Tłı̨chǫ Aquatic Ecosystem Monitoring Project

Final Report



February 28, 2013

Table of Contents

List of Figures ... iii
List of Tables ... iii
Acknowledgements ... 1
Introduction ... 2
Methods ... 2
  Planning Workshops ... 2
  Monitoring Camp – Snare Lake ... 3
    Water Quality ... 3
    Sediment Quality ... 4
    Fish Sampling ... 4
    Fish Tissue Analysis ... 5
    Tłı̨chǫ Knowledge Aquatic Ecosystem Health Datasheet ... 5
  Reporting Back Workshop ... 6
  Community Meeting and School Engagement ... 6
Results ... 6
  Planning Workshops ... 6
  Monitoring Camp – Snare Lake ... 7
    Water Quality ... 7
    Sediment Quality ... 9
    Fish Species diversity ... 11
    Fish tissue analysis ... 11
    Fish Growth ... 12
    Fish Abundance ... 13
    Tłı̨chǫ Knowledge Aquatic Ecosystem Health Datasheet ... 13
  Reporting Back Workshop ... 14
  Community Meeting and School Engagement ... 14
Discussion ... 14
Conclusions and Next Steps ... 15
Appendix 1 – Project Participants ... 17
Appendix 2 – Results from Water Quality Travel and Field Blanks ... 19
Appendix 3 – Surface Water Physical and Nutrient Analysis Results ... 21
Appendix 4 – Surface Water Metal Analysis Results ... 22
Appendix 5 – Sediment Metals Analysis Results ... 23
Appendix 6 – Fish species diversity, length and weight ... 24
Appendix 7 – Metals analysis for fish tissue samples ... 26
Appendix 8 – Age analysis for fish otolith samples ... 27

List of Figures

Figure 1 - Water and sediment sample locations 3
Figure 2 - Example of how otolith layers can be used to age fish 5
Figure 3 - Desired Fish Sampling Locations Identified in Planning Workshop 7
Figure 4 - Mercury concentration in water samples. 9
Figure 5 - Average concentrations of chromium, copper and lead in sediment at each sample site. 10
Figure 6 - Species and number of fish captured on Snare Lake 11
Figure 7 - Mercury levels in Lake Whitefish and Lake Trout tissue sampled from Snare Lake 12
Figure 8 - Length / age relationship in Lake Whitefish and Lake Trout. 12

List of Tables

Table 1 - Location, duration and characteristics of net sets 4
Table 2 - Average Total Length (mm) of Fish Species Captured in Snare Lake 13

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Introduction

The Tłı̨chǫ Aquatic Ecosystem Monitoring Program has been implemented for three years in the Tłı̨chǫ region, most recently in Wekweètì. It was initiated to draft, test and implement scientific and traditional knowledge protocols for monitoring water quality, sediment quality and fish health at the community level in the Tłı̨chǫ region. A main objective of the program is to engage youth, elders and scientists in long term environmental monitoring. In this way the scientific and Tłı̨chǫ knowledge systems are utilized in community based monitoring and contribute to the overall development and implementation of the Marian Lake Watershed Stewardship program. The Tłı̨chǫ Aquatic Ecosystem Monitoring Program is supported by staff from the Tłı̨chǫ Government , Wek'èezhìi Land and Water Board, Wek'èezhìi Renewable Resources Board and Department of Fisheries and Oceans.

Methods

The project consists of four main phases:

- planning workshops in Wekweètì;
- an environmental monitoring camp on Snare Lake that utilized both scientific and traditional knowledge monitoring protocols;
- reporting back workshop in Wekweètì; and,
- community meeting and school engagement.

These activities are discussed in detail below. Simultaneous translation was utilized during all project activities. Appendix 1 lists participants for each activity.

Planning Workshops

Two planning workshops were held to provide a forum to discuss the details of the camp and to review the approach in bringing together Tłı̨chǫ Knowledge and western science to better understand fish and the aquatic environment in the Snare Lake area. The workshop also introduced the concept of indicators relevant to water quality, sediments and fish health. They were held on June 18/19 and August 28/29, 2012 in Wekweètì, (a small Tłı̨chǫ community 200 km northeast of Yellowknife) The first workshop had 11 participants:

- five elders from Wekweètì;
- one elder from Behchokǫ̀
- one representative from Tłı̨chǫ Government;
- two community members;
- one WRRB representative; and
- one translator.

The second workshop had 7 participants:

- three elders from Wekweètì;
- three community members;
- one WRRB representative; and
- one translator.

Monitoring Camp – Snare Lake

A five-day camp was held September 10 -14, 2012 at a traditional fish harvesting site on an island in Snare Lake (figure 1). There were 23 participants:

- 6 elders
- 1 representatives from TG(videographer)
- 1 representatives from WRRB
- 1 fisheries biologists from Golder
- 1 fisheries biologist from DFO
- 1 water quality specialist from WLWB
- 7 youth
- 1 camp cooks
- 1 camp foreman
- 1 youth chaperone
- 2 translators

Water Quality

Surface water samples were collected at a total of five locations upstream (U1 – community water intake, U2 – beach east/upstream of airport) and downstream (D1 – near sewage lagoon, D2 - camp, D3 – downstream of eagle channel near 1st net site) of the community (figure 1). Water at D1 and D3 was sampled by hand from a boat as "grab samples"; the other sites were sampled by wading out from shore primarily due to several consecutive days of poor weather which prevented further sampling from a boat. During field work, the weather was overcast, rainy, and cool (estimated between 0 and 10C).

