Tłı̨chǫ Aquatic Ecosystem Monitoring Program (TAEMP)

Final Report, Gamètì, 2013

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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 will have 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 Tłı̨chǫ and scientific knowledge to address the question: “Are the fish safe to eat and is the water safe to drink?”

In July and August 2013, community elders and youth in Gamètì 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, as well as Tłı̨chǫ and scientific knowledge relevant to water, sediment, fish, and potential contaminants. 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 selected by community members from Gamètì. 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 Rae Lakes. From September 23-27, 2013, the on-the-land monitoring camp occurred. Elders and community members provided direction on 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 Gamètì in February 2014 after all lab 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. Students from Jean Wetrade School also attended the results meeting, and all participants had an opportunity to view a draft video which captured the activities at the on-the-land camp.

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 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 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 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 2013 camp near Gamètì, the TAEMP will visit the community of Whatì in 2014 and complete the initial baseline sampling phase for all four Tłı̨chǫ communities. In 2015, the first round of comparative sampling will begin when the TAEMP returns to the community of Behchokǫ̀. 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, harvesters and youth), the Wek’èezhìı Renewable Resources Board (WRRB), Tłı̨chǫ Government (TG), the Wek’èezhìı Land and Water Board (WLWB), the Department of Fisheries and Oceans (DFO), the Department of Health and Social Services (HSS) and Environment Canada (EC; now Environment and Climate Change Canada).

Methods

The 2013 TAEMP consisted of three main phases:

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

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, one-day workshops were held with community members in June and August to discuss the TAEMP. The workshops provided a forum to discuss concerns related to ecosystem health (including water and fish quality) from a Tłı̨chǫ perspective, and explore scientific concepts such as monitoring and indicators of aquatic ecosystem change.

Key outcomes of the introductory workshop were building understanding regarding what needs to occur at "fish camp" and to allow for advance planning. Specifically, the planning workshop allowed the list of participants to be finalized and clarification(s) regarding assorted logistics for the on-the-land camp, scheduled to take place in late August / early September 2013. The location of the camp and locations for sampling were based on direction given at workshops and in ongoing consultation with elders in the community.

2. On-the-land Monitoring Camp – Rae Lakes

a. Overall

To assess fish, water, and sediment quality, samples were collected 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 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 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's (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 Tłı̨chǫ Government (TG) Wildlife Coordinator and the Wek'èezhìı Land and Water Board (WLWB) Regulatory Officer; procedures were followed to minimize contamination, such as implementation of appropriate Quality Assurance / Quality Control (QA/QC) procedures, in accordance with instructions from the Government of the Northwest Territories 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 on the same day they were collected. 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 suitable for collecting soft, fine grained sediments typically observed in the area.

Sediment samples were collected using an Ekman dredge, 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 supports 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, ultra-low-detection mercury, and microbiological analysis. All bottles (except sterile bottles) were rinsed three times with sample water before filling. Water sampling was led by the Wek'èezhìı Land and Water Board (WLWB) Regulatory Officer and the Tłı̨chǫ Government (TG) Wildlife Coordinator.

d. Fish Sampling

Fish were collected using gillnets set at different locations as determined by community members; net provided fish for tissue sample collection as well as for consumption at camp. Four gillnet sets were conducted over the course of the camp on Rae Lakes (Table 1). The 5.0 and 4.0-inch gillnets were used to target larger fish such as *Łih* (Lake Whitefish), *Łıwezǫ̀* (Lake Trout) and *Ɂhdaa* (Northern Pike) which are the fish primarily caught for food. The number and duration of the gillnet sets was subject to field conditions and safety considerations.

The fish caught were identified to species, were measured to total and fork length (TL and FL) to the nearest millimeter, and weighed (g). Additional data collected included: gender, stage of maturity, and a general description of the contents of the stomach, any parasites

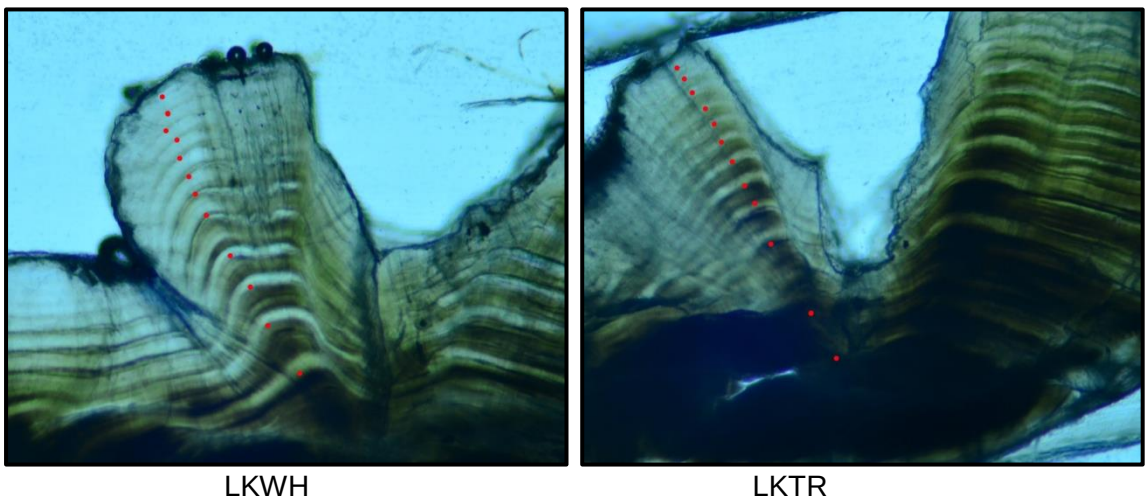
and/or deformities. The target for tissue (for contaminants) and otoliths (for aging) samples was 20 łih and 20 łiwezǫ̀. Łih and łiwezǫ̀ are typically consumed by community members, and focusing tissue sampling on these two species also provided a way to account for differences in mercury levels between benthic and predatory fish.

Table 1. Details for gillnet sets used to collect all fish samples at the TAEMP on Rae Lakes near the community of Gamètì, September 2013.

Net set / pull date	Set Length (hours)	Location (Lat/Long)	Min depth/ Max depth (m)	Mesh size (inches)
Sept. 23 / Sept. 24	19.53	N 63°08.188 W-117°13.385	1.0 / 4.0	5.0
Sept. 25 / Sept. 25	4.00	N 64°12.200 W -117°25.600	4.5 / 13.6	4.0
Sept. 25 / Sept. 26	18.42	N 64°08.291 W -117°13.790	n/c / 8.5	4.0
Total	41.95			

Note: Lat/Long are NAD 83; n/c = not calculated

Fish age was estimated by taking otolith samples, having them cut and mounted on slides, and 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. On the left is a łih (LKWH) estimated to be 12 years, and on the right a łiwezǫ̀ (LKTR) estimated at 12 years.



LKWH LKTR

Figure 1. Two examples of otolith cross-sections obtained from samples collected on Rae Lakes, 2013; a łih (Lake Whitefish; LKWH) estimated at 12 years is shown on the left, and a łiwezǫ̀ (Lake Trout; LKTR) estimated at 12 years on the right. Photos and interpretation provided by North/South Consultants Inc.

e. Fish Tissue Analysis

To determine current levels of contaminants in fishes regularly consumed by local communities, fish tissue samples were collected from łıwezǫ̀ and łih, fish species regularly consumed by Gamètì residents. Fish processing was led by Golder Associates Ltd. and DFO fisheries biologists, and samples were collected under the guidelines established by Environment Canada for sampling for metals (Environment Canada 2012) and the Golder 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 Gamètì to reiterate the goals and objectives of the program, as well as present the results of the analyses. 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 means by which to present results to participants and interested community members. Collaboration with Government of Northwest Territories, Health and Social Services (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 (GNWT HSS, 2015, AMAP 2011). The results workshop was also the venue for the premiere of the draft “fish camp” video; input was gathered from camp participants prior to a final version of the video being posted on the WRRB website.

Results

1. Introductory / Planning Workshops

On June 13, 2013, a one-day workshop was held with community members from Gamètì to introduce and discuss the TAEMP. Participants expressed interest in the fish camp and agreed that monitoring fish, water, and sediment quality is important to monitor changes near Gamètì. Community members spoke of their knowledge of the area and agreed that elders, youth and scientists can work together and take the opportunity to monitor changes as new development occurs. Concerns were raised about contaminants and health of water and fish, about the influence of old mine sites (e.g. in the Hottah Lake area), and contamination from previous exploration activities. Community members spoke of changes in fish that have been noticed, such as spots in the rib area on some łıwezǫ̀, and some deformities; community members wanted to know reasons for the changes. Options for sampling locations were discussed, as were options for the location of the camp given considerations such as water levels and available shelter for boats. There was agreement that sampling should concentrate on łıwezǫ̀ and łih based on primary consumption and health concerns. It was understood that late September was the available window for the camp, and that community support would be required, including the selection of engaged youth. A short visit to Jean Wetrade School provided indication from the principal and science teacher that finding youth who will be engaged should be no problem.

