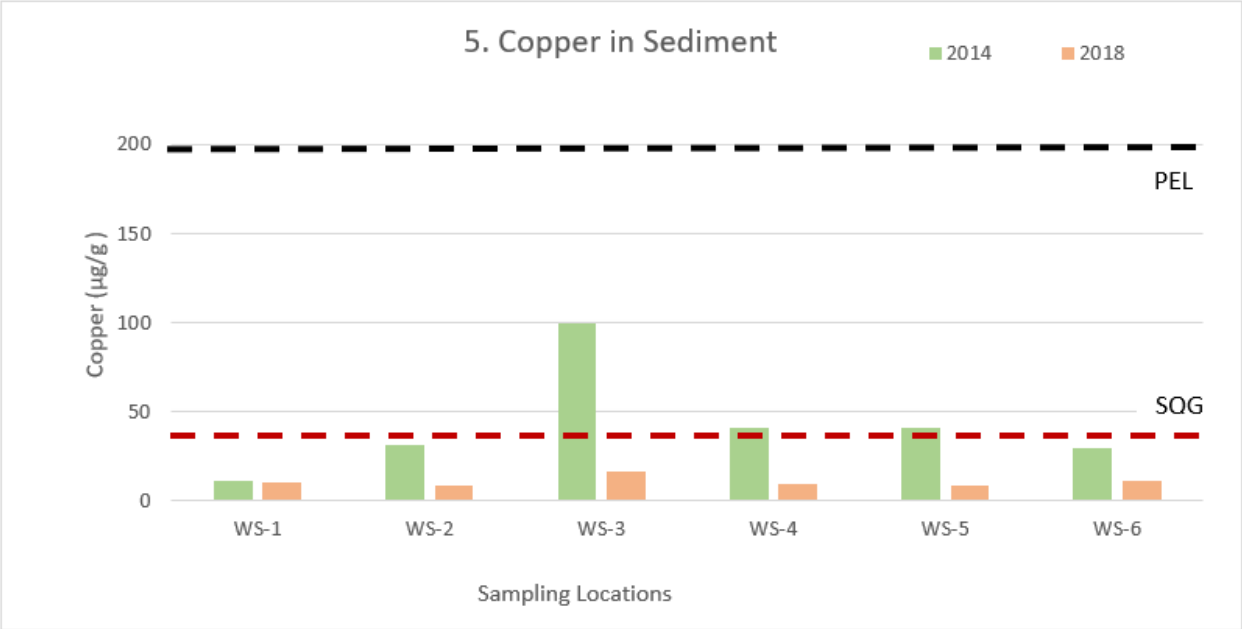


Figure 5 Comparison of the total concentrations of copper for sediment samples collected during the on-the-land component of the Tłı̨chǫ Aquatic Ecosystem Monitoring Program (TAEMP) near Whatì, September 2018 and September 2014. Canadian Council of Ministers of the Environment (CCME) Sediment Quality Guidelines for the Protection of Aquatic Life interim Sediment quality guidelines (SQG) for copper (35.7 µg/g), and probable effects Levels (PEL) for copper (197 µg/L) provided.

d. Fish Species Diversity

Four species of fish were caught on Lac la Martre (Table 3); 21 łih (Lake Whitefish; LKWH), and 27 łiwezǫ̀ǫ̀ (Lake Trout; LKTR), 6 Dehdoo (Longnose Sucker; LNSC) and 14 ịhdaa (Northern Pike; NRPK), for an overall total of 75 fish caught over a combined total of 85.5 hours of net sets. The łiwezǫ̀ǫ̀ (LKTR) and ịhdaa (NRPK) represented the common top predators, and łih (LKWH) and Dehdoo (LNSC) 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 two fish species which had tissues collected for contaminant analyses were łiwezǫ̀ǫ̀ and łih. These two species are regularly used for consumption in Whatì and were the same species for which analyses occurred in 2014.

2018 łiwezǫ̀ǫ̀ (LKTR) results

In 2018 mercury concentrations in tissues were on average 0.282 mg/kg wwt (wet weight; 95% CI+/-0.05) ranging from 0.129 to 0.608 mg/kg wwt, with one of the twenty fish sampled over the guideline for mercury of 0.5 mg/kg, (wet weight, wwt; Health Canada, 2016). Review of mercury concentrations in muscle tissue in relation to fork length and weight suggest positive relationships (Figures 6a, 6b), with the strongest positive relationship suggested with regards to age (Figure 6c).

Łiwezǫ̀ǫ̀ (LKTR) comparison between 2018 and 2014

In 2014 mercury concentrations in tissues were on average 0.330 mg/kg wwt (wet weight; 95% CI+/-0.048) ranging from 0.202 to 0.591 mg/kg wwt. Two fish were found to have mercury concentrations above the Health Canada guideline. These were the two oldest łiwezǫ̀ǫ̀ sampled (18 and 21 years respectively). Compared to the 2014 results trend, mercury concentrations in larger fish in 2018 are less than expected (Figures 6a, 6b and 6c).

2018 łih (LKWH) results

In 2018 mercury concentrations in tissues were on average 0.038 mg/kg wwt (wet weight; 95% CI+/-0.01) ranging from 0.01 to 0.061 mg/kg wwt, with none of the fish sampled having mercury concentrations above the guideline of 0.5 mg/kg, (wet weight, wwt; Health Canada, 2016). Review of mercury concentrations in muscle tissue in relation to fork length, weight and age suggest positive relationships (Figures 7a, 7b and 7c).