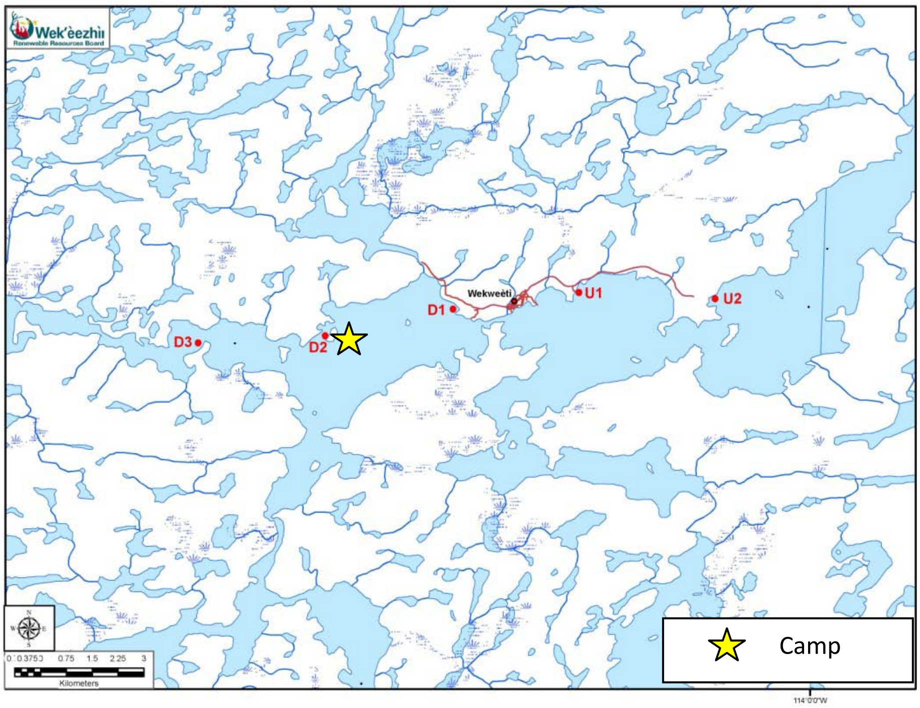

Figure 1 - Water and sediment sample locations

All appropriate QA/QC procedures were followed according to Taiga Environmental Laboratory (Yellowknife) 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.

Samples were immediately placed in a cooler with freezer packs to be kept cool in order 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. The Taiga Environmental Laboratory (Taiga) of AANDC in Yellowknife performed all analyses. Taiga is a member of the Canadian Association of Environmental Analytical Laboratories (CAEAL), a national organization established to ensure consistent laboratory quality assurance.

Sediment Quality

A total of five sediment samples were taken at the same locations as the water sampling sites using an Ekman grab sampler which is suitable for collecting soft, fine grained sediment that is typically observed throughout the watershed. Sediment samples were collected using an Ekman dredge sampler, transferred to a stainless steel tray, then placed into sterile glass jars. Sediment samples were stored in a cooler along with the water samples and sent to Taiga for analysis. If two distinct layers of sediment were captured by the Ekman, they were sampled and submitted for analysis separately. Samples were analysed for standard physical and chemical properties as well as trace metals at Taiga Lab.

Fish Sampling

Nine net sets were completed over the course of the camp on Snare Lake (table 1). A multi-mesh net was used to target multiple sizes of various species of fish whereas 4 and 6-inch nets were used to target larger fish like Lake Whitefish, Lake Trout and Northern Pike. Four additional lake trout were captured and provided by a Wekweètì community member at the end of September as we had not reached our required sample size of twenty for Lake Trout tissue to be tested for metals.

Table 1 - Location, duration and characteristics of net sets

Net set date	Duration (hrs)	Location	Depth (m)	Mesh size (in)
Sept 10, 2012	16	West of camp	3.5 – 5	6.5
Sept 11, 2012	5.5	Channel narrows N of camp	6	Multimesh
Sept 11, 2012	17	Channel narrows N of camp	6	Multimesh
Sept 11, 2012	16.5	SW of camp	4 – 5.5	6.5
Sept 12, 2012	12	Reef island SE of camp	5 – 6.5	6.5
Sept 12, 2012	22	Channel narrows N of camp	12	Multimesh
Sept 12, 2012	22	Shore SE of camp	3 – 4.5	4
Sept 13, 2012	11	Shore SE of camp	3 – 4.5	4
Sept 16, 2012	n/a	Shore SE of camp	3 – 4.5	4

The following standard measurements typical for fish monitoring programs were taken: species identification; length (mm); weight (g); sex, life-stage; reproductive stage; and external and internal health (visual assessment of gross pathology and anomalies). These characteristics can change as a result of changes in water quality and therefore prove to be good indicators. Sagittal otoliths, were processed for aging.

Age estimation was done on otoliths from 20 Lake Trout, 20 Lake Whitefish. Figure 2 shows an otolith and how the annual growth rings can be counted to estimate fish age.

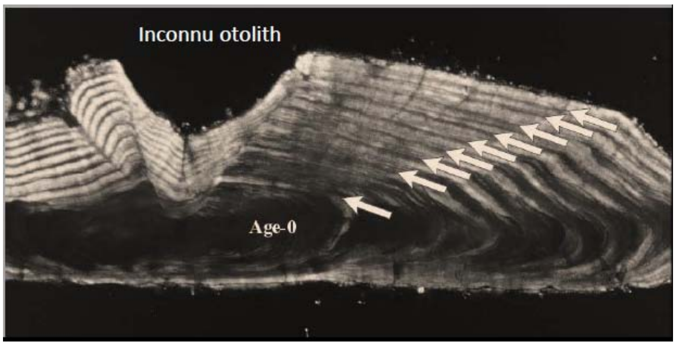

Figure 2 - Example of how otolith layers can be used to age fish[1]

Fish Tissue Analysis

To determine current levels of contaminants in fishes regularly consumed by local communities, we collected fish tissue samples from a top predator (Lake Trout) and an invertebrate feeder (Lake Whitefish). These samples were collected under the guidelines established by Environment Canada for sampling for metals[2]. Twenty samples of Lake whitefish tissue and twenty of Lake trout tissue from fish captured in Snare Lake were sent to ALS Environmental (Vancouver) for total metals analysis including mercury, arsenic and copper (wet weight).