On August 15, 2013, a second workshop was held in Gamètì to finalize planning for the on-the-land 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. Workshop participants developed a list of elders and community members who would participate in the fish camp with an understanding of who would be responsible for what duties. There was agreement that 10 elders (5 women and 5 men) would participate, and participants clarified the need for selecting elders without health concerns that could cause challenges while out-on-the land. It was also agreed that 6 youth (3 young men and 3 young women) should participate, with youth to be selected through cooperation among Jean Wetrade School teachers, support staff and community members. There was agreement that the fish caught would be eaten as part of the focus on having a traditional camp (e.g. traditional foods, no electronic entertainments, traditional activities). The overall sentiment of the meeting was one of cooperation and a want for a safe camp a priority. There was also strong agreement that no drugs or alcohol permitted, and that zero tolerance will be enforced.

Workshop participants agreed that the dates for the camp would be September 23-27, 2013. A number of locations for the camp were proposed (Figure 2), with focus on *Kankwa Ka* – a central location north of Gamètì on a rocky slope with shelter for boats, regardless if wind comes from the east or west. The location would require set-up, given no cabins, and it was proposed that community members depart on September 22 to do preliminary set-up and a ceremony, with final set-up to occur upon arrival of support participants. Community input further clarified where monitoring should occur, building on the map developed at the previous meeting; various locations around camp for setting nets / water sampling provide a good mix of possibilities based on distances and planning for bad weather. Continued agreement on what fish species to sample (łıwezǫǫ̀ and łih) based on the community's consumption / health concerns); other species of interest were also listed *Nǫhkwèe* (Burbot / Loche), *Ts'étı̨ą* (Arctic Grayling), ı̨hdaa, and suckers – both *Dehdoo* (Longnose Sucker) and *Kwìezhìı* (White Sucker).

Community members and elders re-iterated concerns about water levels being low, clarifying that it would be best to have camp in a central location close to deeper water and along / near main route Gamètì community members frequently use. Concerns were voiced again about the impact of the fires close to Gamètì, with specific concerns about the possibility of aquatic health changing and the numbers of fish decreasing due to fire, and the possibility of fires coming closer to Gamètì. A follow-up meeting with WLWB (held on August 16) clarified that a sample taken near a burn area could help to investigate the potential impacts of runoff from the burn area.

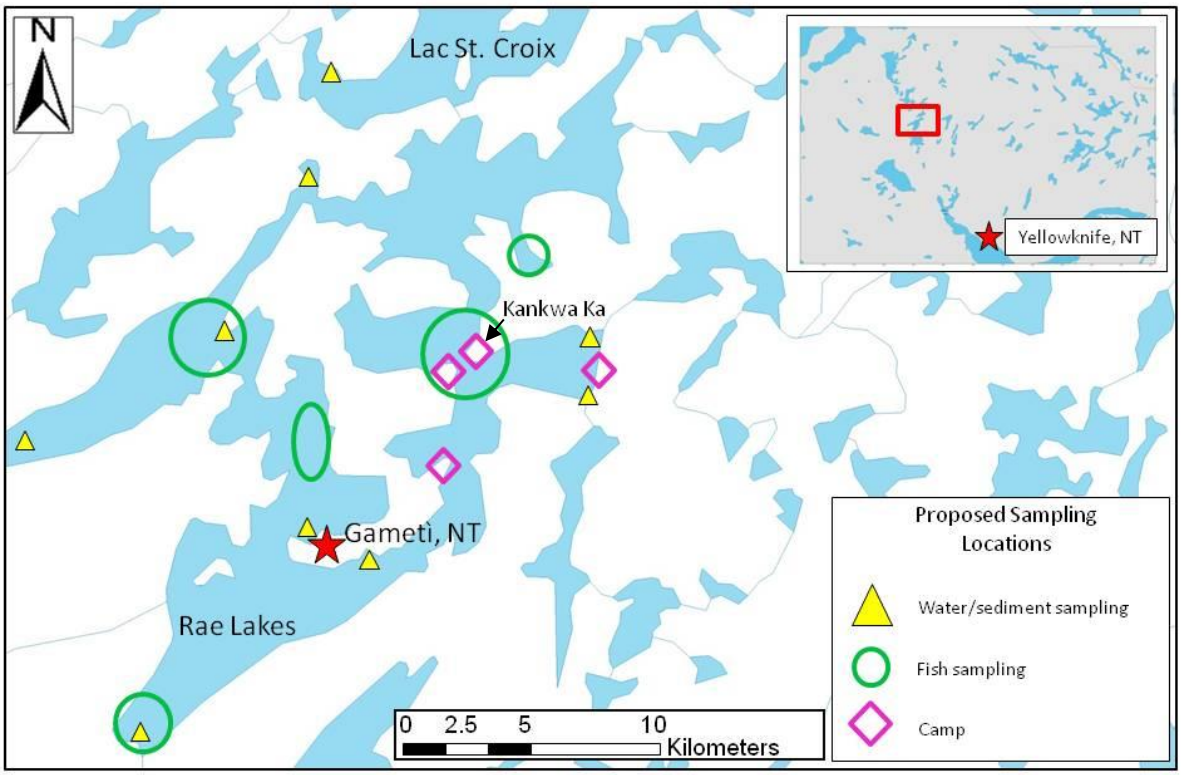


Figure 2. Proposed locations for the camp, and fish, water, and sediment sample collection for the planned TAEMP near the community of Gamètì (on Rae Lakes) as decided by community members at introductory and planning meetings July and August, 2013.

2. On-the-land Monitoring Camp – Rae Lakes

a. Overall

The on-the-land phase of the TAEMP occurred from September 23-27, 2013. Travel to the camp occurred on September 23, though some support staff arrived near dark given delays related to required paperwork for participants. Sampling and other camp activities occurred September 24-26, and participants returned to Gamètì on September 27.

The proposed location (Kankwa Ka; Figure 2) was not the location used for the camp. Instead, the final location selected (Figure 3) was where Louie and Therese Zoe's camp was situated, included a cabin, and was closer to Gamètì than Kankwa Ka. The final location was also where Gamètì community members had traditionally gathered for many years, well prior to the establishment of the community. This historical context to the camp location offered many opportunities for passing on of stories and knowledge connected to the area.

At camp, there were morning and evening planning meetings, initially held in the cook tent and then moved to Louie and Therese Zoe's cabin. The 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 for 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 objective to catch 20 łıwezǫ̀ and 20 łih for collection of tissue samples was achieved. The desired water and sediment samples were also collected. 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 to combine Tłı̨chǫ knowledge with science-based monitoring methods. Experiences at the camp, including a feeding the fire ceremony and youth gaining hands-on experience with sampling methods and the making of dry-fish and bannock, were captured on video. An educational video was produced, showcasing the involvement of the youth and the value and importance of environmental monitoring and the sharing of Tłı̨chǫ knowledge and scientific perspectives.

The impact of fires (to land and water) over the summer was regularly mentioned by elders. Further, water levels were considered to be low by community participants, and water levels made routing and safety important considerations during camp operations. Weather / wind conditions were not problematic and manageable, though low cloud / rainy conditions on the day of departure made for a damp return to Gamètì.

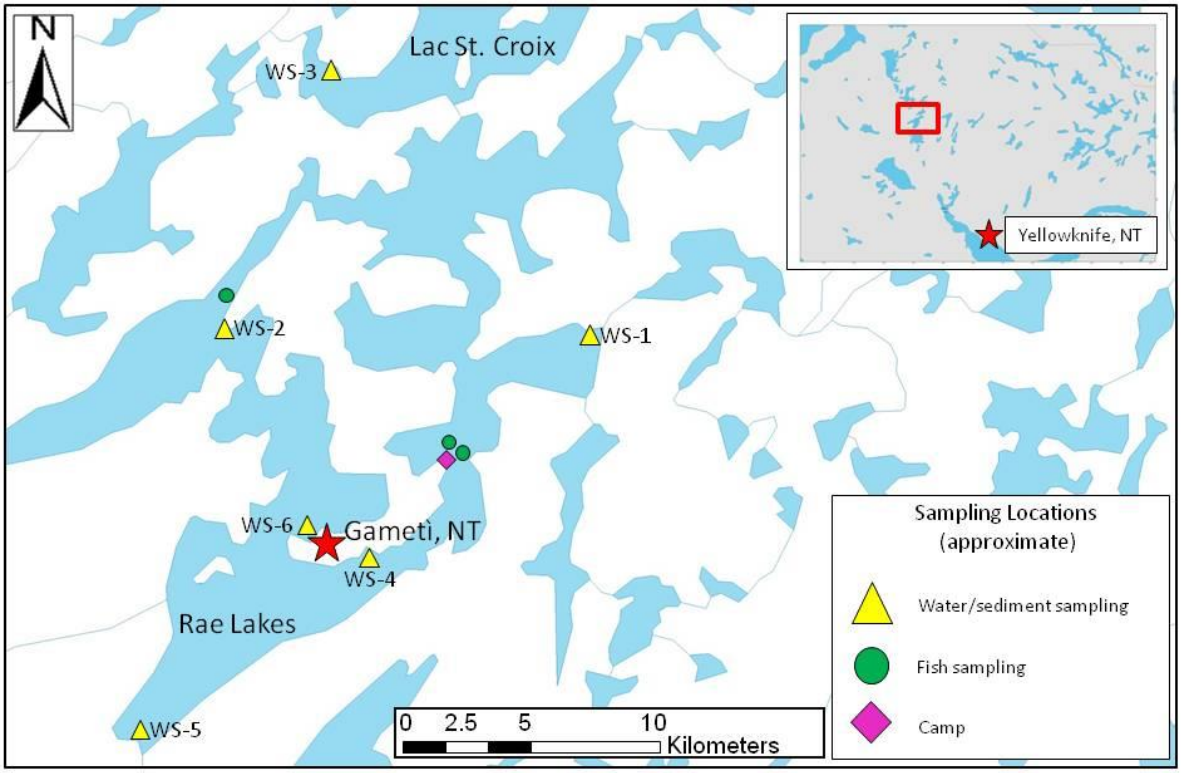


Figure 3. Final location for the camp and locations where fish, water, and sediment samples were collected during the TAEMP near the community of Gamètì (on Rae Lakes), September, 2013.

