Mercury concentration in fish from the Inukjuak River watershed and nearby lakes collected in the summer of 2019

A technical report on laboratory determination of total mercury in fish and statistical analysis

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October 2019

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Acknowledgements

The author thanks Pituvik Landholding Corporation of Inukjuak, Innergex Renewable Energy Inc., Pesca Environnement and local helpers from the community of Inukjuak for providing the fish samples and for recording bio-data for this study. Special thanks are also bestowed to Mr. Peter May of Nunavik Research Centre for his efforts and expertise in age determination of the fish samples. Funding for this study was kindly provided by Innavik Hydro SEC.

Summary

A standard operating protocol (SOP 004M) based on the cold vapour atomic absorption spectrometry (CVAAS) technique developed and optimized at Nunavik Research Centre was used in total mercury determination of 518 muscle samples from 259 fish collected in the summer of 2019 from 11 locations at the Inukjuak River watershed and nearby lakes: 88 brook trout, 101 lake whitefish, 69 lake trout and 1 landlocked Atlantic salmon.

In the standard operating protocol, muscle samples of fish were digested using a two – stage mixed – acids procedure to render organically bound mercury to be converted to mercuric (II) ions which were then chemically reduced to ground state mercury atoms using a acidic solution of tin (II) chloride as a strong reductant in a closed reaction system. Argon gas carried the free mercury atoms into a quartz cell situated in a spectrometer for atomic absorption quantification of the total mercury concentration present in the digested fish tissues.

A stringent quality assurance and quality control protocol was applied to all sessions of analysis to ensure analytical precision and analytical accuracy were always within pre-determined acceptable limits. For each batch of fish samples prepared for analysis: (1) at least two certified reference materials (CRMs) of matrices similar to the samples were included to check for analytical accuracy; (2) reagent blanks and sample blanks were included to check for contamination; and (3) each sample was prepared in duplicate for analysis and each of the two replicates was analyzed in duplication to check for analytical precision.

Seven lake trout and one brook trout out of the 259 fish analyzed were found to have total mercury concentrations exceeded the Health Canada's mercury safety guideline (0.5 µg/g w.w.) for fish destined for commercial consumption (Health Canada 2007). However, 73 fish were found to have mercury concentration above 0.2 µg/g w.w., a guideline recommended for applying to frequent fish consumption on a subsistent basis.

Fish age of the 259 fish samples were determined by examination of fish scales and/or otolithes. The relationships between fish growth parameters (age, length and weight) and total mercury concentration of each fish species were investigated. Strong positive correlations between mercury

concentration and the three fish growth parameters were found for lake trout, brook trout and lake whitefish. Linear regression models of fish mercury concentration on fish age were examined and the predictive power of fish age on mercury concentration for different fish species and different aquatic ecosystems was evaluated.

Purpose of the Investigation

This investigation has generated a very comprehensive data set of mercury concentration of fish from the Inukjuak River watershed prior to the construction phase of the Innavik hydro-power project. The data represent the background baseline mercury concentrations of the three indigenous fish species inhabiting the watershed: brook trout, lake trout and lake whitefish. A comparison of such data set with that would be obtained in the future well after the hydro-power plant has been installed and operational might provide useful information to address the question of possible influence of the construction and operation of the hydro-power plant on the mercury status of fish in the Inukjuak River watershed.

It is well known that large-scale flooding and long-term submersion of vegetated lands might increase bioavailability of naturally occurring mercury to aquatic food chains through an increase in the microbial – mediated methylation of inorganic mercury present in the submerged soils and vegetation. Human activities such as reservoir and dam construction often result in flooding and submersion of vegetated lands. The effect on methylation and the opposing process of demethylation depends on a whole myriad of physicochemical variables specific to the affected ecosystem, these include concentrations of various inorganic chemical ligands especially sulfide and sulfate as well as organic ligands such as humic and fulvic acids; the natural amount of mercury present in the bedrock; the amount of dissolved organic carbons, dissolved oxygen, temperature, acidity, redox potential of the benthic substrate, etc. These variables are often interacting in complex manners in influencing the rate of methylation, the rate of demethylation and the steady state equilibrium of these two processes. However, the outcome of an effect on methylation and demethylation is often manifested as changes in the mercury status of fish living in the aquatic ecosystem affected because the changes of bioavailability of mercury resulting from a change in methylation and demethylation which in turn affect the dietary intake of mercury by fish at the upper end of aquatic food chains. Changes in mercury status of these fish have important public health implications to the community of Inukjuak that relying on them for subsistent harvest.

Fish Samples

Fish samples were collected by a field technician from Global WSP Inc. with the help of members of the community of Inukjuak from eleven locations (see map on page 16) in the watershed of the Inukjuak River and nearby lakes in the summer months of 2019 using gill nets. Bio – data such as length (total and fork lengths), weight, sex and maturity were recorded for each fish (see Appendix B). Otolithes and scales were collected for age determination. Muscle samples, otolithes and scales of 259 fish (88 brook trout, 101 lake whitefish, 69 lake trout and 1 landlocked Atlantic salmon) were shipped to Nunavik Research Centre in Kuujjuaq for total mercury analysis and fish age determination in August 2019.

Acid Digestion of Fish Samples

A two-stage acid digestion procedure was used to prepare the fish samples for total mercury analysis: The first stage used nitric acid to solubilize the fish muscle samples and the second stage used a strongly oxidizing mixture of hydrogen peroxide, nitric acid, sulfuric acid and hydrochloric acid to convert organically bound mercury in the solubilized samples quantitatively and completely into mercuric (II) ions.

First stage (primary) digestion: Between 2 and 2.6 grams (weighed to 0.001g accuracy) of each sample was weighed into a 2.5 x 15cm borosilicate glass test tube (Tissue Culture Grade). Six mL of 70% w/v nitric acid (Trace Metal Grade) was added to each tube and a glass bulb condenser was used to cover each tube (see photo 1). The samples were left at room temperature in a fume hood overnight pre-digesting in the nitric acid. The test tubes were then transferred to a 78 ± 2°C aluminum heating block unit for 6 hours. After this primary digestion stage which solubilized all solid, the samples were allowed to cool to room temperature. The contents of each test tube were then transferred to a 15 - mL capacity graduated polypropylene centrifuge tube using a long (22cm) polyethylene transfer (Pasteur) pipette. Ultrapure water (≥ 18.2 MΩ-cm, Type I) from a wash bottle was used to rinse off the test tubes three times and the rinsing was transferred with the pipette into the 15 - mL centrifuge tube until a 13 - mL volume was reached. The centrifuge tubes were capped and the primary digests were stored at room temperature. At this stage the primary digests were stable and could be archived for later use (photo 2).

Second stage (secondary) digestion: Although the solid fish muscle tissues were solubilized after the primary digestion with nitric acid, much of the mercury present in the primary digests were still organically bound and would not respond to the tin (II) chloride reduction reaction used in the CVAAS technique unless they were first completely broken down and converted to mercuric (II) ions which could then be reduced by tin (II) chloride into ground – state mercury atoms for the CVAAS technique to quantify. The relatively low melting and boiling points of mercury restricted the maximum digestion temperature that was suitable for use without risking loss of mercury from the samples via evaporation. A strongly oxidizing mixture of concentrated nitric, sulfuric and hydrochloric acids together with hydrogen peroxide was found to be able to completely convert all organic mercurial to mercuric (II) ions at a relatively low temperature of 78 ± 2°C without losing mercury from the sample.

A one -mL aliquot of each primary digest was further subjected to a more vigorous mixed – acid oxidation prior to total mercury determination: 0.4 mL of 70% w/v nitric acid and 0.2 mL of 30% w/v hydrogen peroxide solution (Certified ASC Plus, Fisher Scientific) were added to a 1 – mL aliquot of primary digested sample in a 1.3 x 10cm borosilicate glass test tube (Tissue Culture Grade). The test tubes were placed in an aluminum heating block at 78 ± 2°C for two hours (photo 3). They were then allowed to cool to room temperature and 0.4 mL concentrated sulfuric acid (95.0 – 98.0%, Certified ASC Plus, Fisher Scientific) and 0.2 mL concentrated hydrochloric acid (36.5 – 38.0%, Certified ASC Plus, Fisher Scientific) were added to each tube. The samples were swirled to mix and were returned to heating at 78 ± 2°C for further 3 hours. After cooling, 3 mL of 2mM potassium dichromate in 10% v/v hydrochloric acid solution was added and the content of each tube was thoroughly mixed with a vortex mixer. The secondary digests were analyzed for total mercury by the CVAAS technique on the same day. If the secondary digests were not to be analyzed immediately, they could be stored in refrigeration for no longer than 24 hours before being analyzed.

Analyte recovery of this two – stage acid digestion procedure was tested using a standard spike recovery test by digesting one mL of 80 µg/L mercury as methylmercury chloride in 10% v/v nitric acid standard solution with the primary through secondary acid digestion procedure which theoretically should give a final concentration of 1.28 µg/L mercury in the final secondary digest assuming a 100% recovery. The digestion procedure consistently resulted in no lower than 96% recovery of the spiked analyte which was sufficient to validate the digestion procedure.

Cold Vapour Atomic Absorption Spectrometric Mercury Analysis

CVAAS techniques have been used as the standard/ reference technique for mercury analysis of environmental samples for the last several decades by many national laboratories: For example: U.S. EPA Method 245 (U.S. EPA 1994), AOAC Official Method 971.21 (AOAC 1999), CFIA Manual of Chemical Methods (CFIA 1999). A standard operating protocol (SOP 004M) based on the cold vapour atomic absorption spectrometry (CVAAS) technique developed and optimized in 1998 at Nunavik Research Centre has been routinely used in total mercury determinations of a wide range of biological sample matrices. SOP 004M was used in total mercury determination of these fish samples.