Łih (LKWH) comparison between 2018 and 2014

In 2014 mercury concentrations in tissues were on average 0.035 mg/kg wwt (wet weight; 95% CI+/-0.007) ranging from 0.0148 to 0.0781 mg/g wwt. All of the łih sampled fell well below the guideline for mercury of 0.5 mg/kg. Comparison of 2014 results to 2018 results suggests a slightly lower mercury concentration in tissue in 2018, as scatterplots and confidence intervals show a small degree of overlap between years (Figures 7a, 7b and 7c). Comparison of the cumulative data sets (2018 and 2014) for Lake Trout and Lake Whitefish show positive relationships between mercury concentration in tissue and weight, length, and age (Figures 8a, 8b and 8c). Lake Whitefish consistently show lower concentration in their tissues than Lake Trout, with the clearest differentiation visible with regards to age (4c).

No deformities/abnormalities were noted in any of the fish sampled; parasites (e.g. worms and

cysts) were found in majority of individuals, though not at levels considered to be abnormal. Łiwezǫǫ stomach contents included dahts'a (Ninespine Stickleback), dehdoo (Longnose Sucker), Sculpin and łih. Łih stomach contents included small benthic snails and invertebrates.

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.

Other fish species

There were 14 ịhdaa (NRPK) and 6 Dehdoo (LNSC) caught in 2018; tissue samples were not collected for analyses. No other species were caught. By comparison, in 2014, 31 ịhdaa (NRPK) and 0 Dehdoo (LNSC) were caught.

Quality Assurance

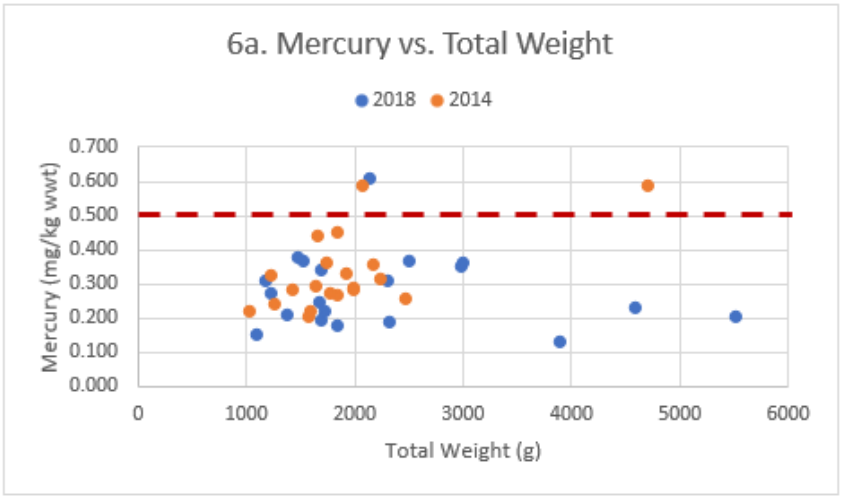
Duplicate fish tissue samples were taken for both łiwezǫǫ and łih. Duplicate results are within normal limits and indicate that the samples were taken and analysed with precision.

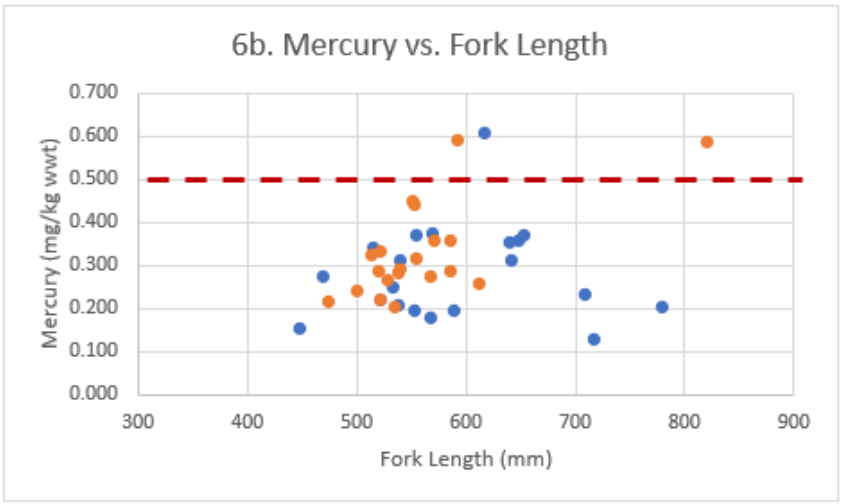
Table 3 Date and duration of net sets, and number of, łih (LKWH), łiwezǫ̀ǫ̀ (LKTR), dehdoo (LNSC) and ịhdaa (NRPK) caught on Lac la Martre near the community of Whatì during the TAEMP, September 10-14, 2018.