b. Water Quality

Locations for all water and sediment samples collected are provided in Table 2. Water sample analyses indicated the pH ranged from 7.43 to 8.23, and hardness levels (i.e. the mineral content) at most sites indicated that water was “hard”. However, the tea water sampling location (WS-1) had a different profile than the other sites, including having the lowest pH and water that was considered the “softest” out of all the samples collected. Table 3 provides some additional examples of the differences between the tea water location (WS-1) and other sampling locations (e.g. total dissolved solids, conductivity, sulphates, etc.).

Sample WS-1 (total: 150µg/L, dissolved: 13.8µg/L) was over the Canadian Council of Ministers of the Environment (CCME) Guideline for the Protection of Aquatic Life (CCME 2014) for aluminium (100µg/L; Figure 4a). Location WS-1 also had the highest measurement (total: 159µg/L, dissolved: 12.0 µg/L) for iron out of the six locations sampled, though guideline for iron (300µg/L) was not exceeded (Figure 4b). Samples collected from WS-1 (total: 0.12µg/L, dissolved: 0.01 µg/L), WS-2 (total: 0.03µg/L, dissolved: 0.01 µg/L), WS-5 (total: 0.1µg/L, dissolved: 0.01µg/L) and WS-6 (total: 0.04µg/L, dissolved: 0.01 µg/L) exceeded the Guideline for mercury (0.026µg/L; note, the duplicate of WS-2 not considered a site) (Figure 5a). Samples WS-1 (total: 0.2µg/L, dissolved: 0.1µg/L) and WS-5 (total: 0.3µg/L, dissolved: 0.1µg/L) exceeded the Guideline for silver (0.1µg/L) (Figures 5b; see also Figure 3 for map of all sampling locations).

Samples collected in a bay near the sewage lagoon indicated bacteria (*Escherichia coli*), Total Coliforms, and Fecal Coliforms were low or not detected.

Table 2 Details for locations where water sampling occurred as part of the TAEMP held on Rae Lakes near the community of Gamètì, September 23-27, 2013.

ID	Description	Location (Lat/Long)
Gameti-1 / WS-1	Tea water spot	N 64°12.1128 / W-117°06.9094
Gameti-2 / WS-2	Near Joe Zoe’s cabin	N 64°11.2352 / W -117°25.5984
Gameti-3 / WS-3	Near recent burn area	N 64°17.2928 / W -117°21.1238
Gameti-4 / WS-4	Community dock	N 64°06.9909 / W -117°21.1260
Gameti-5 / WS-5	Faber Lake outlet	N 64°02.5079 / W -117°27.7897
Gameti-6 / WS-6	Bay near sewage lagoon	N 64°06.6654 / W -117°17.7919

Note: Lat/Long are NAD 83;

Table 3 Examples of results for parameters measured in water samples which highlight differences between sampling location WS-1 (the tea water site; in bold) and other sampling locations on Rae Lakes near Gamètì, 2013.

Parameter	Units	mdl	**WS-1**	WS-2	WS-2 DUP	WS-3	WS-4	WS-5	WS-6	TB	FB
Alkalinity, Total (as $CaCO_3$)	mg/L	0.4	**23.1**	124	123	111	102	99.8	100	<0.4	<0.4
Conductivity, Specific (@ 25°C)	µS/ cm	0.4	**56.8**	371	377	331	310	304	307	<0.4	<0.4
pH	pH units	n/a	**7.43**	8.21	8.21	8.23	8.17	8.22	8.18	5.79	5.51
Solids, Total Dissolved	mg/L	10	**48**	232	230	208	188	184	192	<10	12
Turbidity	NTU	0.05	**2.93**	0.36	0.42	0.33	0.38	0.26	0.27	0.06	0.09
Hardness	mg/L	0.7	**28.7**	196	199	175	161	158	158	1.9	1.3
Sulphate	mg/L	1	**3**	65	65	55	48	47	47	<1	<1

mdl=minimum detection limit; DUP = duplicate; TB = travel Blank; FB = Field Blank

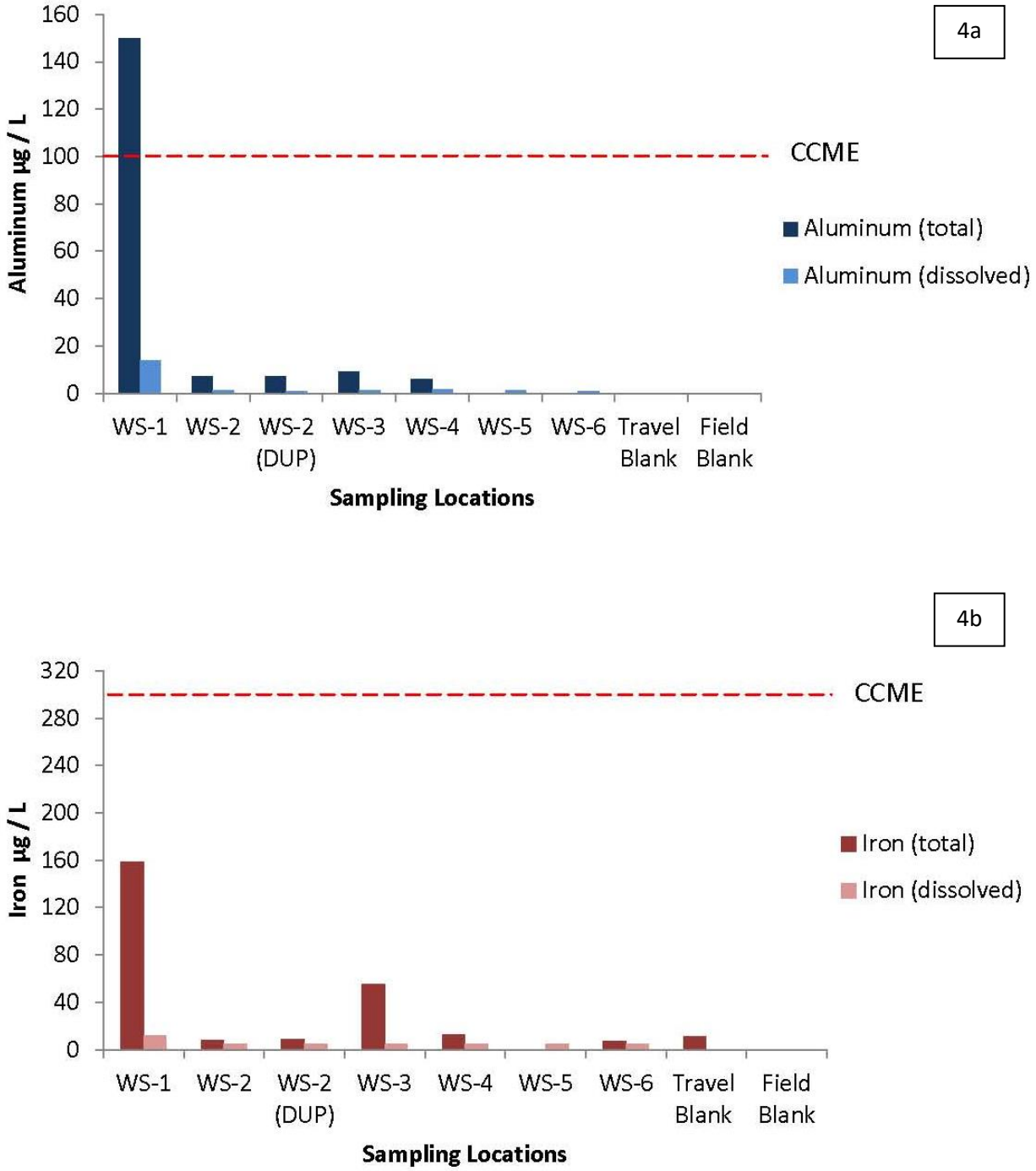
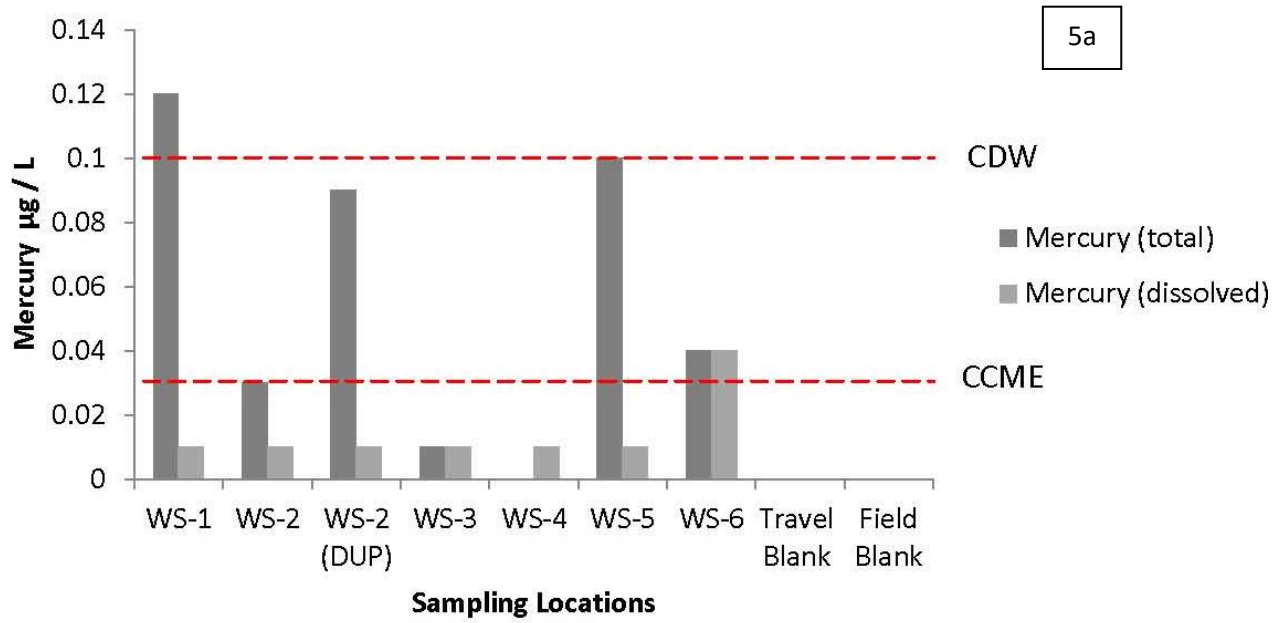