Tłı̨chǫ Knowledge Aquatic Ecosystem Health Datasheet

The Tłı̨chǫ knowledge aquatic ecosystem health datasheet was developed in 2011 through working with Tłı̨chǫ elders from Behchokǫ̀ who participated in the Monitoring Camp as well as a Traditional Knowledge indicators workshop. It has four components:

A. Assessing the health of the aquatic ecosystem
B. Assessing the health of the fish
C. Tłı̨chǫ rules – showing respect for each other
D. Tłı̨chǫ rules – showing respect to animals and the environment

The protocol consists of questions for the youth to engage with their elders and to get them to think about themselves and their relationship with the environment.

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[1] Howland, K., Gendron.M, Tonn. M.T. and R.F. Tallman. 2004. Age determination of a long-lived coregonid from the Canadian North: comparison of otoliths, fin rays and scales in Inconnu (Stenodus leucicthys). Ann. Zool. Fennici 41: 205-214

[2] Environment Canada. 2011. Metal Mining Environmental Effects Monitoring Technical Guidance Document

Reporting Back Workshop

The Reporting Back workshop was held January 14, 2013 in Wekweètì with twelve participants (names and affiliation are given in Appendix 1):

- Five elder camp participants (the sixth was out of town);
- One DFO representative;
- One representative from Golder Associates Ltd.;
- One representative from WRRB;
- Three community of Wekweètì representatives; and
- One translator

Fish tissue results were sent to the GNWT Deputy Chief Public Health Officer, Dr. Kami Kandola who advised on communicating results to the community. Pamphlets on eating fish as a healthy food choice were distributed as well as general information about mercury in fish.

Community Meeting and School Engagement

A public meeting was held in Wekweètì the evening of January 14, 2013. There were approximately 30 people in attendance ranging from school age youth to elders. This included all the elders that had participated in the workshop in the afternoon. We showcased the film produced by Mason Mantla. Sampling results were presented by Paul Vecsei and Deanna Leonard.

Results

Results from each of the project activities are provided below.

Planning Workshops

The Planning Workshop consisted of discussion on elders' interests with respect to what they would like to see monitored and what their concerns were related to water and fish. Participants indicated they would like to see Lake Trout and Lake Whitefish sampled and that they see differences in the size and shape of fish from one end of the lake to the other. Trout are long and narrow at one end and short and fat at the other. Also they indicated the desire to sample more frequently throughout the year. For example, sampling in the spring and fall spawning periods would be good. Four areas to test fish were indicated (figure 3) based on their desire to sample upstream and downstream from the community. The community has sewage discharged after filtering through a wetland and also the community dump is close to the lake shore. Historically, when the town was first settled, garbage was bulldozed directly into the lake.

In the past, people used to fish more frequently than currently. Approximately 40 years ago fish seemed healthy. But there was a point in time (about 20 years ago) when people observed more white cysts/parasites in the flesh of fish being caught in the lake. As a result people stopped fishing and eating fish from the lake. Recently some community members have been setting nets and sharing fish. Today the fish seem to be healthier and fatter. The fish has fewer cysts and is good to eat. Over time, people have observed some abnormalities. In fish found near Winter Lake one was deformed with a big head and small body. It is felt that since the diamond mines were developed, fish, caribou and moose have changed. Observations of long, threadlike worms inside fish have been made. Also pus has been observed in the flesh on the head and backbone.

Participants would like to see more water sampling in each communities. They referred to the program on the Slave River as a good model for a community-based monitoring program. Concern was expressed over Fortune Minerals NICO Project and that perhaps a program could be designed to monitor water quality in that area that might complement the community water sampling programs associated with community water licenses.

An island near the cemetery was chosen as the location for the camp. It is a spiritual site and therefore keeping it clean and behaving appropriately while at camp was important. Having the fish camp at that spot allowed the opportunity to discuss the spiritual leaders and prophets that are important to the Tłı̨chǫ.

It was decided that youth from the community school, Alexis Arrowmaker School, would participate in the camp, grades 7 – 9. The timing of the camp was set for mid- September based on participants schedules and knowledge that most fish species would be abundant during that time.

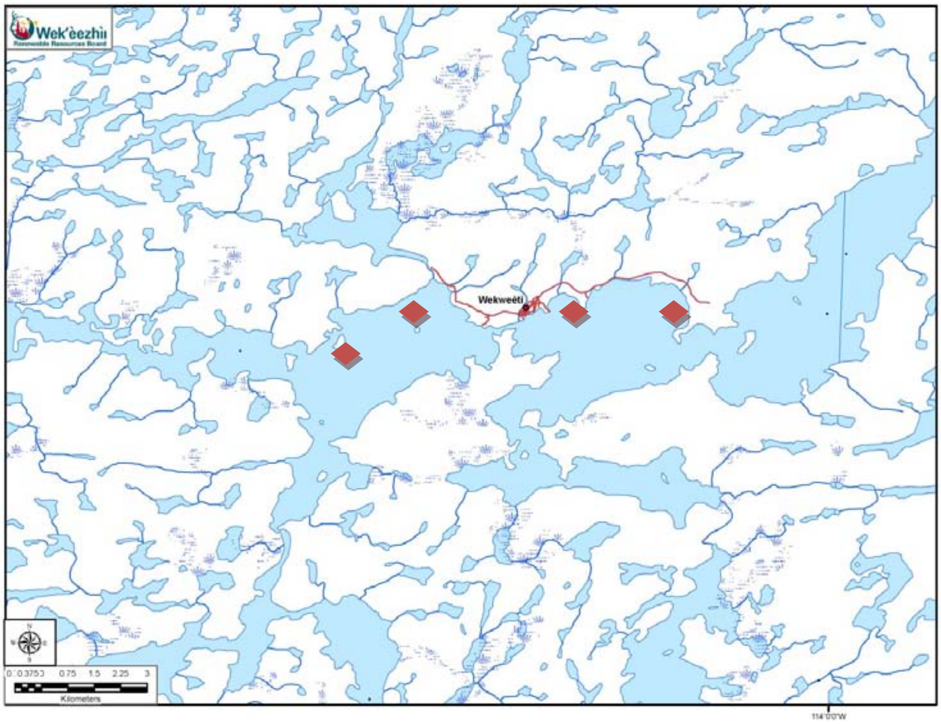

Figure 3 - Desired Fish Sampling Locations Identified in Planning Workshop

Monitoring Camp – Snare Lake

Water Quality

Water quality results were compared to the Canadian Council for Ministers of the Environment (CCME) guidelines for the protection of Freshwater Aquatic Life (FAL). The FAL guidelines are based on a thorough review of information on the toxicity of different water quality parameters, and indicate the concentration of a parameter at 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.