A model PinAAcle 900Z™ atomic absorption spectrometer (Perkin Elmer Inc.) equipped with an electrodeless discharge (EDL) mercury lamp and a model FIAS – 100™ flow injection system (Perkin Elmer Inc.) were used for total mercury determination of the acid digested fish samples (photos 4 & 5). Automation was achieved by using a model AS – 90 autosampler ™ (Perkin Elmer Inc.) and interfacing the system with a personal computer running the AAWinLab

™ version 2.3 software (Perkin Elmer Inc.) (photo 6). The entire automated CVAAS process facilitated a high sample throughput. A 10% w/v tin (II) chloride (A.C.S. Grade) in 30% v/v hydrochloric acid (Trace Metal Grade) was used as the reductant reagent (6 mL / minute flowrate) and a 10% v/v hydrochloric acid as the carrier (10 mL / minute flowrate). The reductant reagent was freshly prepared for each session of analysis. The use of a relatively high concentration of reductant reagent further ensured a complete atomization of mercury in the digests. Normal calibration method using a standard linear plot was used in quantitation of the absorbance signals. Mercury standard solutions used in the calibrations were prepared freshly for each session of analysis using a 1000 – mg /L commercially available mercury standard solution (Fisher Scientific Ltd.) diluted with a mixed – acid matrix in match with the matrix of the digested samples. A typical range of mercury standard solutions used in normal linear calibration was 0.5 to 20.0 µg / L within this range where Beer's Law hold. Appendix A listed out various parameters used in the CVAAS method which has been developed, optimized and routinely used at the analytical lab. of the Nunavik Research Centre for mercury analysis of various wildlife tissue samples. Optimization of various parameters was achieved with the aim of maximizing analytical sensitivity without sacrificing analytical precision to an unacceptable extent (i.e. less than 10% relative standard deviation of variations of signals). With a 500 µL sample injection loop (IL, photo 7), characteristic mass achieved was consistently between 180 and 210 picograms / 0.0044 absorbance – second. Analytical detection limit was around 0.42 µg/L. For a standardized 2.000 grams w.w. fish muscle sample, the sample detection limit was 0.003 µg / g wet weight (w.w.).

The ground – state mercury atoms generated inside the Chemifold ™ mixing block (CMB, photo 7) of the FIAS – 100 where the digested sample came in contact with the tin (II) chloride reductant reagent which transferred into the gas / liquid separator (GLS) via the stripping coil (SC) was carried by a constant stream of argon gas (99.999% purity) at a flowrate of 50 mL / minute through the sample transfer capillary tubing (ST) into the quartz cell (QC, photo 8) for spectrometric quantification of mercury. A "Read Delay" of 4 seconds and a BOC (baseline offset correction) of 3 seconds were used to capture the entire signal peak with optimal analytical sensitivity. The argon gas flowrate was minimized to 50 mL / minute in order to maximize the residence time of the mercury atom cloud in the quartz cell so as to maximize analytical sensitivity since residence time is inversely proportional to the influx or efflux rate of the mercury atom cloud. The relatively low argon flowrate ensured a sharp narrow signal peak. The density of mercury atoms present in the quartz cell is inversely proportional to the intensity of the radiation of resonant wavelength (λ = 253.7nm) that passes through the monochromator and reaching the detector diode from the EDL lamp; hence it is proportional to the mercury concentration in the sample. Further reduction of argon flowrate was found to have a negative effect on analytical precision. The stripping coil was lengthened from the default 10 cm to 25 cm to optimize sensitivity. The reaction coil/loop (RC, photo 7) in which the digested sample and the tin (II) chloride reductant reagent mixed was lengthen from its default 10cm to 21cm to prolong contact time and ensured a more thorough mixing. This also help to ensure a complete atomization of mercury in the digested sample. The waste outlet (W photo 7) from the gas / liquid separator (GLS) was set at a flowrate that was just enough to prevent liquid started appearing in the sample transfer capillary tube leaving the gas / liquid separator. Too high a waste outlet flowrate would cause a loss of sample vapour which contains mercury atoms to waste instead of going to the quartz cell.

Since the kinetics of atomization in the CVAAS technique was not affected by chemical or matrix interference during the detection phase of the process taking place in the quartz cell so long as a complete quantitative conversion of organically bound mercury to mercuric (II) ions was ensured in the sample digestion stage and the tin (II) chloride reduction stage, peak height measurement of the absorption signal was used instead of peak area for quantifying mercury concentration present in the digested samples (photo 6). Peak height of an absorption signal was far less prone to slight fluctuation of the baseline than peak area, hence a better analytical precision and a lower analytical detection limit were ensured. In the present analytical protocol, a peak height smoothing value of 19 points was used to achieve an optimum signal magnitude and analytical precision, as too low a smoothing value could reduce analytical precision and too high a smoothing value could lead to a decrease in signal magnitude.

Calculation of mercury concentration in the fish samples

$$M = \{(m \div 1000 \times fv_2 \times D) \div p\} \div w$$

where:

M = mercury concentration in the fish sample, μg /g fresh weight

m = mercury concentration in the sample digest measured by the CVAAS analysis, μg /L.

fv_2 = total volume of the secondary acid digest, mL.

D = dilution factor of the secondary acid digest prior to CVAAS analysis.

p = portion of the primary acid digest used in secondary digestion, which is $1/ fv_1$, since one mL aliquot of the primary digest was used for the secondary digestion.

fv_1 = total volume of the primary acid digestion, which is 13 mL in this case.

w = fresh weight of fish sample used in the primary digestion, grams.

Quality Assurance

A stringent quality assurance and quality control protocol was applied to every session of analysis to ensure analytical precision and analytical accuracy were always within pre-determined acceptable limits; hence to assure the results have a high probability of being of acceptable quality:

(1) **Analytical Accuracy (AA):** For each session of analysis, at least two certified reference materials (CRMs) with matrices similar to the samples were processed and analyzed in an identical manner as that applied to the samples to check for analytical accuracy (Table 1, figure 1). The CRMs were analyzed in the beginning and at the end of each session of analysis. A recovery of the analyte to within 10% of its certified value was used as a criterion for the validation of the session of analysis (as recommended by the U. S. EPA). Using this well tested and optimized SOP 004M standard protocol, all CRMs were found to have achieved a recovery of the analyte to within 10% of their certified values in all sessions of analysis. In CVAAS

technique, the use of CRMs is particularly useful to check if organically bound mercury has been completely converted to mercuric (II) ions during the acid digestion stage.

Table 1. Certified reference materials used in CVAAS mercury analysis.

Certified Reference Material	Source, year	Certified total mercury concentration, µg / g dry weight	Material composition
DORM 2	National Research Council Canada, 2002	4.64 ± 0.26	Freeze - dried and powdered dogfish muscles
DOLT 2	National Research Council Canada, 2002	2.14 ± 0.28	Freeze – dried and powdered dogfish liver
DORM 4	National Research Council Canada, 2016	0.412 ± 0.036	Freeze – dried and powdered fish protein
CRM 422	Community Bureau of Reference, Brussels, 1992	0.559 ± 0.016	Freeze – dried and powdered cod fish muscles

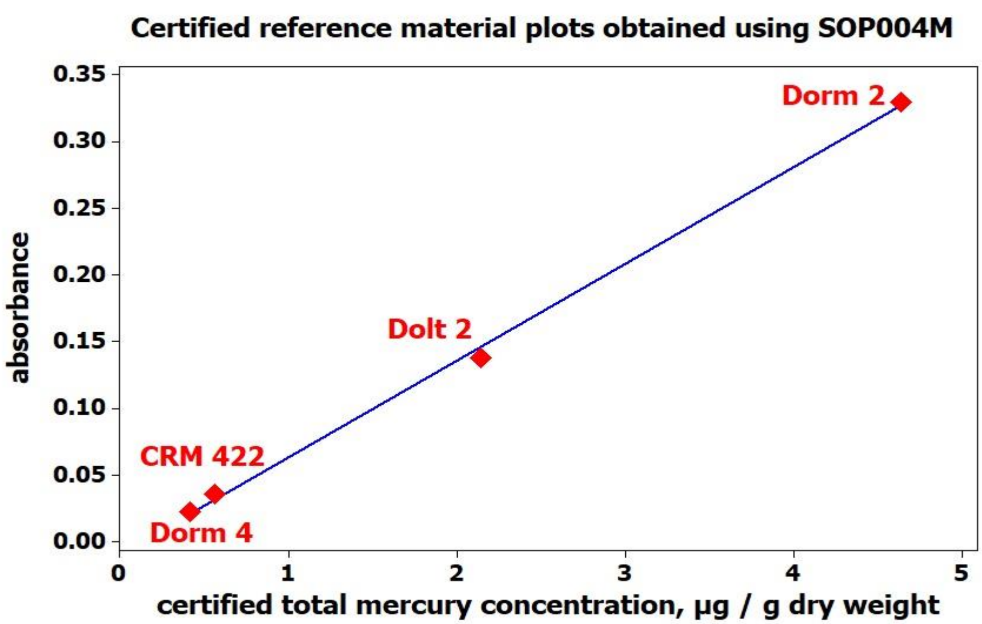


Figure 1. Certified reference material plots.

(2) **Analytical Precision (AP) and replication of sample digestion and analysis:** Each fish sample was prepared and digested in duplication. Each of the two replicates from one fish was analyzed in duplication. The mean value of the two measurements

performed for each digested sample (instrumental AP) was accepted only when the relative standard deviation (RSD, %) of the two measurements was less than 10%. Then, the RSD of the mean values of the two replicated digested samples from the same fish sample was calculated. The RSD of the two replicates of each fish was under 10% for all the 259 fish analyzed (Table 3); hence the mean values of the two replicates of all fish analyzed were accepted as valid.

(3) **Contamination check:** For each session of analysis, digestion blanks in duplicate were processed and analyzed in an identical manner as that applied to the samples to monitor contamination during acid digestion and subsequent preparation of the digested samples for analysis. The analysis session was deemed invalid if signals of any one of the two digestion blanks that were higher than the absorbance corresponding to the analytical detection limit of the analyte. No contamination was found in all sessions of analysis.