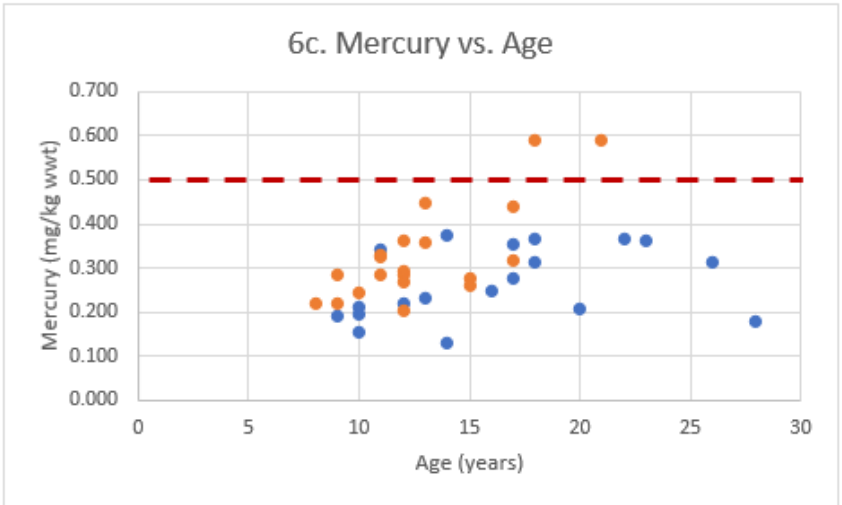
Net set / pull date	Start Coordinates (11V)		End Coordinates (11V)		LKWH	LKTR	NPRK	LNSC
	Easting	Northing	Easting	Northing				
Sept. 11/ Sept. 12	472853	7001972	472848	7001929	4	11	2	0
Sept. 11 / Sept. 12	472383	7001974	472432	7001860	13	6	0	3
Sept. 12 / Sept. 13	470941	7002013	470945	7001974	0	1	7	0
Sept. 12 / Sept. 13	470952	7001966	470941	7001760	7	11	5	3
Pulled Sept. 13	480067	7003957	-	-	2	0	0	0
				TOTALS	26	29	14	6

Table 4 Comparison of 2014 and 2018 average mercury concentrations in tissue samples (mg/kg +/- 95% CI, -α=0.05) collected from łih (LKWH), łiwezǫ̀ǫ̀ (LKTR) caught on Lac la Martre near the community of Whatì during the TAEMP, September 10-14 23, 2018.

Fish species	2014 Average Mercury concentration (+/- 95% CI)	2018 Average Mercury concentration (+/- 95% CI)
łih (Lake Whitefish)	0.0035 mg/kg (+/- 0.007); n=20	0.038 mg/kg (+/-0.01); n=20
łiwezǫ̀ǫ̀ (Lake Trout); with outlier	0.330 mg/kg (+/-0.048); n=20	0.282 mg/kg (+/-0.05); n=20







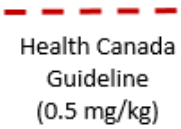
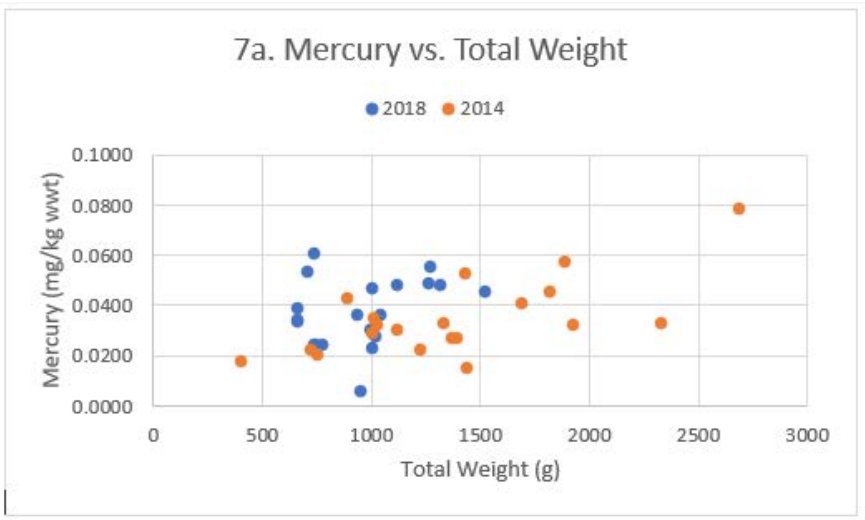
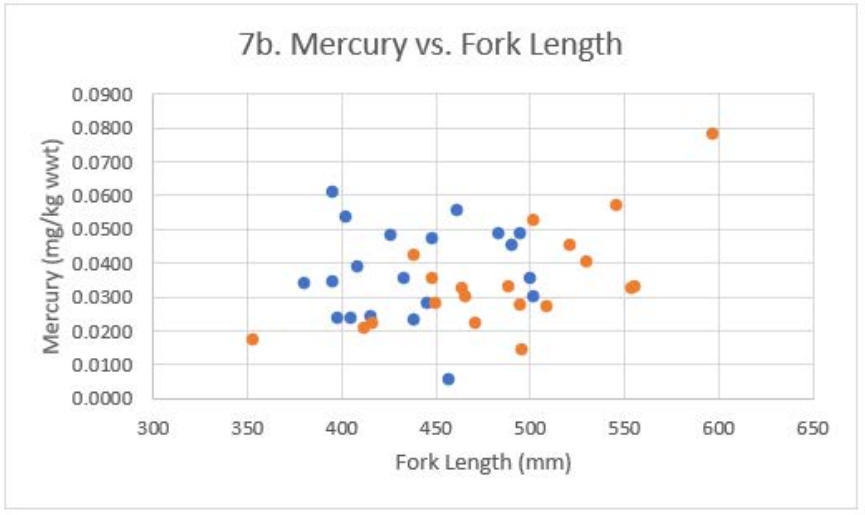


Figure 6 Comparison of the relationships between mercury concentration in tissues (mg/kg; wet weight) and body weight (g) (6a), fork length (mm) (6b), and age (years; estimated via otolith aging) (6c) of łiwezǫ̀ǫ̀ (Lake Trout; LKTR) collected during the on-the-land component of the TAEMP near Whatì in 2018 and 2014. Health Canada Maximum Level for mercury concentration in commercial fish (0.5mg/kg) provided. Note: a łiwezǫ̀ǫ̀ collected in 2018 with a mercury concentration of .608 mg/kg wwt is not shown in 8c as the otolith was lost.