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. Interpretation of travel and field blanks analyses is provided in Appendix 2.

Water quality results for nutrients, physical characteristics, and microbiology are provided in Appendix 3. Overall water quality is good; CCME Guidelines for the Protection of Aquatic Life are not exceeded at any site. Further, Escherichia Coli (E. Coli), the best indicator of fecal contamination[3] was not detected at D1 near the sewage lagoon, suggesting that the lagoon and wetland treatment system is working well.

Results of water quality analysis for metals are provided in Appendix 4. The only occurrences of metal concentrations greater than the CCME guidelines are at sample locations near the shore, in shallow water, where coarse-grained, sandy sediments exist (D2, U1, U2). Key results are discussed below.

At the U2 site, aluminum and iron concentrations marginally exceed the guidelines. Aluminum and iron are both abundant in the lake sediments (shown in Table 3) and the higher concentrations at site U2 correspond to elevated total suspended solids (shown in Table 1), likely due to windy/wavy conditions during sampling.

Results for silver concentration exceed the guideline at the D2, U1and U2 sites. The existing guideline, approved by CCME in 1987, may often be over-protective, because it is based on total silver rather than biologically available silver[4]. Unlike aluminum and iron, silver was not detected in the lake sediment samples; however, the detection limit is much higher in sediment than in water (400µg/kg compared to 0.1µg/kg). Silver can enter water naturally through erosion of rocks and soils and natural silver concentrations commonly exceed the guideline[5]. There is no Canadian drinking water guideline for silver because water contributes negligibly to an individual's daily silver intake – trace amounts of silver in common foods provide most of the daily intake[6].

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[3] Health Canada (2012). Guidelines for Canadian Drinking Water Quality. http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/2012-sum_guide-res_recom/index-eng.php.

[4] British Columbia, Environmental Protection Department (1996). Ambient Water Quality Criteria for Silver: Overview Report. http://www.env.gov.bc.ca/wat/wq/BCguidelines/silver/silver.html.

[5] World Health Organization (1996). Guidelines for Dinking-water Quality, 2nd ed. Vol. 2. *Health criteria and other supporting information.*

[6] Health Canada, 2012

Mercury concentrations at all sites analyzed with both the common and ultra-low-detection limits are displayed in Figure 2, where the difference in detection limits (50 times) can be visualized. Mercury concentration is below the common detection limit at all sites except D2, whereas very small amounts of mercury are present at most sites, based on analysis using the ultra-low-detection limit. The result for mercury at site D2 using the common detection limit is 0.04µg/L; however, an analysis of a second sample shows that the mercury concentration is below the ultra-low-detection limit of 0.0002µg/L (less than 1 part per trillion). These two results do not agree and, therefore, the value of 0.04µg/L is not conclusive. It is possible that the 0.04µg/L result is due to contamination in the field during sampling or at the lab during analysis. Appendix A presents the quality assurance / quality control data from this sampling program and shows that there may be small amounts of mercury contamination during both sampling and analysis.

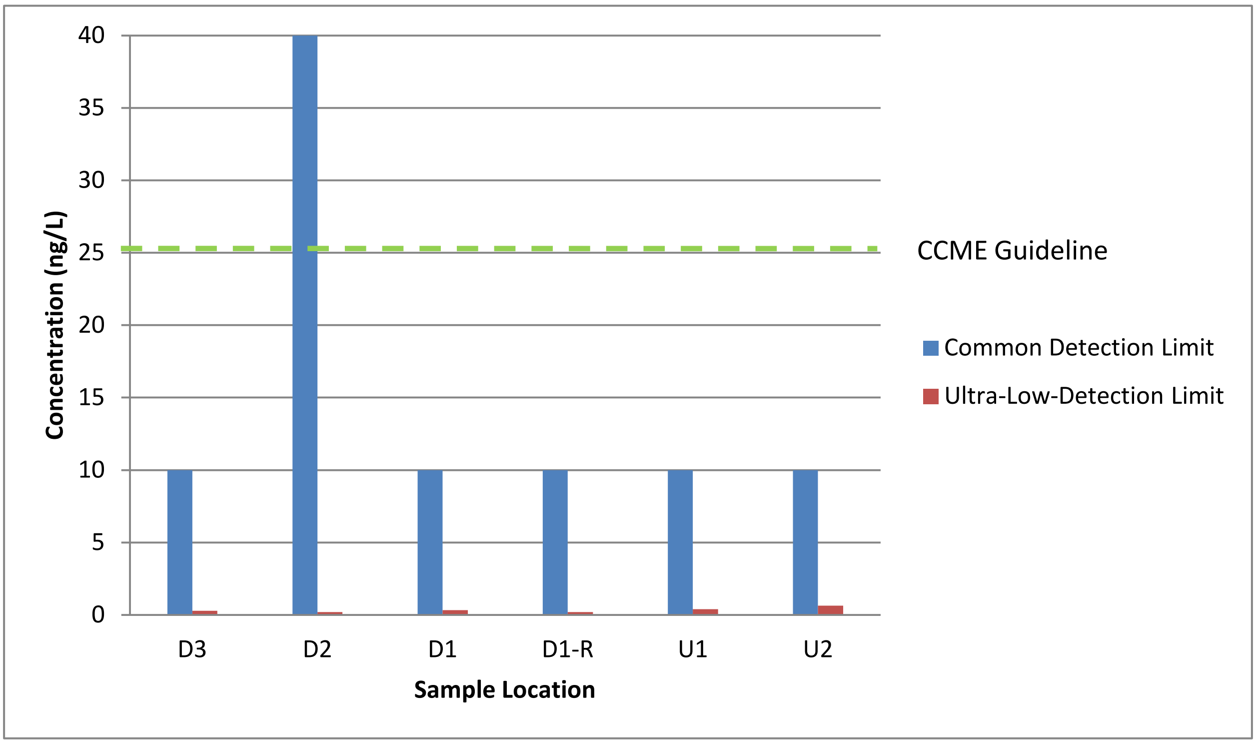

Figure 4 - Mercury concentration in water samples. Analysis with the common detection limit (10ng/L) and with the ultra-low-detection limit (0.2 ng/L). The CCME Guideline for the Protection of Aquatic Life is 26ng/L.