Photo 1. First stage (primary) acid digestion of fish samples.

Photo 2. Primary acid digests of all 259 fish samples in duplicates.

Photo 3. Second stage (secondary) acid digestion.

Photo 4. Perkin Elmer PinAAcle 900z™ atomic absorption spectrometer with quartz cell and heating mantle set up with Perkin Elmer FIAS – 100™ flow injection unit for CVAAS mercury analysis.

Photo 5. Perkin Elmer FIAS – 100™ flow injection unit with Perkin Elmer AS90™ autosampler set up for automated CVAAS mercury analysis.

Photo 6. Perkin Elmer AAWinLab version 2.3™ software used for CVAAS mercury analysis.

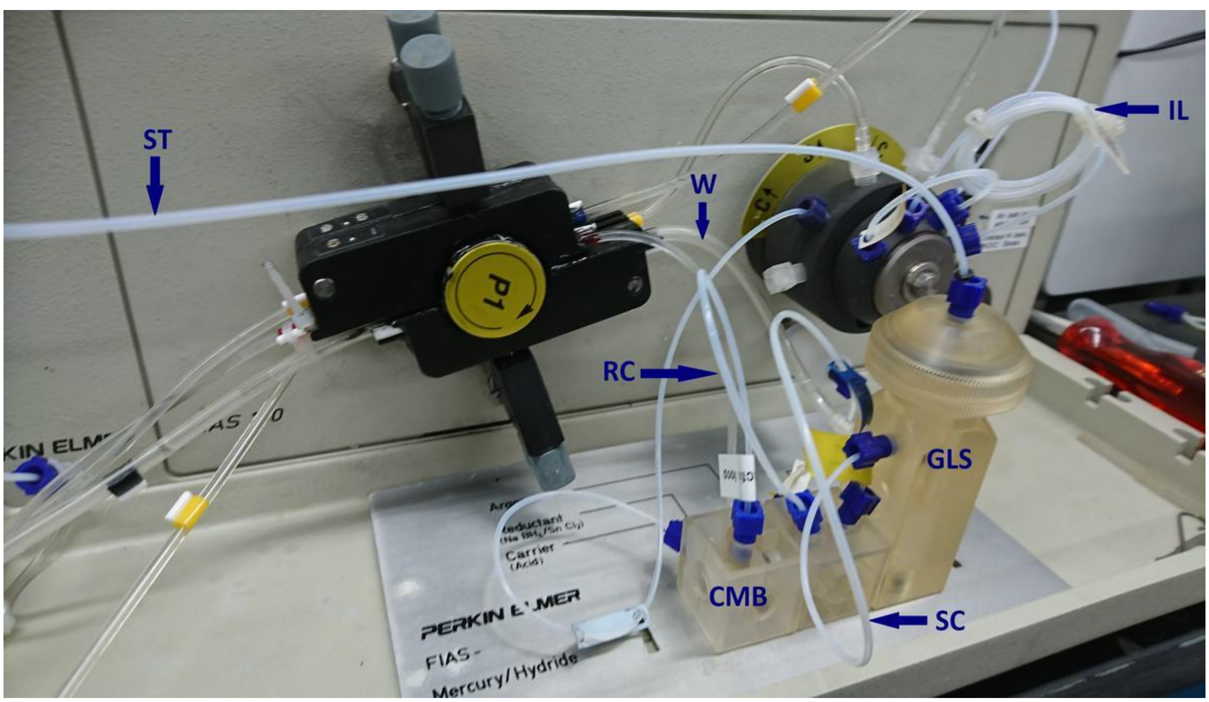


Photo 7. Details of the Perkin Elmer FIAS – 100™ flow injection system.

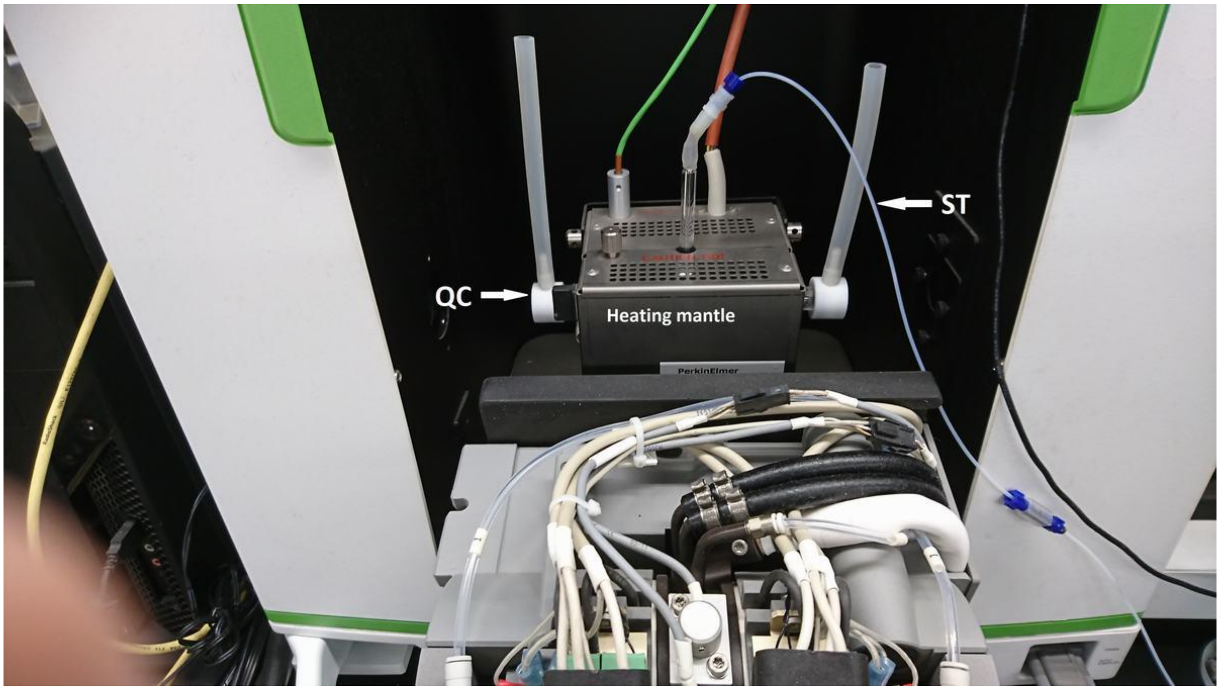


Photo 8. The sample transfer capillary tubing (ST) connecting the FIAS -100™ flow injection system to the quartz cell (QC) situated in the PinAAcle 900z™ atomic absorption spectrometer.

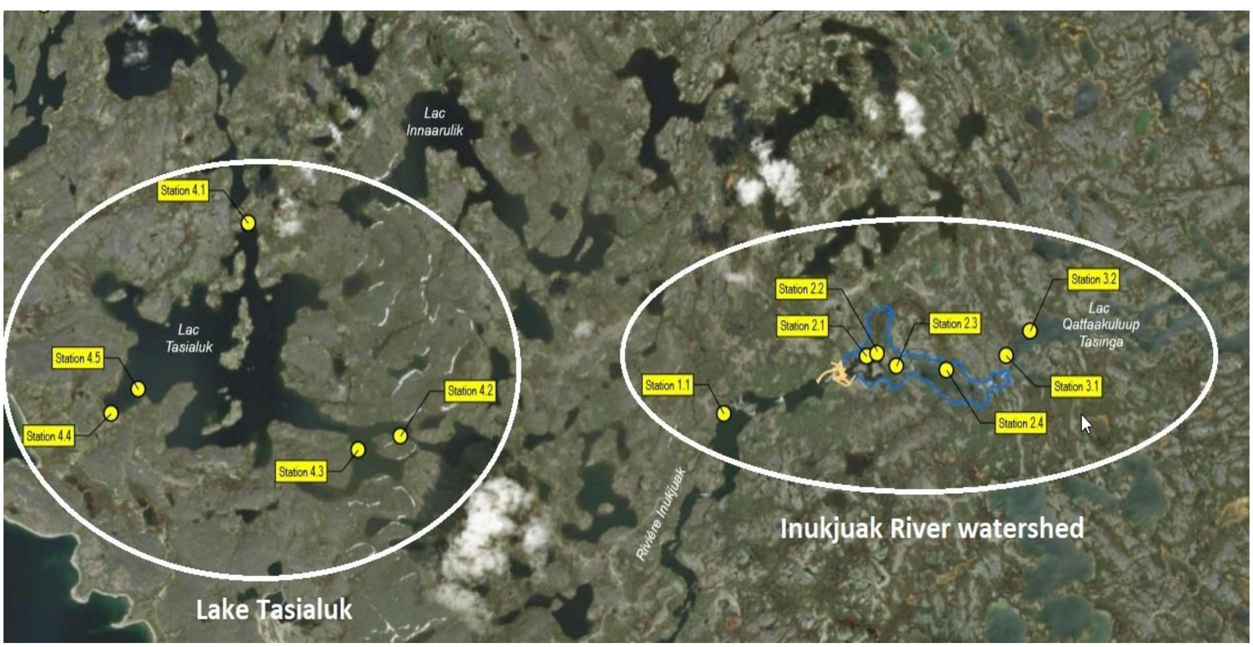
Total Mercury Concentration in Fish:

Table 2 summarized the range of total mercury concentration and the range of age of lake trout, brook trout and lake whitefish collected from the Inukjuak River watershed and lakes nearby for this study. Table 3 detailed the entire data set of total mercury concentration and age of the 259 fish examined.

Table 2. Range of total mercury concentrations and range of fish age of lake trout, brook trout and lake whitefish analyzed for total mercury.