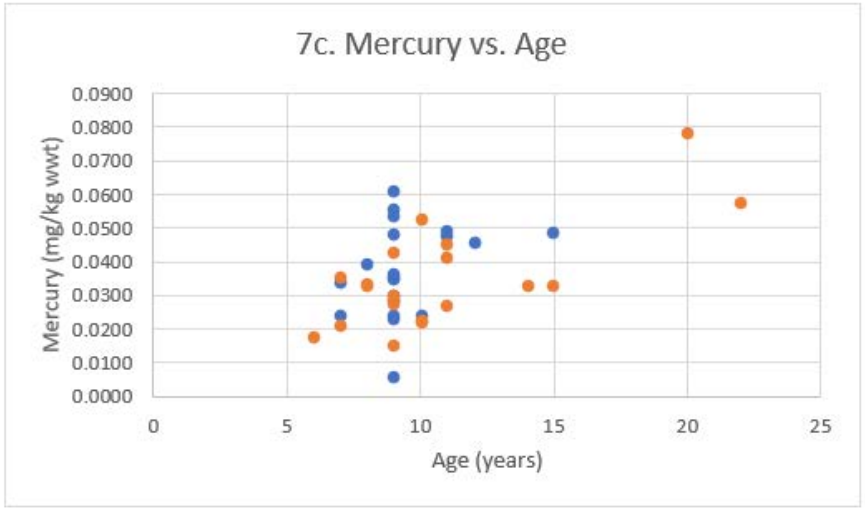
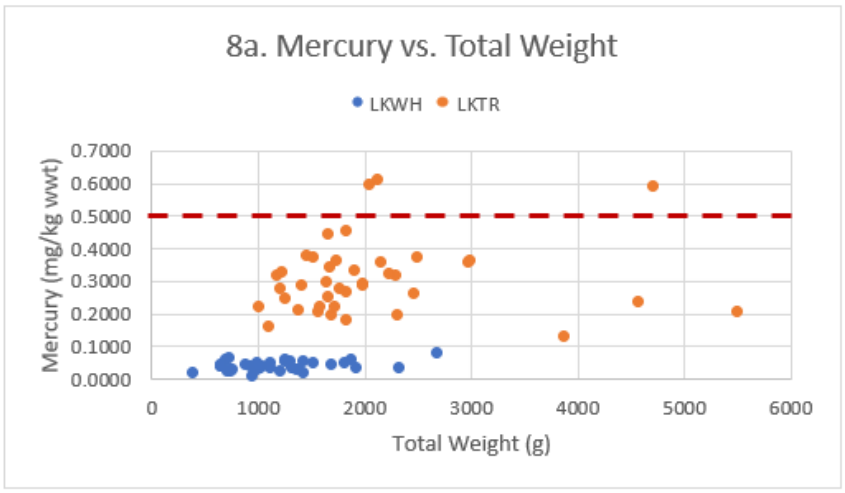
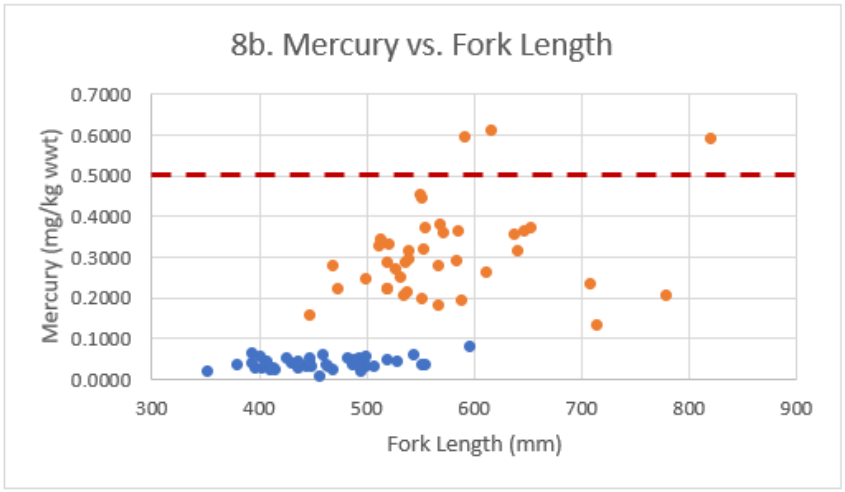
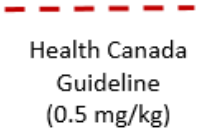


Figure 7 Comparison of the relationships between mercury concentration in tissues (mg/kg; weight) and body weight (g) (7a), fork length (mm) (7b), and age (years; estimated via otolith aging) (7c) of łih (Lake Whitefish; LKWF) collected during the on-the-land component of the TAEMP near Whatì in 2018 and September 2014. Health Canada Maximum Level for mercury concentration in commercial fish (0.5mg/kg) not graphed as mercury concentrations observed in fish were too far below the guideline.