Sediment Quality

Most metals enter water from surface runoff or deposition from the air. Many metals, such as copper, are essential nutrients in aquatic ecosystems, but, at higher concentrations, can potentially harm aquatic life.

Results of sediment quality analysis are shown in Table 3. Two layers of sediment (shallow and deep) were sampled at sites D3 and U2, while replicates (two samples of the same sediment) were sampled at sites D1 and U1. Soil texture (clay, silt, and sand) provides an indication of the type of sediment as well as the depositional environment and depth. Shallow, near-shore areas, such as the beaches sampled at D2, U1, and U2 have relatively coarse-grained, sandy sediment; deeper, off-shore areas, such as sites D3 and D1 have relatively fine grained, silty sediment.

Results show that the CCME guidelines for chromium, copper, and lead are exceeded at one or more sample sites. The average concentrations of these three metals at each sample site are shown in Figure 3 and the results are briefly discussed below. Results for other metals are all less than the CCME sediment quality guidelines.

Chromium concentrations marginally exceed the CCME guideline at sites D1 and D3, corresponding to silty soil (moderate to fine-grained) at these off-shore sampling locations. Concentrations are much lower than the CCME probable effects level, are likely natural, and are unlikely to have an impact on aquatic life.

Copper concentrations exceed the guideline at all sampling locations, but are within the range of natural concentrations in Canadian lakes and streams[7]. Copper, as well as many other metals, is an essential nutrient in aquatic ecosystems, but, at higher concentrations, can potentially harm aquatic life.

The concentration of lead in sediment near the sewage lagoon exceeds the CCME guideline and also exceeds the probable effects level, if the average of the sample (D1) and the replicate (D1-R) is considered (as shown in Figure 3). The concentrations of D1 and D1-R are within the upper range of natural levels[8]. In water, lead concentrations are low – at or below the detection limit.

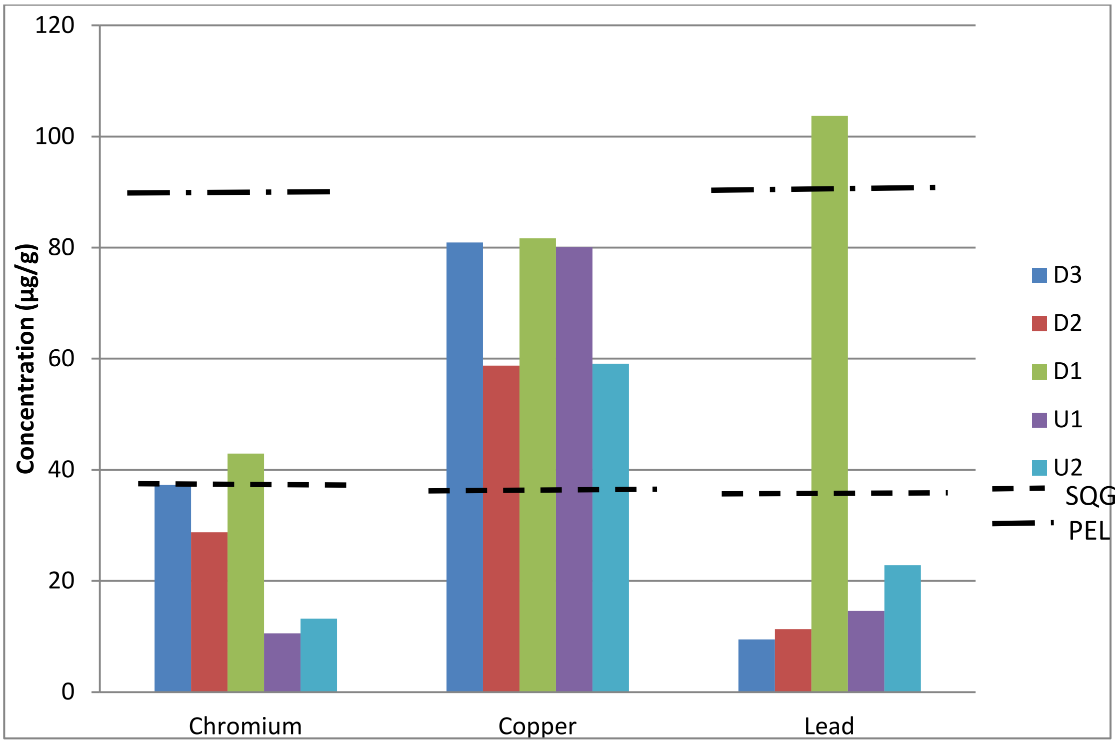

Figure 5 - Average concentrations of chromium, copper and lead in sediment at each sample site. Dashed lines show the CCME sediment quality guideline (SQG); dash-dot lines show the CCME probable effects level for sediment (PEL). The PEL for copper is off the chart (197µg/g)

[7] Canadian Council of Ministers of the Environment (1999). Canadian sediment quality guidelines for the protection of aquatic life: Copper. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.
[8] CCME, 1999

Fish Species diversity

Four species of fish were caught on Snare Lake. Numbers of individuals captured within each species ranged from 3 to 53 (figure 6). Based on the results of our survey, Snare Lake supports a variety of fish species similar to that found in other lakes in the region. Lake Whitefish were the most common species and were captured in a variety of habitats and depths. Round Whitefish appeared less abundant and were more limited in their distribution. The Lake Trout was the most abundant predatory species and co-inhabited most areas with the Lake Whitefish. Northern Pike were rare and limited to shallower backwater habitats. The small-bodied fish fauna of the lake remains largely unknown and could not be effectively sampled with the gear used. For example, Ninespine Stickleback were noted in the stomach contents of predatory fish but none were captured by our multi-mesh gillnets. A summary of the complete fish sampling dataset is provided in Appendix 6.