Fish species (number of samples)	Range of total mercury concentration, µg / g w.w.	Range of fish age, years
Lake Trout (n = 69)	0.088 – 1.59	3 - 17
Brook Trout (n = 88)	0.041 – 0.577	2 - 8
Lake Whitefish (n = 101)	0.037 – 0.424	3 - 14

Mercury concentrations of the three fish species from stations 1, 2 and 3 were grouped together as "Inukjuak River watershed" samples. These were compared with those from station 4 (Lake Tasialuk):



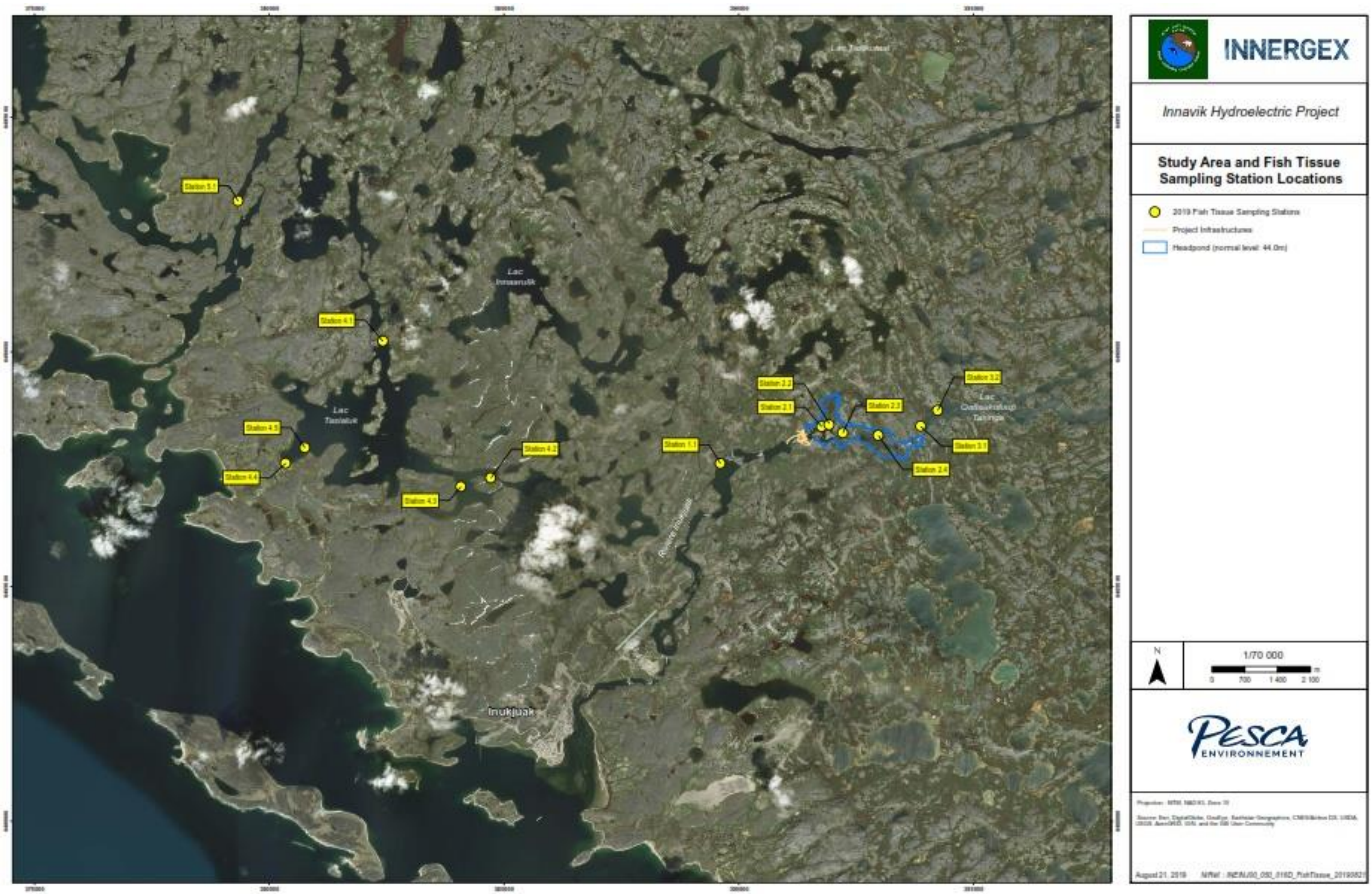

INNERGEX
Innavik Hydroelectric Project
Study Area and Fish Tissue Sampling Station Locations
2019 Fish Tissue Sampling Stations
Project Infrastructures
Headpond (normal level: 44.0m)
N
1/70 000
0 700 1 400 2 100
m
PESCA ENVIRONNEMENT
August 21, 2019
Station 1.1
Station 2.1
Station 2.2
Station 2.3
Station 2.4
Station 3.1
Station 3.2
Station 4.1
Station 4.2
Station 4.3
Station 4.4
Station 4.5
Station 5.1
Lac Innaarulik
Lac Tasialuk
Inukjuak

Table 3. total mercury concentration (µg / g w.w.) of 259 fish collected from the Inukjuak River watershed and nearby lakes.

				Total mercury concentration, µg/g w.w.				
Habitat	# sub-station ID	# Fish ID	Common Name	Replicate 1	Replicate 2	Mean	Relative Standard Deviation, %	Fish age, years
Inukjuak River	1.1	1	Lake trout	0.212	0.211	0.212	0.334	7
Inukjuak River	1.1	2	Brook trout	0.236	0.241	0.239	1.484	7
Inukjuak River	1.1	3	Brook trout	0.205	0.214	0.210	3.036	5
Inukjuak River	1.1	4	Brook trout	0.077	0.077	0.077	0	4
Inukjuak River	1.1	5	Brook trout	0.17	0.166	0.168	1.685	5
Inukjuak River	1.1	6	Brook trout	0.138	0.144	0.141	3.007	5
Inukjuak River	1.1	7	Brook trout	0.198	0.194	0.196	1.444	(a)
Inukjuak River	1.1	8	Brook trout	0.135	0.139	0.137	2.066	6
Inukjuak River	1.1	9	Brook trout	0.108	0.114	0.111	3.82	4
Inukjuak River	1.1	10	Brook trout	0.237	0.246	0.242	2.634	7
Inukjuak River	1.1	11	Brook trout	0.202	0.203	0.203	0.349	6
Inukjuak River	1.1	12	Brook trout	0.099	0.096	0.098	2.174	6
Inukjuak River	1.1	13	Brook trout	0.219	0.216	0.218	0.975	4
Inukjuak River	1.1	14	Brook trout	0.092	0.081	0.087	8.994	4
Inukjuak River	1.1	15	Brook trout	0.264	0.273	0.269	2.369	5
Inukjuak River	1.1	16	Brook trout	0.114	0.117	0.116	1.835	5
Inukjuak River	1.1	17	Brook trout	0.139	0.142	0.141	1.509	5
Inukjuak River	1.1	18	Brook trout	0.13	0.131	0.131	0.542	5
Inukjuak River	1.1	19	Brook trout	0.129	0.131	0.130	1.088	4
Inukjuak River	1.1	20	Brook trout	0.108	0.107	0.108	0.658	4
Inukjuak River	1.1	21	Brook trout	0.113	0.106	0.110	4.521	n.o.
Inukjuak River	1.1	22	Brook trout	0.106	0.111	0.109	3.263	5
Inukjuak River	1.1	23	Brook trout	0.111	0.11	0.111	0.64	5
Inukjuak River	1.1	24	Brook trout	0.274	0.271	0.273	0.778	5
Inukjuak River	1.1	25	Brook trout	0.159	0.159	0.159	0	5
Inukjuak River	1.1	26	Lake whitefish	0.1	0.108	0.104	5.442	8
Inukjuak River	1.1	27	Lake whitefish	0.237	0.243	0.240	1.767	11
Inukjuak River	1.1	28	Lake whitefish	0.127	0.119	0.123	4.602	7
Inukjuak River	1.1	29	Lake whitefish	0.079	0.077	0.078	1.813	6
Inukjuak River	1.1	30	Lake whitefish	0.078	0.075	0.077	2.771	5
Inukjuak River	1.1	31	Lake whitefish	0.073	0.075	0.074	1.911	4
Inukjuak River	1.1	32	Lake whitefish	0.082	0.08	0.081	1.746	6
Inukjuak River	1.1	33	Lake whitefish	0.084	0.084	0.084	0	6
Inukjuak River	1.1	34	Lake whitefish	0.08	0.08	0.080	0	7
Inukjuak River	1.1	35	Lake whitefish	0.136	0.132	0.134	2.11	9
Inukjuak River	1.1	36	Lake whitefish	0.075	0.076	0.076	0.936	5