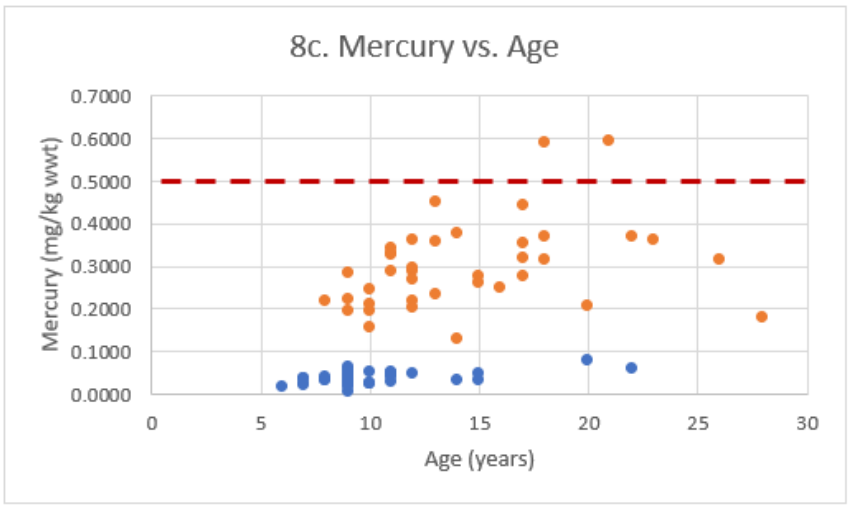


Figure 8 Comparison of the relationships between mercury concentration in tissues (mg/kg wwt) and body weight (g) (8a), fork length (mm) (8b), and age (years; estimated via otolith aging) (8c) for łiwezǫ̀ǫ̀ (LKTR) and łih; (LKWH) using cumulative data for each species collected during the on-the-land component of the TAEMP near Whatì in 2018 and 2014. Note: a łiwezǫ̀ǫ̀ collected in 2018 with a mercury concentration of .608 mg/kg wwt is not shown in 8c as the otolith was lost. Health Canada Maximum Level for mercury concentration in commercial fish 0.5mg/kg) provided.

f. Fish Growth

Overall, review of age in relation to length for the łıwezǫ̨ǫ̀ and łih caught in Lac la Martre suggest rapid growth in approximately the first 5 years, followed by no appreciable increase in size from 10 years to maximum age (Figure 9); no regression analyses were performed.

Łiwezǫ̨ǫ̀ (LKTR)

Łiwezǫ̨ǫ̀ from which tissues were sampled for analyses in 2018 (n=20) were on average 590 mm in length (fork length; 95% CI+/-37.14) ranging from 448 to 780 mm. They weighed on average 2284 g (total weight; 95% CI+/-519.34) ranging from 1100 to 5510 g, and were on average 16 years old (via otolith aging; 95% CI+/-2.53) ranging from 9 to 28 years (n=19; 1 of the 20 fish could not be aged due to missing otoliths).

By comparison, łıwezǫ̨ǫ̀ sampled in 2014 (n=20) were on average 559.25 mm in length (fork length; 95% CI+/-30.78) ranging from 474 to 821 mm. They weighed on average 1905.5 g (total weight; 95% CI+/-328.66) ranging from 1020 to 4710 g and were on average 13 years old (via otolith aging; 95% CI+/-1.46) ranging from 8 to 21 years.

Łih (LKWF)

Łih sampled in 2018 (n=20) were on average 438 mm in length (fork length; 95% CI+/-17.32) ranging from 380 to 499 mm. They weighed on average 954 g (total weight; 95% CI+/-109.44) ranging from 660 to 1520 g. and were on average 9 years old (via otolith aging; 95% CI+/-0.77) ranging from 7 to 15 years.

By comparison, łih sampled in 2014 (n=20) were on average 485 mm in length (fork length; 95% CI+/-25.32) ranging from 353 to 597 mm. They weighed on average 1372 g (total weight; 95% CI+/- 221.55) ranging from 400 to 2680 g, and were on average 11 years old (via otolith aging; 95% CI+/-1.81) ranging from 6 to 22 years. The łih sampled in 2018 were on average 7% smaller than in 2014.

Other fish species

In 2018, Įhdaa (NRPK) caught and measured (n=7) were on average 721 mm in length (fork length; 95% CI+/-68.41) ranging from 607 to 889 mm. They weighed on average 3201 g (total weight; 95% CI+/-1078.91) ranging from 1910 to 6210g. Neither otolith for aging or tissue samples for contaminant analyses were collected.

By comparison, Įhdaa caught and measured in 2014 were on average 595.44 mm in length (fork length; 95% CI+/-122.20; n=17) ranging from 69.8 to 882 mm. They weighted on average 2687.15 (total weight; 95% CI+/-408.54; n=14) ranging from 1560-4480 g. Neither otolith for aging or tissue samples for contaminant analyses were collected.