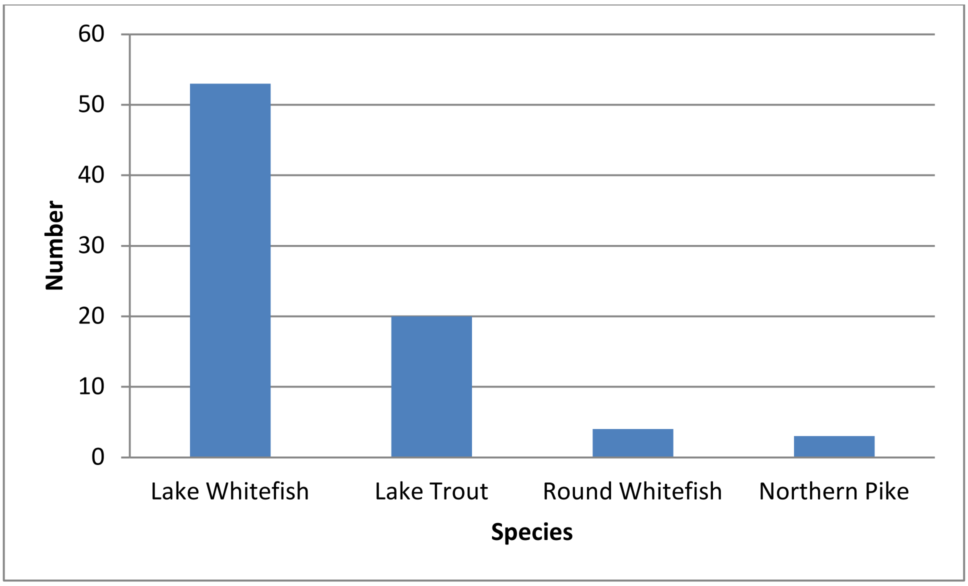

Figure 6 - Species and number of fish captured on Snare Lake

Fish tissue analysis

The full list of metals tested for and results are given in Appendix 7. The larger Lake Trout showed mercury levels that exceeded the Health Canada Guidelines for commercial sales of fish for consumption[9]. Four other Lake Trout exceeded guidelines for consumption but Lake Whitefish samples and the remaining 16 Lake Trout were below the guideline for mercury (figure 7). The large Lake Trout had a mercury measurement of 3.39mg/kg wet weight and is not show on the chart. This fish (sample #45) was 27 years old and weighed 7.5 kg. It was the significantly larger than the other Lake trout and can be considered an extreme outlier.

[9] There are no Health Canada Guidelines for fish caught for recreational or subsistence purposes.

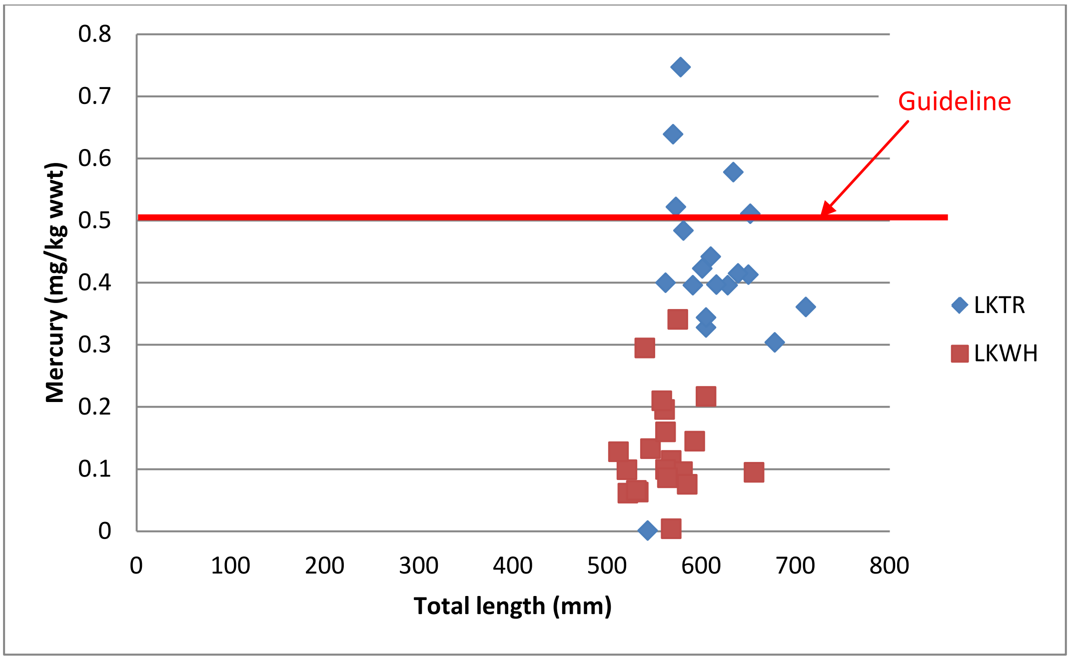

Figure 7 - Mercury levels in Lake Whitefish and Lake Trout tissue sampled from Snare Lake. Twenty samples of each species were analysed and are shown except for one outlier, a Lake Trout that had a value of 3.39 mg/kg wwt.

Fish Growth

A healthy fish population is usually characterized by a steady growth rate while stressed populations often exhibit increasing or decreasing trends in growth[10]. Figure 8 shows the length – age growth curves for both Lake Whitefish and Lake Trout captured in Snare Lake. Growth rate is similar to other lakes in the Northwest Territories but the Lake Whitefish appear to be living longer and hence, grow larger.