Figure 4 Results of water quality analyses for aluminium (4a) and iron (4b) (total and dissolved) for six samples (with one duplicate), a travel blank, and a field blank (µg/L) collected during the TAEMP near Gamètì (on Rae Lakes), September, 2013. Canadian Council of Ministers of the Environment (CCME) guidelines provided for both metals (100µg/L and 300µg/L for aluminium and iron, respectively).



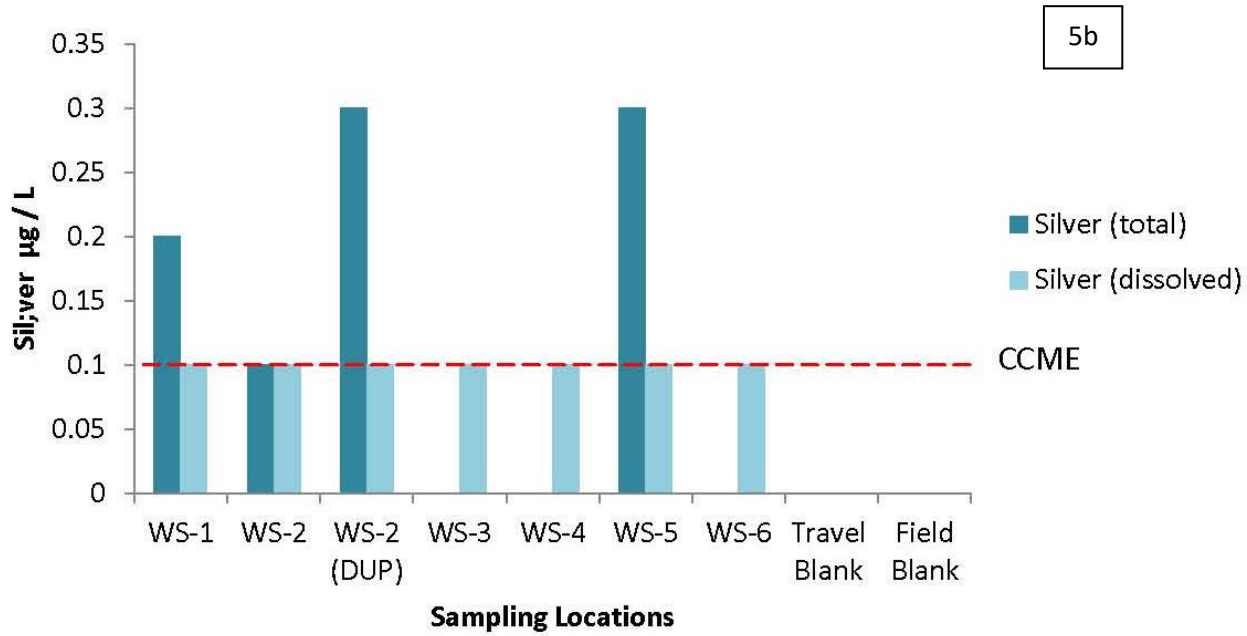


Figure 5 Results of water quality analyses for mercury (5a) and silver (5b) (total and dissolved) for six samples (with one duplicate), a travel blank, and a field blank (µg/L) collected during the TAEMP near Gamètì (on Rae Lakes), September, 2013. Canadian Council of Ministers of the Environment (CCME) guidelines provided for both metals (0.026µg/L and 0.1µg/L for mercury and silver, respectively). Canadian Drinking Water (CDW) guideline also provided for mercury (0.1 µg/L).

c. Sediment Quality

Organic carbon was higher in sediments at WS-3 (17.7%, organic carbon total), the sampling location furthest north from the camp and closest to 2013 fire activity. Organic carbon ranged from 1.82 to 7.85 percent at all other sampling locations.

Arsenic exceeded the CCME Sediment Quality Guideline (SQG), but not the Probable Effects Level (PEL; CCME 2014) at WS-2 (7.3mg/kg); the SQG for mercury is 5.9mg/kg and the PEL is 17.0mg/kg (Figure 6a; see Figure 3 for sampling locations). Arsenic at all other sampling locations ranged from 1.1 to 2.6mg/kg.

Chromium exceeded the CCME SQG, but not the PEL (CCME 2014) at WS-2 (82.2mg/kg); the SQG for mercury is 37.0mg/kg and the PEL is 90mg/kg (Figure 6b; see Figure 3 for sampling locations). Chromium at all other sampling locations ranged from 18.5 to 34.5mg/kg.

Copper exceeded the CCME SQG, but not the PEL (CCME, 2014) at WS-2 (52mg/kg), and WS-3 (46mg/kg); the SQG for copper is 36mg/kg and the PEL is 197mg/kg (Figure 6c, see Figure 3 for sampling locations). Copper at all other sampling locations ranged from 11 to 31mg/kg.

No other parameters exceeded the CCME SQG or PEL in the sediments analyzed.

Fecal Coliforms were not detected in sediments from collected at WS-6, the sampling location near the sewage lagoon.

d. Fish Species Diversity

Four species of fish were caught on Rae Lakes (Table 4), with łıwezǫ̀ǫ̀ (LKTR) and ¡hdaa (NRPK) the common top predators, and łih (LKWH) representing a benthic invertebrate feeder. There were 21 łıwezǫ̀ǫ̀, 25 łih, 1 Round Whitefish (RHWH; also *łih*), and 15 ¡hdaa caught, for an overall total of 62 fish caught over a combined total of 41.95 hours of net sets (see also Table 1). Smaller fish fauna could not be effectively sampled with the mesh size in the gillnets used.

Table 4. Date and duration of net sets, and number of łıwezǫ̀ǫ̀ (LKTR), łih (LKWH), Round Whitefish (RNWH; also łih) and ¡hdaa (NRPK) caught on Rae Lakes near the community of Gamètì during the TAEMP, September 23-25, 2013.