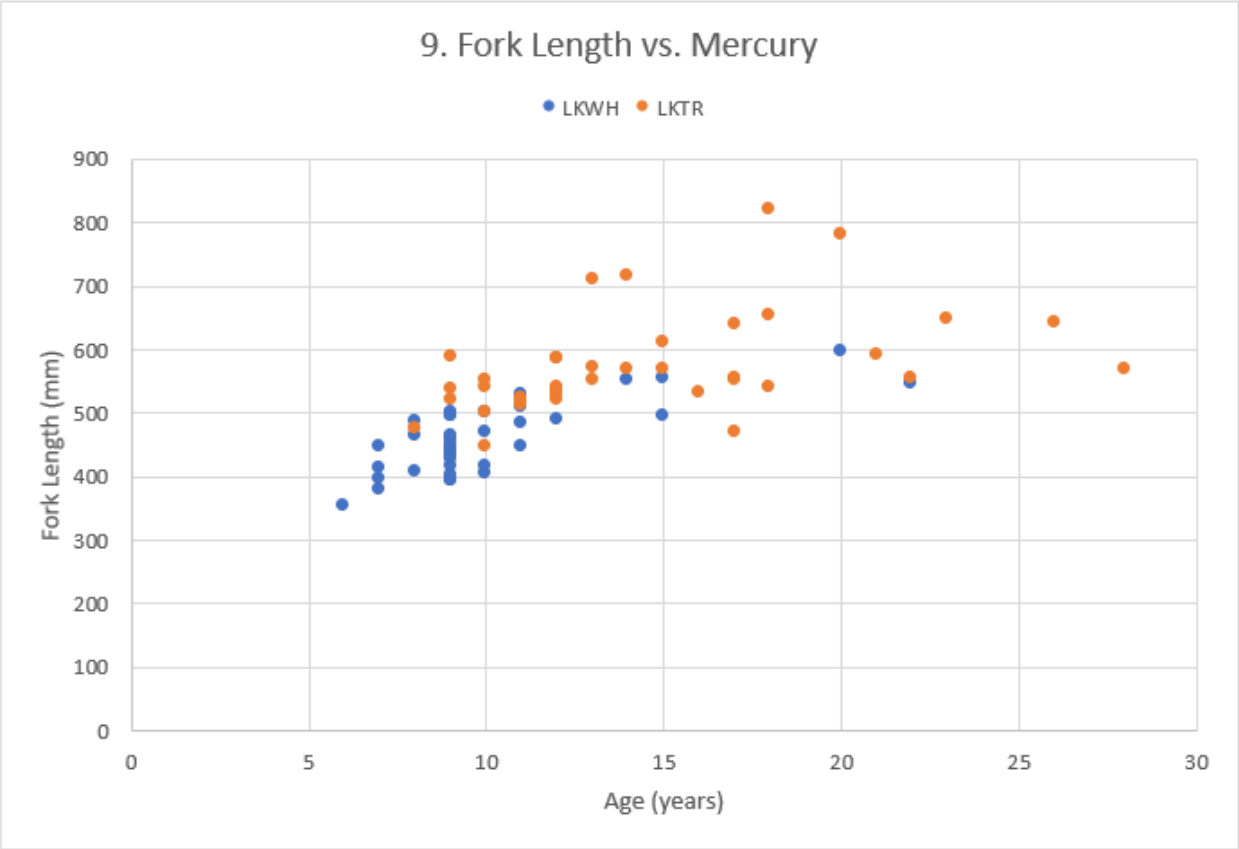


Figure 9 Relationships between fork length (mm) and age (years; estimated via otolith aging) in łiwezǫ̀ǫ̀ (LKTR) and łih (LKWH) that were collected on Lac la Martre during the TAEMP near Whatì, September 2018 and September 2014 (cumulative data).

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 2014, 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 Tłı̨chǫ communities.

Elders and other community members guided all aspects of the project, with Tłı̨chǫ knowledge (i.e. Traditional knowledge, or TK) incorporated throughout by design. The on-the-land component of the TAEMP provided an opportunity for youth to engage with their community elders, assisting in the youth's education in observing, monitoring and understanding the aquatic ecosystem from a Tłı̨chǫ perspective. The TAEMP also offered an opportunity for visiting 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 through exchange of TK and science-based information while completing the required sampling and the various tasks needed for the operation of a traditional camp.

TAEMP staff asked community members about their perspectives regarding how to properly utilize TK within the project. Perspectives were shared at meetings, camp, and via answers to a series of interview questions. In general, elders were pleased with their involvement at camp and with the opportunities provided to pass on TK, for example through a gravesite visit, net repair, storytelling, and teachings related to proper behaviours while at camp and on-the-land, and the history of the struggles people underwent to survive. Youth and visiting researchers were able to observe traditional methods of preparing and cooking fish, and were able to practice these skills at the camp.

The *Common Fish of the Tłı̨chǫ Region*, a basic field guide to fish found in Wek'èezhìı, was provided to participants at camp; it is available through the WRRB website (https://wrrb.ca/sites/default/files/Tlicho%20Fish%20Guide%202016_final_for%20posting_1.pdf).In addition to providing the updated fish guide, educational videos highlighting activities at the on-the-land camps specific to each Tłı̨chǫ community have been developed by NWT-based filmmakers with assistance from WRRB staff. All are currently available on the WRRB website (https://www.wrrb.ca/news/taemp-fish-camp-videos). In addition, two educational videos have been developed that provide demonstrations of fish, water and sediment sampling. All the videos have been printed on DVD and have been provided to all four the Tłı̨chǫ schools along with the updated fish guides. The sampling videos are also be available on the WRRB website (https://wrrb.ca/news/new-educational-videos-fish-water-and-sediment-sampling-taemp-fish-camps).

3. Results Workshop

A results meeting open to the public was held in Wekweètì April 25, 2019, and a presentation providing a comparison of the 2014 to 2018 results for fish, water and sediment was given. The results meeting was attended by a few elders who participated in the 2018 camp, as well as a number of interested community members.