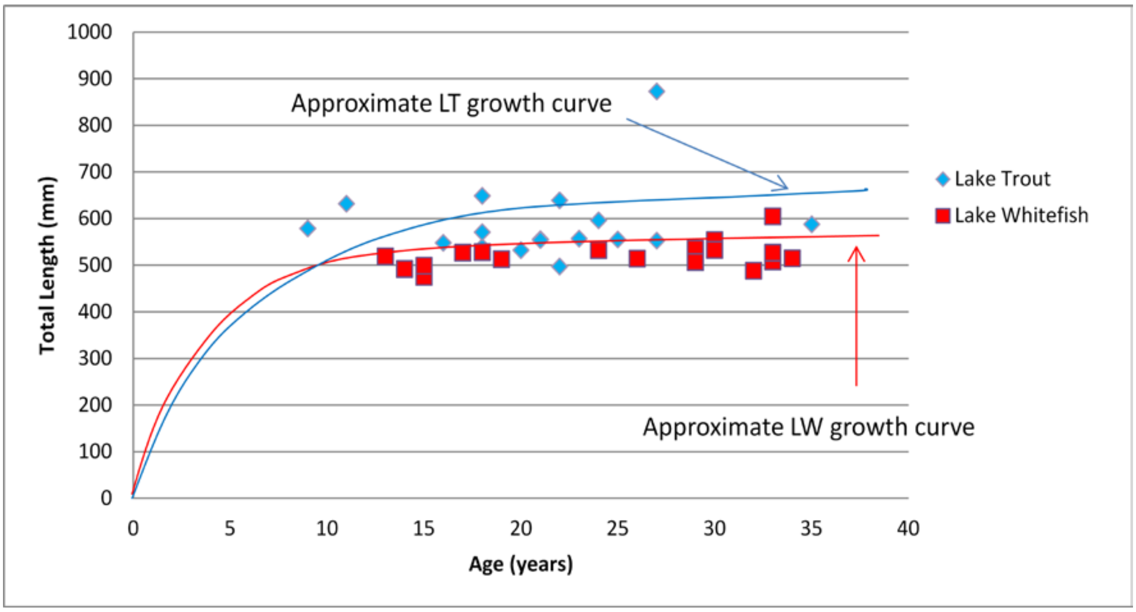

Figure 8 - Length / age relationship in Lake Whitefish and Lake Trout.

[10] Colby 1984

The 2012 monitoring camp served as baseline data collection against which future changes could be measured. In upcoming Snare Lake surveys, change in growth rate of Lake Whitefish and Lake Trout can be an indicator of change in exploitation levels. Current exploitation of Snare fishes is considered low but fishing effort has not been adequately quantified.

Multiple size classes of the four species of fish were captured in Snare Lake. Average size for each species is given in Table 2. On average, Lake Whitefish were older than similar stocks in the Great Slave Lake basin. Their size was correspondingly larger as well.

Table 2 - Average Total Length (mm) of Fish Species Captured in Snare Lake

Species	Number	Average Total length (mm)	Standard deviation
Lake Trout	20	617.3	47.40516849
Lake Whitefish	53	485.0	151.8428613
Northern Pike	3	603.3	239.6024485
Round Whitefish	4	259.3	71.13543421

Maturity refers to the ability to reproduce. Mean age at maturity is a statistic that describes the age at which the "average fish" spawns for the first time[11] . Fish populations that are stressed by excessive harvest and/or changes in habitat may show changes in age at maturity[12] . While we documented sex, maturity and even gonad weight, the mean age at maturity was not quantified since we do not know the age of first time spawners. Trends in mean age at maturity will not likely be examined for the Snare Lake Lake Whitefish stock. Results from the age estimation from fish otoliths are provided in Appendix 8.

Fish Abundance

Abundance is a biological statistic used to describe the quantity of fish in a population. In response to stress, annual abundance often becomes more variable[13] . The use of abundance as an indicator of stock status involves comparing current abundance with some previous baseline condition and examining the range over which abundance varies between years. We plan to make such comparisons in the subsequent Snare Lake surveys, provided sample size is adequate.

Tłı̨chǫ Knowledge Aquatic Ecosystem Health Datasheet

The youth interviewed all the women elders present at the camp as they are typically the ones that cut up and process the fish. None of the youth completed Sections C and D which had to do with their relationship to the land. All interviewees stated that they felt the weather was warmer in recent times than it had been in the past. Although the taste of the water hasn't changed, all interviewees stated that water levels were down from previous levels. The kinds of fish typically captured in Snare Lake include: Lake Whitefish, Lake Trout and Northern Pike. This has not changed from the past. One interviewee has noticed more cysts and parasites in the fish flesh in recent years. In recent years one interviewee said that she has noticed white on the back and lumps on the

[11] OMNR 1983
[12] Colby 1984
[13] Colby 1984

stomach like fish eggs. She doesn't eat the fish when this is present. The women elders said they eat all the fish in the area except if it has too many cysts in the flesh. The fish tastes the best when it is fat in the belly and if it is fresh. They all have observed magpies in the area which are new to the area. None were aware of any plants or animals that have disappeared from the region.

Reporting Back Workshop

The participants of the Reporting Back Workshop were very interested in the results and asked questions of clarification of the Fish biologists present. The issue of mercury contamination was discussed in depth and that the lake whitefish and lake trout from Snare Lake continue to be healthy food choices and do not pose a risk to consumers in the community. Residents of Wekweètì continue to be concerned about potential contamination of their water from nearby mines or future mines that may be built. They fully support continuation of the monitoring program.

Community Meeting and School Engagement

A half day presentation at the school was given to all but the youngest kids. The topics ranged from fish adaptations to their environment to the aquatic food web. Kids were engaged and interested in the presentations and were excited to see the film that was produced at the camp. The presentation ended with an interactive exercise that demonstrated bioaccumulation in the aquatic food web.

The evening community meeting was extremely well attended with most of the audience staying right to the end. The camp film was shown at the start and then a general presentation of the program, monitoring camp and sampling results followed. Questions from the audience centred on the issue of mercury and whether it was safe to continue to eat Lake Trout from Snare Lake. Pamphlets on mercury in fish and fish as a healthy food choice were handed out.