				Total mercury concentration, µg/g w.w.				
Habitat	# sub-station ID	# Fish ID	Common Name	Replicate 1	Replicate 2	Mean	Relative Standard Deviation, %	Fish age, years
Inukjuak River	1.1	37	Landlocked atlantic salmon	0.058	0.052	0.055	7.715	4
Inukjuak River	2.1	38	Lake whitefish	0.089	0.087	0.088	1.607	4
Inukjuak River	2.1	39	Lake whitefish	0.44	0.408	0.424	5.337	14
Inukjuak River	2.1	40	Lake whitefish	0.1	0.103	0.102	2.079	8
Inukjuak River	2.1	41	Lake whitefish	0.282	0.278	0.280	1.01	11
Inukjuak River	2.1	42	Lake whitefish	0.062	0.063	0.063	1.131	4
Inukjuak River	2.1	43	Brook trout	0.074	0.068	0.071	5.976	4
Inukjuak River	2.1	44	Lake whitefish	0.105	0.106	0.106	0.67	4
Inukjuak River	2.1	45	Lake whitefish	0.081	0.08	0.081	0.878	5
Inukjuak River	2.1	46	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.1	47	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.1	48	Brook trout	n.s.	n.s.	n.s.	n.s.	n.s.
Lake Qattaakuluup Tasinga	3.1	49	Lake trout	0.53	0.549	0.540	2.491	15
Lake Qattaakuluup Tasinga	3.1	50	Lake trout	0.47	0.482	0.476	1.784	12
Lake Qattaakuluup Tasinga	3.1	51	Lake trout	0.195	0.197	0.196	0.721	5
Lake Qattaakuluup Tasinga	3.1	52	Lake trout	0.173	0.176	0.175	1.215	4
Lake Qattaakuluup Tasinga	3.1	53	Lake trout	0.183	0.192	0.188	3.392	n.o.
Lake Qattaakuluup Tasinga	3.1	54	Brook trout	0.065	0.062	0.064	3.34	3
Lake Qattaakuluup Tasinga	3.1	55	Brook trout	0.144	0.138	0.141	3.009	4
Lake Qattaakuluup Tasinga	3.1	56	Brook trout	0.2	0.214	0.207	4.783	4
Lake Qattaakuluup Tasinga	3.1	57	Brook trout	0.584	0.57	0.577	1.716	7
Lake Qattaakuluup Tasinga	3.1	58	Lake whitefish	0.08	0.083	0.082	2.602	5
Lake Qattaakuluup Tasinga	3.1	59	Lake whitefish	0.103	0.099	0.101	2.802	5
Lake Qattaakuluup Tasinga	3.1	60	Lake whitefish	0.101	0.098	0.100	2.132	5
Lake Qattaakuluup Tasinga	3.1	61	Lake whitefish	0.097	0.094	0.096	2.221	7
Lake Qattaakuluup Tasinga	3.1	62	Lake whitefish	0.087	0.089	0.088	1.607	6
Lake Qattaakuluup Tasinga	3.1	63	Lake whitefish	0.09	0.096	0.093	4.562	7
Lake Qattaakuluup Tasinga	3.1	64	Lake whitefish	0.097	0.092	0.095	3.746	7
Inukjuak River	1.1	65	Brook trout	0.069	0.074	0.072	4.951	3
Inukjuak River	1.1	66	Brook trout	0.061	0.064	0.063	3.394	3
Inukjuak River	1.1	67	Brook trout	0.154	0.159	0.157	2.262	4
Inukjuak River	1.1	68	Brook trout	0.105	0.109	0.107	2.645	5
Inukjuak River	1.1	69	Brook trout	0.097	0.094	0.096	2.221	5
Inukjuak River	1.1	70	Brook trout	0.329	0.322	0.326	1.521	6
Inukjuak River	1.1	71	Brook trout	0.175	0.176	0.176	0.403	5
Inukjuak River	1.1	72	Brook trout	0.081	0.078	0.080	2.668	5
Inukjuak River	1.1	73	Brook trout	0.117	0.12	0.119	1.79	5
Inukjuak River	1.1	74	Lake whitefish	0.108	0.117	0.113	5.653	7

				Total mercury concentration, µg/g w.w.				
Habitat	# sub-station ID	# Fish ID	Common Name	Replicate 1	Replicate 2	Mean	Relative Standard Deviation, %	Fish age, years
Inukjuak River	1.1	75	Lake whitefish	0.325	0.343	0.334	3.811	11
Inukjuak River	1.1	76	Lake whitefish	0.142	0.137	0.140	2.538	10
Inukjuak River	1.1	77	Lake whitefish	0.197	0.181	0.189	5.984	12
Inukjuak River	1.1	78	Lake whitefish	0.109	0.106	0.108	1.973	7
Inukjuak River	1.1	79	Lake whitefish	0.139	0.141	0.140	1.01	8
Inukjuak River	1.1	80	Lake whitefish	0.078	0.079	0.079	0.901	5
Inukjuak River	1.1	81	Lake whitefish	0.083	0.087	0.085	3.329	5
Inukjuak River	1.1	82	Lake whitefish	0.072	0.074	0.073	1.937	6
Inukjuak River	1.1	83	Lake whitefish	0.083	0.088	0.086	4.14	6
Inukjuak River	1.1	84	Lake whitefish	0.083	0.088	0.086	4.14	6
Inukjuak River	1.1	85	Lake whitefish	0.077	0.075	0.076	1.861	5
Inukjuak River	1.1	86	Lake whitefish	0.081	0.08	0.081	0.878	6
Inukjuak River	1.1	87	Lake whitefish	0.086	0.091	0.089	4	5
Inukjuak River	1.1	88	Lake whitefish	0.075	0.085	0.080	8.838	4
Inukjuak River	1.1	89	Lake whitefish	0.087	0.085	0.086	1.644	5
Inukjuak River	1.1	90	Lake whitefish	0.073	0.071	0.072	1.964	4
Inukjuak River	1.1	91	Lake whitefish	0.073	0.074	0.074	0.962	4
Inukjuak River	1.1	92	Brook trout	0.057	0.055	0.056	2.525	2
Inukjuak River	2.2	93	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	94	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	95	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	96	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	97	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	98	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	99	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	100	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	101	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	102	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	103	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	104	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	105	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	106	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	107	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	108	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	109	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	110	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	111	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	112	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.

Habitat	# sub-station ID	# Fish ID	Common Name	Total mercury concentration, µg/g w.w. Replicate 1	Replicate 2	Mean	Relative Standard Deviation, %	Fish age, years
Inukjuak River	2.2	113	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	114	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	115	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	116	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	117	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.2	118	Lake whitefish	0.083	0.081	0.082	1.724	5
Inukjuak River	2.2	119	Lake whitefish	0.082	0.088	0.085	4.992	5
Inukjuak River	2.2	120	Lake whitefish	0.088	0.089	0.089	0.799	6
Inukjuak River	2.2	121	Lake whitefish	0.07	0.067	0.069	3.096	5
Inukjuak River	2.2	122	Lake whitefish	0.083	0.079	0.081	3.491	5
Inukjuak River	2.2	123	Lake whitefish	0.09	0.092	0.091	1.554	5
Inukjuak River	2.2	124	Lake whitefish	0.083	0.079	0.081	3.491	6
Inukjuak River	2.2	125	Lake whitefish	0.063	0.061	0.062	2.281	6
Inukjuak River	2.2	126	Lake whitefish	0.079	0.076	0.078	2.737	6
Inukjuak River	2.2	127	Lake whitefish	0.155	0.16	0.158	2.245	5
Inukjuak River	2.2	128	Lake whitefish	0.069	0.066	0.068	3.263	5
Inukjuak River	2.2	129	Lake whitefish	0.091	0.096	0.094	3.782	8
Inukjuak River	2.2	130	Lake whitefish	0.327	0.317	0.322	2.196	10
Inukjuak River	2.2	131	Lake whitefish	0.316	0.31	0.313	1.356	11
Inukjuak River	2.2	132	Brook trout	0.22	0.233	0.227	4.057	7
Inukjuak River	2.2	133	Brook trout	0.099	0.096	0.098	2.175	5
Inukjuak River	2.2	134	Brook trout	0.113	0.113	0.113	0	5
Inukjuak River	2.2	135	Brook trout	0.169	0.17	0.170	0.417	4
Inukjuak River	2.1	136	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Inukjuak River	2.1	137	Longnose sucker	n.s.	n.s.	n.s.	n.s.	n.s.
Lake Qattaakuluup Tasinga	3.1	138	Lake whitefish	0.119	0.114	0.117	3.035	3
Lake Qattaakuluup Tasinga	3.1	139	Lake whitefish	0.082	0.082	0.082	0	3
Lake Qattaakuluup Tasinga	3.1	140	Lake whitefish	0.119	0.123	0.121	2.337	9
Lake Qattaakuluup Tasinga	3.1	141	Lake whitefish	0.086	0.088	0.087	1.625	8
Lake Qattaakuluup Tasinga	3.1	142	Lake whitefish	0.179	0.191	0.185	4.589	12
Lake Qattaakuluup Tasinga	3.1	143	Lake whitefish	0.112	0.126	0.119	8.319	9
Lake Qattaakuluup Tasinga	3.1	144	Lake whitefish	0.064	0.065	0.065	1.096	6
Lake Qattaakuluup Tasinga	3.1	145	Lake whitefish	0.087	0.092	0.090	3.955	5
Lake Qattaakuluup Tasinga	3.1	146	Lake whitefish	0.089	0.088	0.089	0.799	6
Lake Qattaakuluup Tasinga	3.1	147	Lake whitefish	0.082	0.08	0.081	1.746	4
Lake Qattaakuluup Tasinga	3.1	148	Lake whitefish	0.084	0.08	0.082	3.449	4
Lake Qattaakuluup Tasinga	3.1	149	Brook trout	0.172	0.164	0.168	3.367	5
Lake Qattaakuluup Tasinga	3.1	150	Brook trout	0.182	0.184	0.183	0.773	n.o.