Net set / pull date	Location (Lat/Long)	LKTR	LKWH	RNWH	NRPK
Sept. 23 / Sept. 24	N 63°08.188 / W-117°13.385	3	13	1	15
Sept. 25 / Sept. 25	N 64°12.200 / W-17°25.600	6	4	0	0
Sept. 25 / Sept. 26	N 64°08.291 / W-117°13.790	12	8	0	0
	Totals	21	25	1	15

Note: Lat/Long are NAD 83

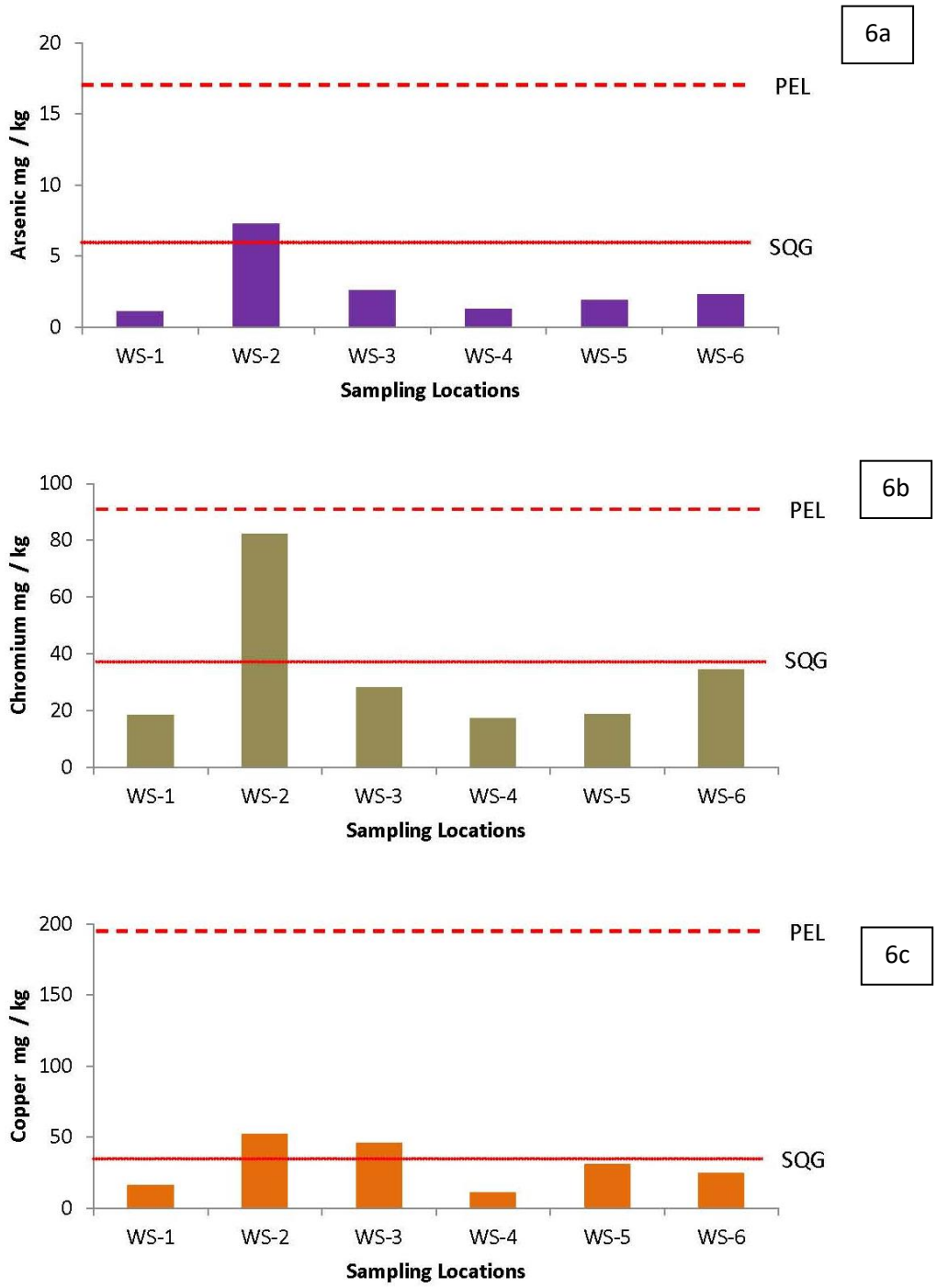


Figure 6 Results of sediment quality analyses for arsenic (6a) and chromium (6b) and Copper (6c) for six samples (mg/kg) collected during the TAEMP near Gamètì (on Rae Lakes), September, 2013. Canadian Council of Ministers of the Environment (CCME) Probable Effects Level (PEL) and Sediment Quality Guidelines (SQL) are provided for metals (PEL 17.0mg/kg, SQG 5.9mg/kg for arsenic; PEL 37mg/kg, SQG 90mg/kg for chromium, and PEL 36mg/kg, SQG 197mg/kg for copper, respectively).

e. Fish Tissue Analysis

The average mercury concentration for łıwezǫ̨ sampled (n=20) was 0.468g/kg (95% CI+/-0.066) and ranged between 0.251-0.825mg/kg (wet weight). Seven of the twenty fish were found to be above the mercury concentration guideline of 0.5mg/kg, (wet weight, wwt; Health Canada, 2014a). Six of the twenty łıwezǫ̨ showed mercury concentrations close to the guideline (falling between 0.4 and 0.5), with the remaining seven łıwezǫ̨ all under 0.4mg/kg ww. Of note, the oldest (35 and 30 years), the longest (802 and 774mm), and the heaviest (5380 and 4570g) łıwezǫ̨ did not show the highest concentrations of mercury. Mercury concentrations in relation to age (Figure 7a) suggest a positive relationship. However, the relationships between mercury concentrations in tissue in relation to weight and fork length (Figures 8a and 9a; respectively) were not as clear. Weight and fork length in relation to mercury tissue concentration were not found to be significant.

Although 20 łih were available for contaminants analyses, only 19 were analysed due to processing errors. Also, otholith aging was not completed for one of the 19 łih as the otolith was shattered and unusable. As a result, a total 18 łih were aged and had corresponding mercury analysis done to allow for comparison. The average mercury concentration for łih sampled (n=19) was 0.092mg/kg (95% CI+/-0.025) and ranged between 0.049-0.287mg/kg (wet weight). All of the łih sampled fell well below the guideline for mercury 0.5mg/kg, (wet weight, wwt; Health Canada, 2014a). Regression analyses examining the relationship between age, weigh and length to mercury concentrations in tissue were all non-significant.

Cysts (parasites) were found in all łıwezǫ̨ sampled - on the outside (outer wall) of the stomach and to a lesser degree, on the upper intestine and pyloric ceaca, with parasitic worms found in one stomach. However, nothing abnormal was noted. The majority of stomachs were empty; those with contents included *Łìhtsoa* (ciscoes) and *Dahts'a* (sticklebacks). In łih, cysts (parasites) were found in locations previously noted for łıwezǫ̨ though nothing abnormal was noted. Gut contents included snails, and invertebrates / amphipods. No deformities were noted in the łıwezǫ̨ or łih sampled.

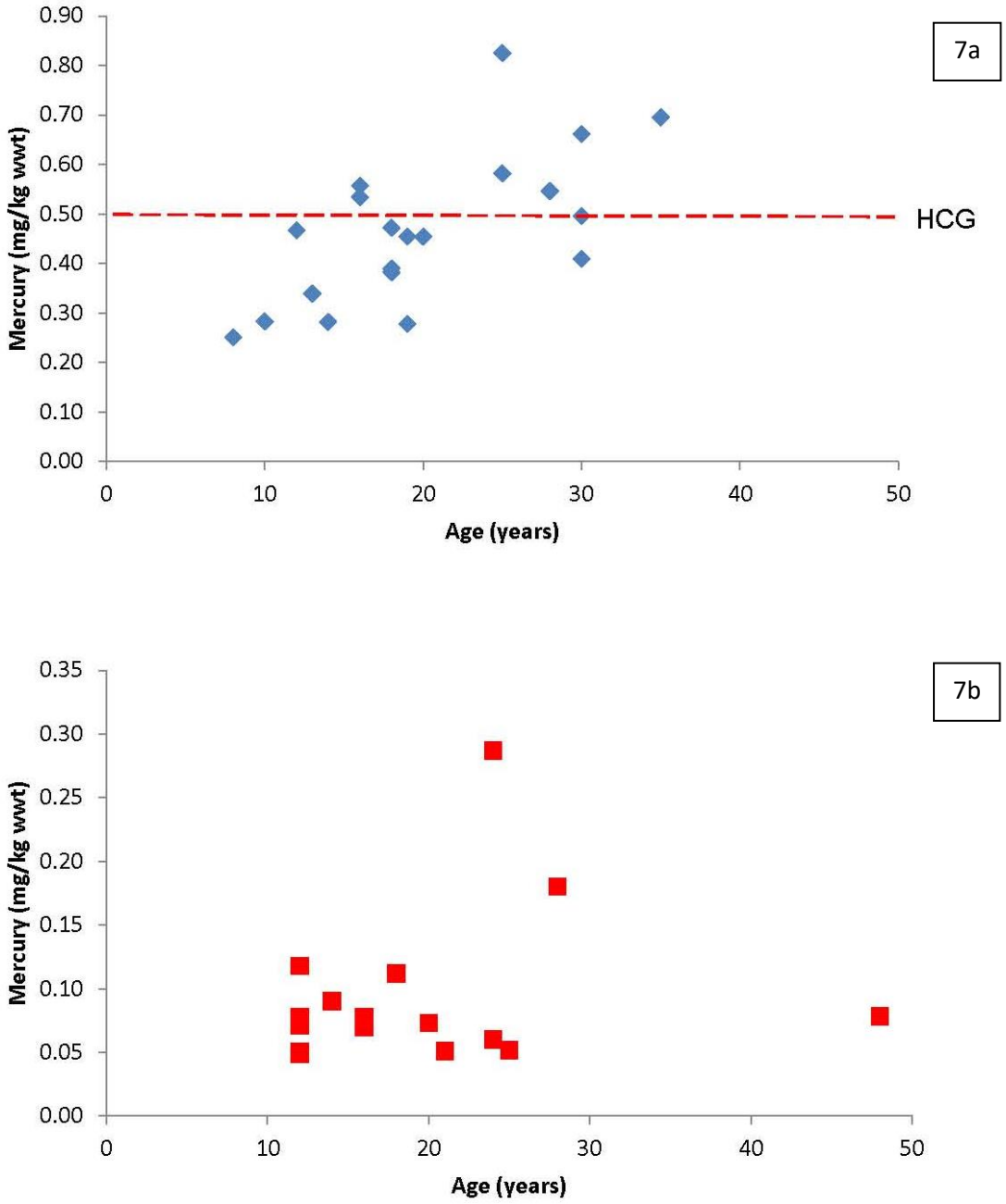


Figure 7. Relationship between mercury concentration in tissues (mg/kg; wet weight) and age (years; estimated via otolith aging) of łıwezǫ̀ǫ̀ (7a) and łih (7b) collected during the TAEMP near Gamètì (on Rae Lakes), September 2013. Health Canada Guideline (HCG) for mercury (0.5mg/kg for retail fish) provided.