Discussion

The traditional knowledge and scientific data gathered at the monitoring camp form an invaluable baseline against which we can measure change. Interviews with Wekweètì elders documented observations of decreases in water level as well as changes in the abundance of fish parasites. The types of fish they catch has not changed nor their abundance. Elders have observed a new bird species in the area (i.e. magpie) but no plants or other animals.

Overall water quality in Snare Lake is good; CCME Guidelines for the Protection of Aquatic Life are not exceeded at any site. Further, E. Coli was not detected in the water near the sewage lagoon, suggesting that the lagoon and wetland treatment system is working well. The only occurrences of metal concentrations greater than the CCME guidelines are at sample locations near the shore, in shallow water, where coarse-grained, sandy sediments exist.

With respect to the sediments that were sampled, CCME guidelines for chromium, copper, and lead are exceeded at one or more sample sites. Chromium concentrations are much lower than the CCME probable effects level, are likely natural, and are unlikely to have an impact on aquatic life. Copper concentrations exceed the guideline at all sampling locations, but are within the range of natural concentrations in Canadian lakes and streams. And while lead exceeds the CCME guideline as well as the probable effects level, concentrations of lead in the water are low – at or below the detection limit.

While a relatively small number of fish were captured certain trends were apparent. Lake Whitefish were the most abundant in our catches since the lake has suitable habitat and food typically required by lacustrine benthic invertebrate-feeders. Their size was unusually large and individuals were among the longest lived when compared to other populations sampled elsewhere in the Northwest Territories. They achieved this greater size because they were so long-lived. Based on the size and age of the individuals we captured, it is apparent that Snare Lake Whitefish are not over-exploited by community subsistence fishing.

Lake Trout were relatively abundant and almost as widespread as the Lake Whitefish. Growth (size at age) appeared typical for a northern population in a mid-sized lake. Due to small sample size and the discrepancy between the largest individual and the considerably smaller size of the rest of the samples, no definitive conclusion can be made on the effects of exploitation. However, based on discussion with community members, subsistence fishing appears to be of low intensity and only periodic.

Other fish species such as Round Whitefish and Northern Pike were caught in too small numbers to make any worthwhile conclusions concerning their life history or their overall abundance in Snare Lake. Also, it should be noted that our sampling was limited to a few areas in one part of the lake.

The fish tissue analysis showed that mercury levels are relatively low except in the larger Lake Trout. Lake Trout is a predatory fish and as such bioaccumulates mercury as it consumes prey. Small to moderate sized Lake Trout were within Health Canada guidelines and do not pose a health risk. All samples of Lake Whitefish tissue had very low amounts of mercury.

Conclusions and Next Steps

The bringing together of Tłįchǫ elders, youth and scientists provides a unique opportunity to share traditional and modern ways of understanding and learning about the environment and the changes that are occurring. Understanding how these changes might be related and what we can expect going into the future will benefit from collaborative projects such as this that bring together science and traditional knowledge in a way that can educate us all on environmental issues.

Annual implementation of the program through the consistent use of the monitoring protocols refined this year and will be key in achieving the main goals of long-term monitoring: detecting change over time and space.

Recommendations

It is recommended to add questions to the Traditional Knowledge Aquatic Ecosystem Health Datasheet that relate to consumption habits. This would help identify health risks when mercury is detected in the sampled fish. Some questions could be:

- How many people in your community set fishing nets?

- How many households in your community eat fish on a regular basis?
- How often do you eat fish?
- How often do you fish?
- How many fish do you usually catch?
- What time of year do you fish?
- What types of fish do you most commonly eat?
- Is there anything you want to tell us about the fish and water?

Appendix 1 – Project Participants

Planning Workshop 1 - Participants

Elders from Wekweeti
Joseph Judas
Isadore Washee
Mary Rose Boline
John Smallgeese
Noella Kodzin

Other community members
Virginia Lamouelle
Nick Lamouelle

Elder from Behchoko
Harry Apples

Tłįchǫ Government
Adeline Football

Wek'èezhìi Renewable Resources Board
Karin Clark

Translators
Jonas Lafferty

Planning Workshop 2 - Participants

Elders from Wekweeti
Madeline Judas
Marie Adele Football
Isadore Washee

Other community members
Joe Dryneck
Bobby Pea'a
William Quitte

Wek'èezhìi Renewable Resources Board
Karin Clark

Translators
Jonas Lafferty

Monitoring Camp Participants

Elders from Wekweeti
Jimmy Kodzin
Noella Kodzin
Madeline Judas
Joseph Judas
Marie Rose Boline
John Smallgeese

Camp Cook/Workers
Bessie Pea'a
Noel Quitte

Wek'èezhìi Renewable Resources Board
Karin Clark

Department of Fisheries and Oceans
Deanna Leonard

Golder Associates
Paul Vecsei

Translators
Jonas Lafferty
James Rabesca

Youth
Mackenzie Tsatchia
Lilah Judas
Logan Judas
Trent Rabesca
Justin Tsatchia
Beazoa Football
Nathanial Tom

Chaperone
Pamela Lamouelle

Reporting Back Workshop Participants

Elders from Behchokǫ̀
Jimmy Kodzin
Madeline Judas
Joseph Judas
Marie Rose Boline
John Smallgeese

Department of Fisheries and Oceans
Deanna Leonard

Other community members
Pamela Lamouelle
Noel Quitte
Bessie Pea'a

Golder Associates
Paul Vescei

Wek'èezhìi Renewable Resources Board
Karin Clark

Translators
James Rabesca

Appendix 2 – Results from Water Quality Travel and Field Blanks

Appendix 3 – Surface Water Physical and Nutrient Analysis Results

Appendix 4 – Surface Water Metal Analysis Results

Appendix 5 – Sediment Metals Analysis Results

Appendix 6 – Fish species diversity, length and weight

Appendix 7 – Metals analysis for fish tissue samples

Appendix 8 – Age analysis for fish otolith samples