Aimee Guile (WRRB), and Monica Redmond (Golder) presented the fish, water and sediment results. Participants were interested in the results and asked questions for clarification. The issue of mercury contamination was discussed, and community members were relieved to hear fish from Lac la Martre continue to be healthy food choices. Part of the presentation also provided information on parasites commonly found in fish, their life cycles and their potential impacts to human health. 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 (łıwezǫ̀; LKTR) and the benthic strategist (łih; LKWF). Importantly, community members were also pleased to hear that there were no appreciable differences between the 2014 and 2018 results for mercury concentrations in fish tissues, and that sediment and water analyses also indicated no appreciable differences between 2014 and 2018.

With the support of school staff, Aimee Guile and Monica Redmond shared information about the camp with the grade 7 to grade 12 students at Mezi Community School on April 26, 2019. They spoke about the health of the water and fish in Whatì, and the importance of safety. Aimee Guile also gave an engaging presentation to the students which included a slideshow with some of his photos of fish and the camp. The students were interested in the images Aimee showed and what she had to say.

Discussion

Overall, results from the 2018 TAEMP near Whatì indicated that fish are healthy and habitat is clean in Lac la Martre. 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 2014 and 2018 results suggested that there was no appreciable change in the fish, water or sediments.

Fish tissue analysis indicated mercury levels were low in łih (LKWF), with all tissue samples showing mercury concentrations below the Health Canada guideline. Łiwezǫ̀ǫ̀ (LKTR) samples had higher concentrations overall, which was not unexpected given that they are predatory fish which commonly exhibit higher levels due to bioaccumulation and biomagnification, while łih primarily feed on small fish and arthropods and typically show lower levels of contaminants (GNWT 2016a, b, Health Canada 2011, Cabana et al. 1994). On average the concentration of mercury in łıwezǫ̀ǫ̀ tissue was below the guideline, and none of the tissue samples for either species showed levels of mercury that were considered abnormal for northern lakes. Further, when comparing fish tissue results from 2018 to 2014, no appreciable differences were noticed between years for either łıwezǫ̀ǫ̀ or łih. 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).

Analyses of water and sediment results supported the expectation that water and sediment quality is “good” (i.e. not abnormal) in Lac la Martre. 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.

Overall, the sampling results indicate there was no appreciable change in the water quality and sediment quality between 2014 and 2018, with the understanding that some variation of parameters is to be expected with varying natural conditions and low frequency sampling. In short, Lac la Martre water is typical of water originating on the Precambrian Shield and would be classified as an oligotrophic lake. 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 Lac la Martre are typical of water originating on the Precambrian Shield and would be classified as an oligotrophic lake.

The impacts of field conditions, field sampling methods, contamination, and lab methods were also noted as potential contributing factors to some of the results observed. The importance of repeat sampling, sufficient replicates per sample site, as well as incorporation of additional sampling methods (e.g. sediment cores vs. Ekman sediment samples) was acknowledged. Further, discussion regarding the use of sediment cores to supplement and further contextualize information gathered via grab samples has been discussed with Tłı̨chǫ Government and research staff involved with the Marian Lake Stewardship Program, along with elders from each of the four Tłı̨chǫ communities. Lastly, to determine if water bodies are being affected by industry and human activities, comparison of the study area water quality data to water quality data collected from a water body of roughly the same size in the same area of the study area would be appropriate. Though this was not done in 2014 or 2018, this practice would provide the best representation of natural, unaffected water quality data. The hope is, with collaboration with academic partners and GNWT Waters Division staff, that such comparisons will occur.

There has been ongoing concern among the Tłı̨chǫ people regarding whether fish are healthy and safe to eat, and Tłı̨chǫ elders continue to emphasize that up-to-date studies documenting contaminant levels to determine the health of fish are needed. Previously, Lockhart et al. (2005) reported elevated mercury in fish collected in Marian River and Slemon Lake in 1979 and 1983 (respectively), and in Lake Trout sampled from Rae Lakes in 2000. Continued standardized sampling at lakes near Tłı̨chǫ communities will help to track environmental changes. This will help to address concerns identified by Tłı̨chǫ people, and assist other NWT decision-makers by providing locally-collected data. For example, the Marian sub-watershed contains the Fortune Minerals NICO mine location, and the Tłı̨chǫ All-season road scheduled to begin construction in fall may also have impacts (Cott et al. 2015). The general lack of information on the fish and water quality metrics used to help determine freshwater health in various sub-watersheds in the NWT is highlighted in the WWF Freshwater Health Assessments for Watersheds in Canada (WWF 2016, 2015); the TAEMP will also help address gaps in watershed knowledge associated with Wek’èezhìı. The TAEMP also broadens the geographic coverage of sampling for mercury, as recommended in the Aboriginal and Northern Development Canada (now Indigenous and Northern Affairs Canada) State of Knowledge Report (AANDC 2012).

With the conclusion of the TAEMP near Whatì in 2014, baseline sampling was completed near all four Tłı̨chǫ communities. In 2015, when the TAEMP returned to Behchokǫ̀, a new phase began: the first round of comparative sampling. The comparative sampling phase (2015-2018) provided data that allowed for the monitoring of changes and provided relevant information to assist in cumulative effects analyses and informed decision-making. The TAEMP will contribute to the implementation of the NWT Water Stewardship Strategy 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 Tłı̨chǫ 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 the related

Tłı̨chǫ All-season Road), and/or natural disturbances. Finally, TAEMP continues to assist in the promotion, understanding, and protection of source water for Tłı̨chǫ communities.