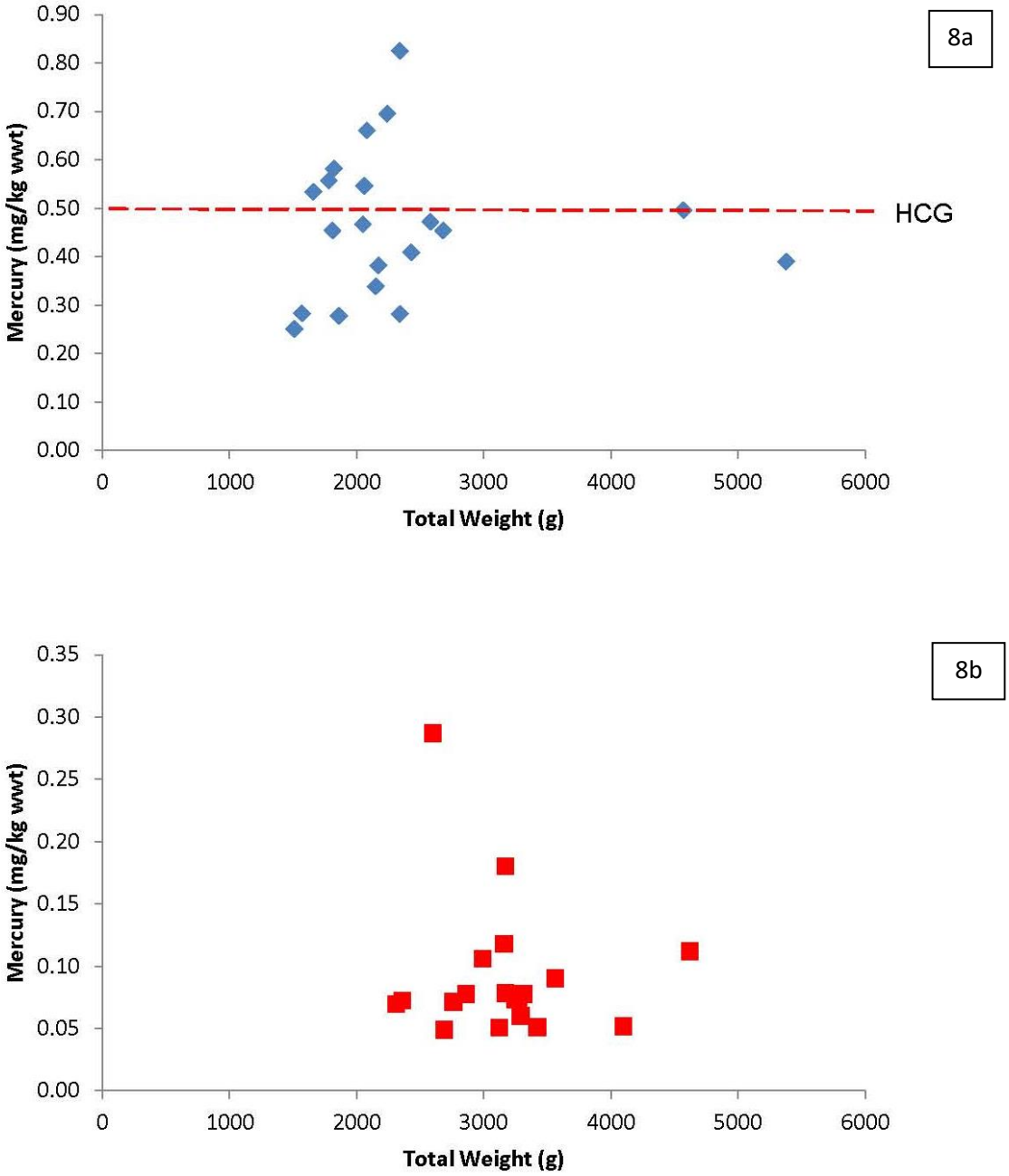


Figure 8. Relationship between mercury concentration in muscle tissue (mg/kg; wet weight) and body weight (g), of łıwezǫ̀ǫ̀ (8a) and łih (8b) collected during the TAEMP near Gamètì (on Rae Lakes), September 2013. Health Canada Guideline (HCG) for mercury (0.5mg/kg for retail fish) provided.

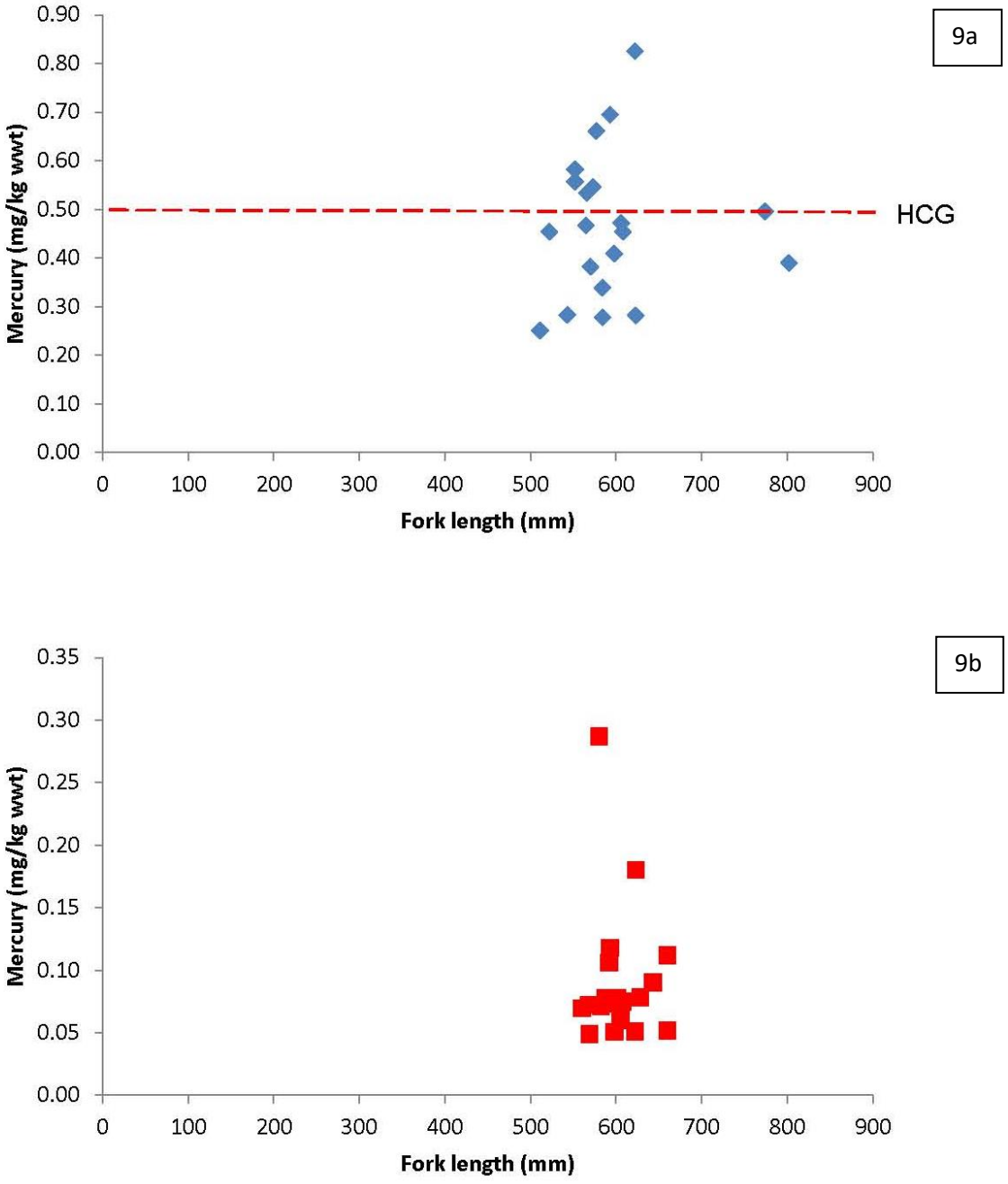


Figure 9. Relationship between mercury concentration in muscle tissue (mg/kg; wet weight) and fork length (mm), of łıwezǫ̀ǫ́ (9a) and łih (9b) collected during the TAEMP near Gamètì (on Rae Lakes), September 2013. Health Canada Guideline (HCG) for mercury (0.5mg/kg for retail fish) provided.

f. Fish Growth

Review of age in relation to length for both łih and łıwezǫ̀ǫ̀ captured in Rae Lakes suggest generally positive relationships (Figure 10); no regression analyses were performed.