				Total mercury concentration, µg/g w.w.				
Habitat	# sub-station ID	# Fish ID	Common Name	Replicate 1	Replicate 2	Mean	Relative Standard Deviation, %	Fish age, years
Lake Qattaakuluup Tasinga	3.1	151	Lake trout	1.613	1.573	1.593	1.775	17
Lake Qattaakuluup Tasinga	3.1	152	Lake trout	1.346	1.354	1.350	0.419	n.o.
Lake Qattaakuluup Tasinga	3.2	153	Brook trout	0.065	0.063	0.064	2.209	3
Lake Qattaakuluup Tasinga	3.2	154	Brook trout	0.046	0.05	0.048	5.892	2
Lake Qattaakuluup Tasinga	3.2	155	Brook trout	0.066	0.064	0.065	2.175	3
Lake Qattaakuluup Tasinga	3.2	156	Brook trout	0.146	0.147	0.147	0.483	4
Lake Qattaakuluup Tasinga	3.2	157	Brook trout	0.146	0.14	0.143	2.967	4
Lake Qattaakuluup Tasinga	3.2	158	Brook trout	0.285	0.274	0.280	2.783	7
Lake Qattaakuluup Tasinga	3.2	159	Brook trout	0.297	0.28	0.289	4.166	n.o.
Lake Qattaakuluup Tasinga	3.2	160	Lake trout	0.252	0.254	0.253	0.559	6
Lake Qattaakuluup Tasinga	3.2	161	Lake trout	0.153	0.156	0.155	1.373	5
Lake Qattaakuluup Tasinga	3.2	162	Lake trout	0.16	0.149	0.155	5.034	4
Lake Qattaakuluup Tasinga	3.2	163	Lake trout	0.159	0.152	0.156	3.183	4
Lake Qattaakuluup Tasinga	3.2	164	Lake trout	0.301	0.296	0.299	1.185	7
Lake Qattaakuluup Tasinga	3.2	165	Lake trout	0.465	0.461	0.463	0.611	9
Lake Qattaakuluup Tasinga	3.2	166	Lake trout	0.489	0.487	0.488	0.29	10
Lake Qattaakuluup Tasinga	3.2	167	Lake trout	0.45	0.493	0.472	6.45	n.o.
Lake Qattaakuluup Tasinga	3.2	168	Lake whitefish	0.08	0.08	0.080	0	4
Lake Qattaakuluup Tasinga	3.2	169	Lake whitefish	0.034	0.039	0.037	9.68	4
Lake Qattaakuluup Tasinga	3.2	170	Lake whitefish	0.074	0.081	0.078	6.387	5
Lake Qattaakuluup Tasinga	3.2	171	Lake whitefish	0.042	0.048	0.045	9.429	5
Lake Qattaakuluup Tasinga	3.2	172	Lake whitefish	0.064	0.061	0.063	3.394	5
Lake Qattaakuluup Tasinga	3.2	173	Lake whitefish	0.043	0.048	0.046	7.771	5
Lake Qattaakuluup Tasinga	3.2	174	Lake whitefish	0.066	0.075	0.071	9.027	7
Lake Qattaakuluup Tasinga	3.2	175	Lake whitefish	0.214	0.219	0.217	1.633	12
Lake Qattaakuluup Tasinga	3.2	176	Lake whitefish	0.244	0.243	0.244	0.29	12
Lake Qattaakuluup Tasinga	3.2	177	Lake whitefish	0.293	0.296	0.295	0.72	10
Lake Qattaakuluup Tasinga	3.2	178	Lake whitefish	0.147	0.141	0.144	2.947	12
Lake Qattaakuluup Tasinga	3.2	179	Lake whitefish	0.095	0.1	0.098	3.627	8
Lake Qattaakuluup Tasinga	3.2	180	Lake whitefish	0.058	0.058	0.058	0	4
Lake Qattaakuluup Tasinga	3.2	181	Lake whitefish	0.228	0.239	0.234	3.332	12
Lake Tasialuk (Control)	4.1	182	Brook trout	0.115	0.121	0.118	3.596	6
Lake Tasialuk (Control)	4.1	183	Brook trout	0.106	0.106	0.106	0	5
Lake Tasialuk (Control)	4.1	184	Brook trout	0.115	0.116	0.116	0.612	4
Lake Tasialuk (Control)	4.1	185	Brook trout	0.156	0.142	0.149	6.644	7
Lake Tasialuk (Control)	4.1	186	Brook trout	0.047	0.045	0.046	3.074	2
Lake Tasialuk (Control)	4.1	187	Lake trout	0.323	0.32	0.322	0.66	n.o.
Lake Tasialuk (Control)	4.1	188	Lake trout	0.112	0.118	0.115	3.69	4

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Habitat	# sub-station ID	# Fish ID	Common Name	Replicate 1	Replicate 2	Mean	Relative Standard Deviation, %	Fish age, years
Lake Tasialuk (Control)	4.1	189	Lake trout	0.424	0.417	0.421	1.177	7
Lake Tasialuk (Control)	4.1	190	Lake trout	0.289	0.282	0.286	1.734	9
Lake Tasialuk (Control)	4.1	191	Lake trout	0.573	0.597	0.585	2.901	13
Lake Tasialuk (Control)	4.2	194	Cisco	n.s.	n.s.	n.s.	n.s.	n.s.
Lake Tasialuk (Control)	4.2	195	Cisco	n.s.	n.s.	n.s.	n.s.	n.s.
Lake Tasialuk (Control)	4.2	196	Cisco	n.s.	n.s.	n.s.	n.s.	n.s.
Lake Tasialuk (Control)	4.2	200	Lake whitefish	0.048	0.044	0.046	6.148	5
Lake Tasialuk (Control)	4.2	201	Lake trout	0.447	0.452	0.450	0.787	7
Lake Tasialuk (Control)	4.2	202	Lake trout	0.21	0.211	0.211	0.336	9
Lake Tasialuk (Control)	4.2	203	Lake trout	0.182	0.177	0.180	1.97	7
Lake Tasialuk (Control)	4.2	204	Lake trout	0.27	0.254	0.262	4.317	7
Lake Tasialuk (Control)	4.2	205	Lake trout	0.238	0.245	0.242	2.05	7
Lake Tasialuk (Control)	4.2	206	Lake trout	0.477	0.436	0.457	6.35	9
Lake Tasialuk (Control)	4.2	207	Lake trout	0.15	0.16	0.155	4.562	8
Lake Tasialuk (Control)	4.2	208	Lake trout	0.199	0.185	0.192	5.156	6
Lake Tasialuk (Control)	4.2	209	Lake trout	0.206	0.195	0.201	3.879	8
Lake Tasialuk (Control)	4.2	210	Lake trout	0.452	0.47	0.461	2.761	9
Lake Tasialuk (Control)	4.2	211	Brook trout	0.114	0.118	0.116	2.438	3
Lake Tasialuk (Control)	4.3	212	Lake trout	0.743	0.767	0.755	2.248	>12
Lake Tasialuk (Control)	4.3	213	Lake trout	0.142	0.128	0.135	7.333	8
Lake Tasialuk (Control)	4.3	214	Lake trout	0.229	0.256	0.243	7.872	11
Lake Tasialuk (Control)	4.3	215	Lake trout	0.606	0.589	0.598	2.012	unreadable
Lake Tasialuk (Control)	4.3	216	Lake trout	0.459	0.472	0.466	1.974	9
Lake Tasialuk (Control)	4.3	217	Lake trout	0.317	0.313	0.315	0.898	9
Lake Tasialuk (Control)	4.3	218	Lake trout	0.372	0.424	0.398	9.239	11
Lake Tasialuk (Control)	4.3	219	Lake trout	0.364	0.346	0.355	3.586	9
Lake Tasialuk (Control)	4.3	220	Lake trout	0.337	0.328	0.333	1.914	n.o.
Lake Tasialuk (Control)	4.3	221	Lake trout	0.286	0.285	0.286	0.248	8
Lake Tasialuk (Control)	4.3	222	Lake trout	0.289	0.282	0.286	1.734	n.o.
Lake Tasialuk (Control)	4.3	223	Lake trout	0.352	0.352	0.352	0	10
Lake Tasialuk (Control)	4.3	224	Lake trout	0.345	0.331	0.338	2.929	n.o.
Lake Tasialuk (Control)	4.3	225	Lake trout	0.348	0.339	0.344	1.853	10
Lake Tasialuk (Control)	4.3	226	Lake trout	0.287	0.296	0.292	2.183	7
Lake Tasialuk (Control)	4.3	227	Lake trout	0.331	0.352	0.342	4.348	8
Lake Tasialuk (Control)	4.3	228	Lake trout	0.429	0.442	0.436	2.11	8
Lake Tasialuk (Control)	4.3	229	Lake trout	0.115	0.118	0.117	1.821	6
Lake Tasialuk (Control)	4.3	230	Lake trout	0.235	0.242	0.239	2.075	7
Lake Tasialuk (Control)	4.3	231	Lake trout	0.261	0.258	0.260	0.817	n.o.

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Habitat	# sub-station ID	# Fish ID	Common Name	Replicate 1	Replicate 2	Mean	Relative Standard Deviation, %	Fish age, years
Inukjuak River	2.3	232	Brook trout	0.066	0.07	0.068	4.159	4
Inukjuak River	2.4	233	Brook trout	0.043	0.044	0.044	1.626	2
Inukjuak River	2.4	234	Brook trout	0.058	0.058	0.058	0	2
Inukjuak River	2.4	235	Brook trout	0.107	0.109	0.108	1.309	5
Inukjuak River	2.4	236	Brook trout	0.065	0.067	0.066	2.142	4
Inukjuak River	2.4	237	Brook trout	0.066	0.067	0.067	1.063	4
Inukjuak River	2.4	238	Lake whitefish	0.06	0.059	0.060	1.188	4
Inukjuak River	2.4	239	Lake whitefish	0.057	0.063	0.060	7.072	4
Inukjuak River	2.4	240	Lake whitefish	0.103	0.102	0.103	0.69	9
Inukjuak River	2.4	242	Lake whitefish	0.113	0.124	0.119	6.564	8
Inukjuak River	2.4	244	Lake whitefish	0.064	0.062	0.063	2.244	5
Inukjuak River	2.4	245	Lake whitefish	0.054	0.059	0.057	6.258	5
Inukjuak River	2.4	246	Lake whitefish	0.066	0.066	0.066	0	7
Inukjuak River	2.4	247	Lake whitefish	0.072	0.072	0.072	0	7
Inukjuak River	2.4	248	Lake whitefish	0.168	0.158	0.163	4.338	10
Inukjuak River	2.4	249	Lake whitefish	0.226	0.243	0.235	5.126	12
Inukjuak River	2.4	250	Lake whitefish	0.234	0.253	0.244	5.52	12
Lake Tasialuk (Control)	4.1	251	Brook trout	0.044	0.042	0.043	3.288	4
Lake Tasialuk (Control)	4.1	252	Brook trout	0.121	0.123	0.122	1.159	7
Lake Tasialuk (Control)	4.1	253	Brook trout	0.1	0.092	0.096	5.893	5
Lake Tasialuk (Control)	4.1	254	Brook trout	0.138	0.134	0.136	2.079	3
Lake Tasialuk (Control)	4.1	255	Brook trout	0.057	0.061	0.059	4.793	5
Lake Tasialuk (Control)	4.1	256	Brook trout	0.098	0.095	0.097	2.198	6
Lake Tasialuk (Control)	4.1	257	Brook trout	0.121	0.133	0.127	6.685	6
Lake Tasialuk (Control)	4.1	258	Brook trout	0.098	0.096	0.097	1.458	5
Lake Tasialuk (Control)	4.1	259	Brook trout	0.064	0.059	0.062	5.75	n.o.
Lake Tasialuk (Control)	4.1	260	Brook trout	0.098	0.092	0.095	4.466	6
Lake Tasialuk (Control)	4.1	261	Brook trout	0.042	0.04	0.041	3.449	2
Lake Tasialuk (Control)	4.1	262	Brook trout	0.047	0.043	0.045	6.284	3
Lake Tasialuk (Control)	4.1	263	Brook trout	0.048	0.044	0.046	6.148	4
Lake Tasialuk (Control)	4.1	264	Brook trout	0.123	0.121	0.122	1.159	7
Lake Tasialuk (Control)	4.1	265	Brook trout	0.124	0.126	0.125	1.131	7
Lake Tasialuk (Control)	4.1	266	Brook trout	0.242	0.243	0.243	0.292	8
Lake Tasialuk (Control)	4.1	267	Brook trout	0.062	0.058	0.060	4.713	5
Lake Tasialuk (Control)	4.1	268	Brook trout	0.07	0.074	0.072	3.928	4
Lake Tasialuk (Control)	4.1	269	Brook trout	0.098	0.097	0.098	0.725	7
Lake Tasialuk (Control)	4.1	270	Brook trout	0.106	0.101	0.104	3.416	6
Lake Tasialuk (Control)	4.1	271	Brook trout	0.157	0.166	0.162	3.941	5