Conclusions and Next Steps

The Tłı̨chǫ 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 Tłı̨chǫ knowledge of the environment near communities. This increases the capacity of Tłı̨chǫ 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 Tłı̨chǫ 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 Tłı̨chǫ 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 Tłı̨chǫ citizens living in communities. A four-year rotation through Tłı̨chǫ communities also allows for the potential that community members will repeatedly participate in, contribute to, and learn from the TAEMP – notably the youth. The possibility for youth continuing with more specific environmental monitoring-related 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 Tłı̨chǫ communities. In 2015, when the TAEMP returned to Behchokǫ̀ the first round of comparative sampling began. The comparative sampling will provided data that will continue to assist addressing community concerns related to changes in the environment, and the TAEMP will continue to build on work carried out since 2010. The comparative sampling phase (2015-2018) provided data that allowed for the monitoring of changes and provided 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 Tłı̨chǫ 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 the related Tłı̨chǫ All-Season Road), and/or natural disturbances such as fire (Baltzer 2015). Finally, TAEMP continues to assist in the promotion, understanding, and protection of source water for Tłı̨chǫ communities.

Management of the TAEMP will be handed over to the Tłı̨chǫ Government for the 2019 program and onward. The WRRB has led the program through its four initial baseline sampling years (2010-2014) as well as the first four comparative sampling years (2015-2018). It is anticipated that the WRRB will continue to assist the TEAMP as a partner in future years while the program is led by the Tłı̨chǫ Government.

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Appendix 1 – Project Participants

Introductory Workshop (August 17, 2018)

Community Members
Joe Champlain
Madeline Champlain
Jimmy Nitsiza
Margaret Nitsiza
Lucy Nitsiza
Francis Simpson
Georgina Simpson
Evelyn Flunkie
Archie Nitsiza
John Beaverho
Elizabeth Young

Support Staff:

Samantha Migwi	TG (Behchokǫ̀)
Priscilla Lamouelle	TG (Behchokǫ̀)
Laura Meinert	WRRB (Yellowknife)
Aimee Guile	WRRB (Yellowknife)

Translation:
Jonas Lafferty
James Rabesca

Planning Workshop (September 5, 2018)

Community Members
Madeline Champlain
Jimmy Nitsiza
Margaret Nitsiza
Lucy Nitsiza
Francis Simpson
Evelyn Flunkie
Archie Nitsiza
John Beaverho
Lawrence Nitsiza
Peter Nitsiza
Louisa Nitsiza

Support Staff:

Joline Huskey	Tłı̨chǫ Government (Behchokǫ̀)
Laura Meinert	WRRB (Yellowknife)
Aimee Guile	WRRB (Yellowknife)

Translation:
Jonas Lafferty
James Rabesca

Fish Camp (September 10-14, 2018)

Whatì Elders:

- Francis Simposon
- Georgina Simpson
- Joe Champlain
- Madeline Champlain
- Jimmy Nitsiza
- Margaret Nitsiza
- Lucy Nitsiza

Whatì Youth:

- Carmen Flunkie
- Rianna Nitsiza
- Sabrina Football
- Allision Nitsiza-Alexis
- Prestley Alexis

Whatì Community Support:

- Jessica Wetrade Chaperone
- Archie Nitsiza Foreman
- John Beaverho Camp Assistant
- Peter Nitsiza Camp Assistant
- Lawrence Nitsiza Boat Driver
- Louisa Nitsiza Cook
- Evelyn Flunkie Cook

Partners:

- Laura Meinert WRRB
- Aimee Guile WRRB
- Anneli Jokela WLWB
- Francois Larouche DFO
- Lisa Marie Zoe Tłı̨chǫ Government (Whatì)
- Albertine Eyakfwo Tłı̨chǫ Government (Whatì)
- Samantha Migwi Tłı̨chǫ Government (Whatì)
- Monica Redmond Golder Associates

Translation

- Jonas Lafferty
- James Rabesca

Additional Support:

- Jody Pellissey WRRB
- Sean Richardson Tłı̨chǫ Government (Behchokǫ̀)
- Nicole Dion ENR
- Shirley Beaverho TG (Whatì)
- Linna O'Hara HSS
- Staff at Mezi Community School

Results Workshop (April 25-26, 2019)

Elders and camp participants)

- Joe Champlaine
- Samantha Migwi

Community Members

- 9 adult males
- 6 adult females
- 7 youth males
- 3 youth females

Partners:

- Pricilla Lamouelle TG (Behchokǫ̀)
- Lisa Zoe TG (Whatì)
- Aimee Guile WRRB
- Monica Redmond Golder Associates Ltd.

Translation:

- Jonas Lafferty
- James Rabesca

School Visit

- 19 males
- 9 females
- 2 teachers

Appendix 2 – Results from Water Quality Travel Blanks and Duplicates

Field quality assurance/quality control (QA/QC) measures carried out for this program consisted of a travel blank and a duplicate. 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 duplicates were taken on site. The blanks were carried and analyzed the same as samples which were collected on site.

The presence of measurable 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. The 2018 travel blank results do not indicate that there was any contamination in the field. The 2018 duplicate results are within expected margins and do not indicate that there was any sampling or lab cross-contamination.

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