Łıwezǫ̀ǫ̀ sampled for tissue analyses and aging (n=20) ranged from 511-802mm in fork length, 1510-5380g in weight, and were estimated to be 8-35 years of age. Average fork length was 596.25mm (95% CI+/-31.62mm), and average weight 2354.0g (95% CI+/-421.04g). All łıwezǫ̀ǫ̀ caught (n=21) also ranged from 511-802mm and 1510-5380g, had an average fork length of 596.00mm (95% CI+/-30.08mm), and the average weight of 2338.10g (95% CI+/-401.70g).

Łih sampled for tissue analyses (n=19) ranged from 560-660mm in fork length, 2310g-4620g in weight, and (n=18; see previous explanation for decreased sample size under fish tissue analyses) were estimated to be 12-48 years of age. Average fork length 603.95mm (95% CI+/-13.08) and average weight was 3158.42g (95% CI+/-248.10). All łih caught (n=25) ranged in fork length from 527-660mm, with average fork length of 596.12.20mm (95% CI+/-12.17), and average weight 3007.04g (95% CI+/-226.63).

Įhdaa sampled (n=15) ranged from 635 to 803mm in fork length, and 1680-4010g in weight. The average fork length was 694.00mm (95% CI+/-26.16), and average weight was 2267.33 (95% CI+/-320.03). Įhdaa did not have clethria collected and were not aged (note: in Northern pike more often it is clethria, not otoliths, that are used for aging). The one Round Whitefish caught was not measured.

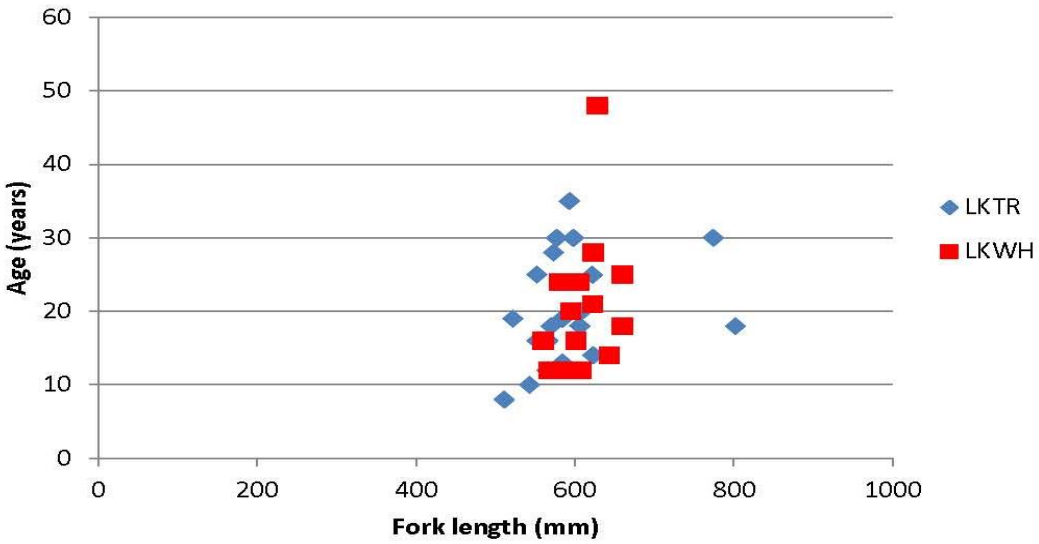


Figure 10. Relationship between fork length (mm) and age (years; estimated via otolith aging) in łıwezǫ̀ǫ̀ (LKTR; n=20) and łih (LKWH; n=18) collected during the TAEMP near Gamètì (on Rae Lakes), September 2013.

g. Cultural / Educational Activities

At camp, community members led the feeding of the fire ceremony. However, the ceremony occurred on the morning of September 24, instead of the evening of arrival, with the recognition that delays in departure for some participants on September 23 led to some confusion at the start of the camp, including a delay in opening the camp in a proper fashion.

Throughout the camp, elders shared their knowledge and stories, and the youth assisted with camp chores. Though direction of community members, elders and support staff, youth learned about what life at a camp requires. Youth also assisted in cleaning the camp site, learning what is required regarding basic camp maintenance and respect. On the last full day of the camp there was also a visit by a small group of community members who were interested in the activities at the camp. The visitors did not stay long, but had time to interact with camp participants and share information prior to the visitors continuing on their journey.

Youth also learned practical skills such as how to make bannock, and the young women expressed an interest in making bannock for their families after they returned to Gamètì – notably, one mentioned that it was her first time making bannock and that she planned to make it for her mom. Everyone enjoyed the traditional foods prepared by the camp cooks, and fish caught were used for both sampling and consumption. Youth also participated in the making of dry fish, observing the elders as they skillfully scaled and filleted the fish. On the last evening community members harvested a moose, which was viewed as a much welcomed gift by the elders, and the meat was divided fairly. On the last evening there was also a hand games demonstration in the cabin, with youth demonstrating their skills to all participants. The hand games provided entertainment for everyone, and there was much laughter and good spirits at the last night at camp.

An interesting aspect of the final location of the camp was that it was a place that Tłı̨chǫ people traditionally gathered and stayed well prior to the establishment of the community of Gamètì. The significance of the location was reinforced when elders spoke of the hardships people faced while living out on the land, and the knowledge that was gained by living in a location for many years. Elders shared stories about the history of the area and spoke of the importance of fish and the use of fish traps to catch fish in the past, gathering and storing fish for the winter. Stories regarding the traditional trails nearby and the routes that people used to visit the barren lands were also passed on to participants.

On-shore demonstrations were given for both fish sample processing and water and sediment sample collection. Paul Vecsei (Golder Associates Ltd.), with assistance from Deanna Leonard (DFO), demonstrated how to process fish for sampling and how to obtain the required information from fish (e.g. length, weight, sexual maturity, otholith 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. invertebrate feeders), as well as the stomach contents which indicate what prey the different lifestyles focus on. Sarah Elsasser (WLWB) and Sean Richardson, Wildlife Coordinator (TG), led the field demonstration (note: an on shore demonstration was not conducted) and the collection of water and sediment samples. Sampling in the field involved interested youth, and under supervision, youth assisted with the collection of some samples. Particular focus was given to explain the need for proper procedure to avoid contamination of samples.

A variety of camp activities were captured on video by Mason Mantla, of the Tłı̨chǫ Government's Community Action Resource Team (CART) (available at: http://www.wrrb.ca/news/new-gameti-fish-camp-video-ready-viewing).

Highlights from the video included positive commentary on the camp provided by elders, youth and support staff. For example, Elder Louie Zoe spoke of how traditional knowledge and science were taught and how participants worked together at the fish camp:

> *"I watch you work very well together on things working with the students. Therefore I'm very thankful. You have set the net in front of the students and what you are doing is teaching them something they can use in the future. There's been some testing of the water. Therefore I'd like to thank you for what they see and are being taught, is something they can use in the future. Later on in the future when they gain the skills themselves they will do what they have seen and may be able to do it on their own*"

and,

> *"The kid that spoke, that is the reason why we're here, all of us. You heard a lot of talking we're all here gathered together. When kids talk to us like this, they will pick up our knowledge, our culture. In the future, when they have kids of their own , our knowledge and culture will continue to go on and on"*

After completion of the camp activities and during review of results, the guide, "Common Fish in the Tłı̨chǫ Region" originally developed and produced in 2012 was updated. Two additional fish species were added, the *Ts'étı̨ą* (Arctic Grayling) and the Round Whitefish (also *Łih*), along with more biological information for every species along with higher quality pictures. The names of all the fish featured in the guide are provided in both Tłı̨chǫ and English, and the internal and external anatomy (another new 2014 addition) were also labelled in both languages. The guide dedicated to the memory of Harry Mantla, a skilled hunter and trapper who passed on his knowledge of Tłı̨chǫ traditions and values to many (guide available at: http://www.wrrb.ca/sites/default/files/fish_guide_2014_4_0.pdf).