				Total mercury concentration, µg/g w.w.				
Habitat	# sub-station ID	# Fish ID	Common Name	Replicate 1	Replicate 2	Mean	Relative Standard Deviation, %	Fish age, years
Lake Tasialuk (Control)	4.1	272	Lake trout	0.298	0.315	0.307	3.922	7
Lake Tasialuk (Control)	4.1	273	Lake trout	0.273	0.3	0.287	6.664	10
Lake Tasialuk (Control)	4.1	274	Lake trout	0.088	0.087	0.088	0.808	4
Lake Tasialuk (Control)	4.1	275	Lake trout	0.536	0.515	0.526	2.826	11
Lake Tasialuk (Control)	4.1	276	Lake trout	0.41	0.411	0.411	0.172	13
Lake Tasialuk (Control)	4.4	277	Lake trout	0.128	0.13	0.129	1.096	4
Lake (Control)	5.1	278	Brook trout	0.042	0.039	0.041	5.237	2
Lake (Control)	5.1	279	Brook trout	0.054	0.052	0.053	2.668	2
Lake (Control)	5.1	280	Brook trout	0.079	0.082	0.081	2.635	3
Lake (Control)	5.1	281	Lake whitefish	0.046	0.043	0.045	4.766	3
Lake (Control)	5.1	282	Lake whitefish	0.043	0.04	0.042	5.111	3
Lake (Control)	5.1	283	Lake whitefish	0.087	0.089	0.088	1.607	5
Lake (Control)	5.1	284	Lake whitefish	0.041	0.04	0.041	1.746	3
Lake (Control)	5.1	285	Lake whitefish	0.063	0.063	0.063	0	5
Lake (Control)	5.1	286	Lake whitefish	0.122	0.124	0.123	1.15	8
Lake (Control)	5.1	287	Lake whitefish	0.135	0.14	0.138	2.572	10
Lake (Control)	5.1	288	Lake trout	0.18	0.165	0.173	6.149	5
Lake (Control)	5.1	289	Lake trout	0.147	0.152	0.150	2.365	8
Lake (Control)	5.1	290	Lake trout	0.282	0.3	0.291	4.374	8
Lake (Control)	5.1	291	Lake trout	0.105	0.114	0.110	5.812	6
Lake (Control)	5.1	292	Lake trout	0.18	0.182	0.181	0.781	7
Lake (Control)	5.1	293	Lake trout	0.096	0.095	0.096	0.74	3
Lake (Control)	5.1	294	Lake trout	0.277	0.3	0.289	5.636	7
Lake (Control)	5.1	295	Lake trout	0.213	0.21	0.212	1.003	9
Lake (Control)	5.1	296	Lake trout	0.162	0.153	0.158	4.041	7
Lake (Control)	5.1	297	Lake trout	0.241	0.256	0.249	4.27	7
Lake (Control)	5.1	298	Lake trout	0.367	0.356	0.362	2.152	9
Lake (Control)	5.1	299	Lake trout	0.391	0.378	0.385	2.39	8

n.o., no otolith
n.s. no sample
(a) two different otolithes

Box – and – whisker plots were used for visually depicting mercury data of the three fish species from the Inukjuak River watershed and Lake Tasialuk. They were particularly useful for visually estimating various L – estimators such as interquartile range, midhinge, median, midrange, trimean, etc. for indicating central tendency, statistical dispersion and the distribution shape of each data set. As indicated by the box – and – whisker plots (figures 2, 3 & 4), the arithmetic means (•) were always above the medians (horizontal lines inside the boxes) for mercury concentrations in fish from the Inukjuak River watershed which indicated positively skewed frequency distributions of the data. Whereas the frequency distributions of the mercury data of fish from Lake Tasialuk were closer to normal. The central tendency of the data was gauged by the medians (Q_2) which provided a robust measure in skewed distributions. The 95% confidence intervals of the medians were represented by the inner red boxes. The interquartile ranges (outer yellow boxes) within which 50% of the data were located (i.e. between the first quartile Q_1 and the third quartile Q_3) were used to show data dispersions and variability since they were less influenced by extreme values and were less influenced by sampling fluctuation in highly skewed distributions. Upper and lower whiskers (vertical lines above and below the interquartile boxes) showed the range of values that fell within the "upper and lower inner fences": Upper inner fence = $Q_3 + 1.5\ (Q_3 - Q_1)$; lower inner fence = $Q_1 - 1.5\ (Q_3 - Q_1)$. Outliers (◆) were defined as data points that fell below the first quartile minus 1.5 x interquartile range or above the third quartile plus 1.5 x interquartile range of the data set. The number (n) below the lower whiskers indicated the number of fish.

Table 4 summarized the box – and – whisker plots: Tukey's trimean (TM) measures the probability distribution's location and is defined as the weighted average of the distribution's median and its two quartiles: $TM = \{ Q_1 + 2Q_2 + Q_3 \} \div 4$. An advantage of the trimean as a measure of the centre of a distribution is that it is statistically robust for data set with non-normal frequency distributions, extensive dispersion and the presence of outliers. it combines the median's emphasis on centre values with the midhinge (i.e. average of Q_1 and Q_3)' s attention to the extreme (Tukey 1977).

Figure 2. Box – and – whisker plot of mercury concentration in lake trout from the Inukjuak River watershed (stations 1, 2 and 3) and Lake Tasialuk (station 4).

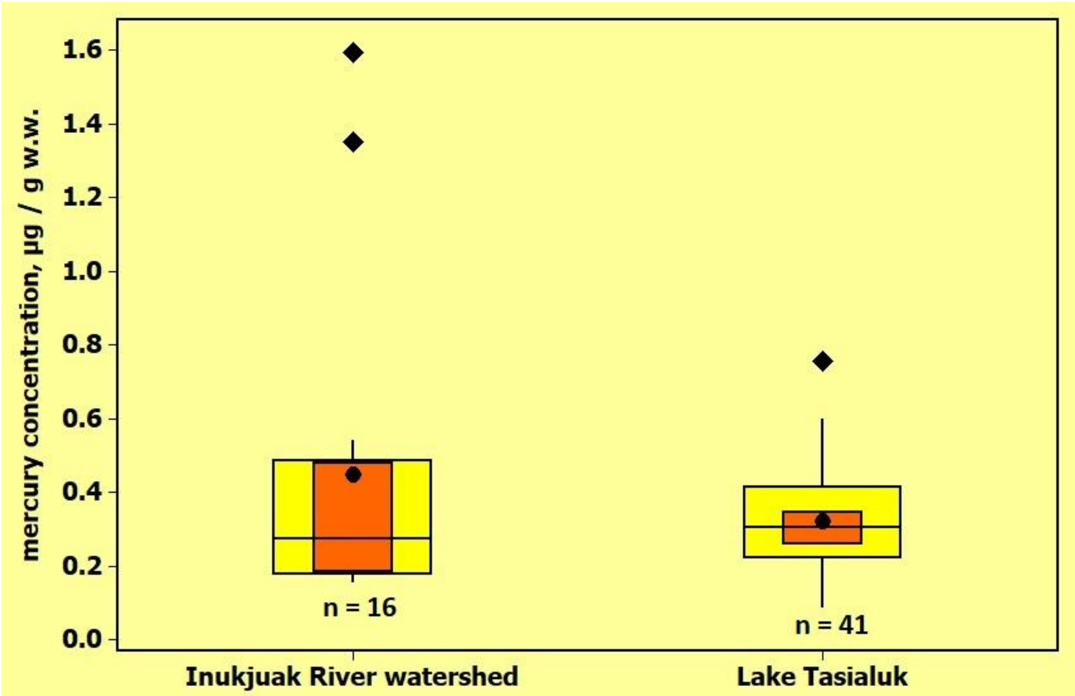


Figure 3. Box – and – whisker plot of mercury concentration in brook trout from the Inukjuak River watershed (stations 1, 2 and 3) and Lake Tasialuk (station 4).