3. Results Workshop

A workshop was held in Gamètì February 10, 2014 to report lab results back to camp participants and interested community members. Paul Vecsei (Golder Associates Ltd.) presented the results related to fish, and Sarah Elsasser (WLWB) presented the water and sediment results. The meeting was well attended and included the majority of participants of the camp, along with students from Jean Wetrade School (18 students in total) and other interested community members. Participants of the workshop were interested in the results and asked a number of questions for clarification. Participant found the findings related to the tea water location of interest, and the convergence of TK and science was highlighted and appreciated. Mercury contamination was also discussed, and community members were relieved to hear that the łih and łıwezǫ̀ǫ̀ from Rae Lakes continue to be healthy food choices and did not pose a risk for normal consumption. Further, with regards to consumption, Paul Vecsei was able to provide information in an understandable fashion, notably providing details of his level of personal fish consumption as an example, and he was able to provide clarification on the potential differences between consumption of Lake Trout and Lake Whitefish. Further, prior to the results workshop, TAEMP support staff discussed results with

GNWT HSS staff to ensure the messaging to the community members would be appropriate. At the end of the meeting the draft educational video highlighting camp activities was premiered and was well received; no changes to the video were suggested.

Discussion

Overall, results from the 2013 TAEMP near Gamètì indicated that fish are healthy and habitat is clean in Rae Lakes. The message provided to the community was that water, fish and sediment quality are good, where "good" indicates that results were not considered abnormal and that there were no health concerns highlighted.

No contaminant levels observed in łih or łıwezǫ̀ were considered to be abnormal. Though łıwezǫ̀ were found to have a higher mercury concentration than łih, this was not unexpected given that they are a large 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 (Health Canada, 2015, 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 suggested positive relationships (as expected) and that statistical analyses of TAEMP results are being discussed with academic partners. Łih were large and fatty, and the low mercury levels observed (none were above the Guideline) did not provide concern for the important fish targeted by the community for consumption. Notably, the łih caught were also some of the largest that the support staff biologists had seen. Also, an otolith was estimated at 48 years, making it a "record" age for a łih in the NWT. Interestingly, the łih estimated to be 48 years also had one of the lower mercury concentrations among the whitefish sampled.

Results from the 2013 monitoring program near Gamètì support the expectation that water quality and sediment quality are good in Rae Lakes. 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. 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.

Two water samples were over the Guideline for silver, though there is no Canadian drinking water guideline for silver because water contributes negligibly to an individual's daily silver intake (Health Canada 2014b). Also, of the water samples collected, results for 5 out of 6 indicated water is considered "hard", which is not unexpected given the natural occurrence of minerals in the environment (e.g. calcium and magnesium). Two sediment samples were slightly over the Sediment Quality Guideline for copper but not over the Probable Effects level, and the levels observed are well within the range of natural concentrations in

Canadian lakes and streams CCME 2014). Arsenic concentrations exceeded the SQG only slightly at one sampling location, a location which also showed an exceedance of the SQG for chromium. However, with regards to chromium and arsenic concentrations, neither were at levels to suggest concern (Health Canada 2013b).

The “tea water” location (WS-1) had the highest mercury concentration (0.2 ug per L) and exceeded the Aquatic Effects guideline for mercury, with one other location also exceeding the CCME guideline. However, in the North, it is not unusual for lakes to have higher than guideline values for metals (AMAP 2011). Further, the Canadian Drinking Water Quality Guideline or mercury is 1 ug/L (Health Canada 2014b). Since Gamètì drinks this water, we look to the Drinking Water Guidelines, and we also look and compare to fish results to ensure the fish is safe to eat because sometimes (e.g. in the case of mercury), they bioaccumulate (as previously mentioned for the łıwezǫ̨ǫ̀). If mercury levels were high, this is where consumption warnings might be put in place; high mercury levels were not apparent in the łıwezǫ̨ǫ̀ sampled. The tea water location also had the highest aluminium concentration (total: 150µg/L). However, there is no consistent convincing evidence that aluminium in drinking water causes adverse health effects, and recommendations for direct or in-line filtration plants have operational guidance values of less than 200ug/L (Health Canada 2014b aluminium). Overall, the “tea water” sampling location also had quite a different profile than the other sampling sites. The site was located at the inlet of a very shallow stream where people go to get their tea water because the taste of the water is considered best for tea, and the water doesn’t leave a residue on kettles or pots. Lab analyses showed the water was “softer” than other sites, and provided a great example of how Tłı̨chǫ Knowledge identified the special nature of a location near Gamètì. Further, the tea water location also provided a clear indication of how TK and science can work together to highlight unique aspects of the aquatic environment near Tłı̨chǫ communities.

Organic carbon was higher in the sediments at the sampling location furthest north from the camp, which may be explained by the fact that a forest fire occurred during the early summer of 2013. Further sampling, as well as information provided by studies examining the impact of fires on terrestrial and aquatic ecosystems may provide further insights (e.g. two separate projects led by Dr. Jennifer Baltzer at Wilfred Laurier University, and John Chételat at Environment and Climate Change Canada).

Bacteria (*Escherichia coli*, Total Coliforms, and Fecal Coliforms) were low or not detected in the bay near the sewage lagoon. This suggests that there is no contamination of the lake from the lagoon, notably as *E. coli* are a good indicator of fecal contamination (Health Canada 2014b).

Elders and other community members guided all aspects of the project, with Tłı̨chǫ knowledge incorporated throughout, by design. The application of Tłı̨chǫ knowledge included: selection of participants, selection of the camp location and establishment of the on-the-land camp, direction on where samples are 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 Tłı̨chǫ perspective. Elders and community members passed on Tłı̨chǫ knowledge to youth fostering interest in

monitoring near communities and assisting with the continuation of Tłı̨chǫ 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 Gamètì, findings were discussed in a public forum which helped build a shared appreciation of the similarities in perspectives provided by both Tłı̨chǫ knowledge and science.

Conclusions and Next Steps

The Tłı̨chǫ Aquatic Ecosystem Monitoring Program (TAEMP) 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 WRRB will continue to utilize 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 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. For example, during the 2013 TAEMP, a participating youth specifically voiced an interest in continuing training in environmental monitoring, and looked forward to the return of the fish camp in four years so that they could participate once again. 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 2013 camp near Gamètì, the TAEMP still needs to visit the Tłı̨chǫ community of Whatì to complete the initial baseline sampling phase. With completion of baseline sampling near Whatì in 2014, the first round of comparative sampling will begin in 2015 when the TAEMP returns to the community of Behchokǫ̀. The 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.

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Appendix 1 – Project Participants

Introductory Workshop (June 25, 2014)

Gametì Community members:

- Therese Arrowmaker
- Joe Black
- Camilla Chocolate
- William Chocolate
- Charlie Gon
- Joe Mantla
- Fred Mantla
- Lisa Mantla
- Rosie Mantla
- Dora Wedawn
- Antoine Wetrade
- Archie Wetrade
- Jenifer Wetrade
- Marie Adele Wetrade
- Edward Williah
- Joe Zoe
- Louie Zoe

Support Staff:

- Kerri Garner TG
- Joseph Judas WRRB (Board member)
- James Rabesca Translation
- Boyan Tracz WRRB

Planning Workshop (August 15, 2013)

Gametì Community members:

- Joe Black
- Therese Arrowmaker
- Charlie Gon
- Joe Mantla
- Dora Wedawin
- Marie Adele Wetrade
- Louie Zoe
- Joe Zoe
- Therese Zoe

Attended for brief period:

- Mary Adele Apples
- Brendan Bekale
- Celine Koyina
- Jennifer Wetrade

Support Staff:

- Kerri Garner TG
- Jonas Lafferty Translation
- Boyan Tracz WRRB

- Paul Vescei Golder

Fish Camp (September 23-27, 2013)

Gametì Elders:

- Alfonse Apples
- Mary Anne Apples
- Therese Arrowmaker
- Therese Gon
- Joe Mantla
- Rosie Mantla
- Dora Wedawin
- Charlie Wetrade
- Joe Zoe
- Louie Zoe
- Therese Zoe

Gametì Youth:

- Allison Apples
- Tsi'waa Apples
- Jarrett Arrowmaker
- Jennelle Arrowmaker
- Hunter Mantla
- Forrest Zoe

Gametì Community Members:

- Gabrielle Apples Cook
- Charlie Gon Foreman
- Celine Koniya Cook
- Francis Zoe Foreman's Helper
- Nelson Zoe Foreman's Helper

Partners:

- Susan Beaumount WRRB
- Sarah Elsasser WLWB
- Kerri Garner TG
- Deanna Leonard DFO
- Irene Mantla TG
- Mason Mantla TG
- Sean Richardson TG
- Boyan Tracz WRRB
- Paul Vecsei Golder Associates
- Jennifer Wetrade TG

Translation

- Jonas Lafferty
- James Rabesca

Video

- Mason Mantla CART (TG)

Results Workshop, February 10, 2014

A final list of all participants was not prepared, partially due to the number of attendees (estimated at 30-40, of which approximately 18 were youth). The meeting was well attended, and included the majority of camp participants (elders, youth and support staff; see photo below), along with students from Jean Wetrade School (18 students in total), and other interested community members. Attendees included: elders, senior students from Mezi Community School, and a number of interested community members. Support staff included Susan Beaumont (WRRB), Sarah Elsasser (WLWB), Kerri Garner (TG) Jonas Lafferty (translation), James Rabesca (translation), Sean Richardson (TG), Boyan Tracz (WRRB), and Paul Vecsei (Golder Associates).

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 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 (MDL), 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