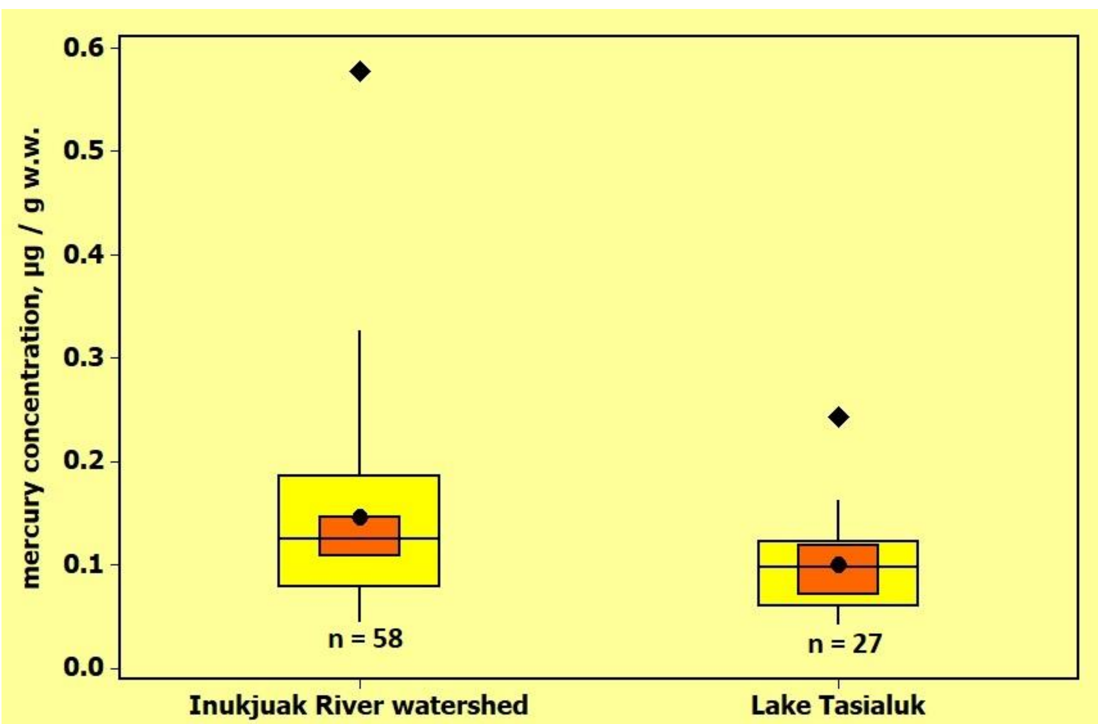


Figure 4. Box – and – whisker plot of mercury concentration in lake whitefish from the Inukjuak River watershed (stations 1, 2 and 3).

(note: there is only one lake whitefish from Lake Tasialuk, hence excluded from the plot)

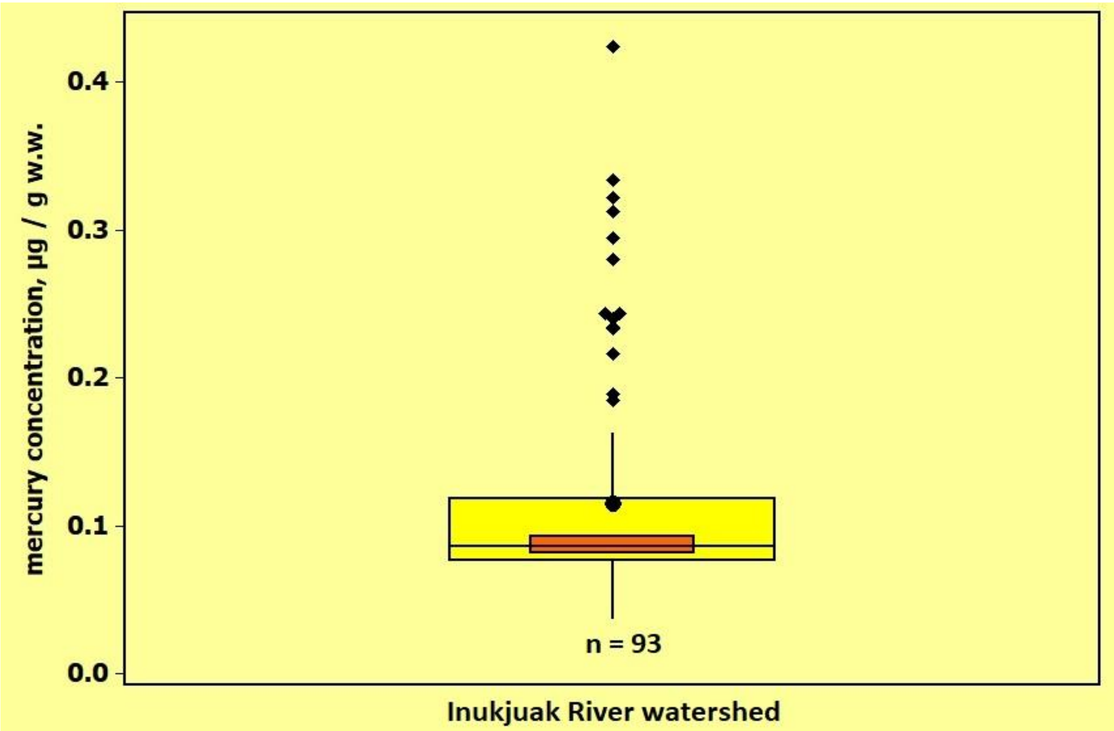


Table 4. Summary of the box – and – whisker plots of mercury data of fish from Inukjuak watershed and Lake Tasialuk. Mercury concentration in µg / g w.w.

Location	Fish species	Tukey's Trimean [a]	Interquartile Range (IQR)	1st Quartile Q_1	2nd Quartile Q_2	3rd Quartile Q_3	95% confidence intervals of the median (upper, lower limits)
Inukjuak River watershed	Lake trout	0.304	0.307	0.178	0.276	0.485	0.184, 0.479
Lake Tasialuk	Lake trout	0.313	0.191	0.225	0.307	0.416	0.262, 0.345
Inukjuak River watershed	Brook trout	0.129	0.107	0.079	0.124	0.186	0.108, 0.146
Lake Tasialuk	Brook trout	0.094	0.062	0.060	0.098	0.122	0.072, 0.118
Inukjuak River watershed	Lake whitefish	0.092	0.043	0.076	0.086	0.119	0.081, 0.093

[a] Tukey's trimean (TM) which is a measure of a probability distribution's location defined as a weighted average of the distribution's median (Q_2) and its two quartiles (Q_1 , Q_3):

$$TM = \{ Q_1 + 2Q_2 + Q_3 \} \div 4$$

The mercury data for lake trout from the Inukjuak River watershed and from Lake Tasialuk have unequal variances (Levene's test statistic = 6.09, p – value = 0.017). The mercury data of lake trout from the Inukjuak River watershed were highly skewed and highly deviated from normal distribution (Anderson – Darling test statistic = 1.986, p – value < 0.005), although the mercury data of lake trout from Lake Tasialuk were normally distributed (Anderson - Darling test statistic = 0.388, p – value = 0.372). Log_e transformation has greatly improved the lake trout mercury data of the Inukjuak River watershed and rendered the frequency distribution very close to normality (Anderson – Darling test statistic = 0.723, p – value = 0.048). The mercury data of lake trout from Lake Tasialuk remained normally distributed after log_e transformation (Anderson – Darling test statistic = 0.483, p – value = 0.218). Despite log_e transformation, the variances of the mercury data of lake trout from the Inukjuak River watershed and that from Lake Tasialuk though have improved but still unequal (Levene test statistic = 4.63, p – value = 0.035). In view of these findings, the relatively robust non-parametric Welsh's t – test (Welsh 1951) was used to test if there are significant differences in log_e transformed mercury concentrations between lake trout from the Inukjuak River watershed and those from Lake Tasialuk. The Welsh's t – test is suitable to apply to data sets with unequal variances but with frequency distributions not too much deviated from normality. The unbalanced design of the data sets also rendered Welsh's t – test a preferred choice. The test yielded $F_{1,\ 20.203}$ of 0.492 and a p – value of 0.491 The F - value calculated was lower than the critical F_α value of 3.84 at the 0.05 level of significance; hence, there was no significant difference of the log_e transformed mean mercury concentrations of lake trout between the Inukjuak River watershed and Lake Tasialuk at the 0.05 level of significance.

The mercury data of brook trout from the Inukjuak River watershed and Lake Tasialuk also have unequal variances (Levene's test statistic = 4.50, p – value = 0.037). Similar to the lake trout mercury data, the mercury data of brook trout from the Inukjuak River watershed were highly skewed and highly deviated from normal distribution (Anderson – Darling test statistic =

1.978, p – value < 0.005), although the mercury data of brook trout from Lake Tasialuk were quite normally distributed (Anderson - Darling test statistic = 0.652, p – value = 0.079). Log_e transformation has greatly improved the brook trout mercury data of the Inukjuak River watershed and rendered the frequency distribution normal (Anderson – Darling test statistic = 0.285, p – value = 0.616). However, the mercury data of brook trout from Lake Tasialuk deviated further away from normality after $\log_e$ transformation: Anderson - Darling test statistic has elevated to 0.848 while p – value has decreased to 0.025. Log_e transformation rendered the variances of the mercury data of brook trout from the Inukjuak River watershed and that from Lake Tasialuk became equal (Levene test statistic = 1.43, p – value = 0.236). In view of these findings, the nonparametric Mann – Whitney U – test (Mann and Whitney 1947) was used to test if there were significant differences in $\log_e$ transformed mercury concentrations between brook trout from the Inukjuak River watershed and those from Lake Tasialuk. Mann – Whitney U – test searches the central tendency differences between the medians of the two samples that might represent different populations. It is a robust, yet statistically powerful test suitable for testing two samples whose frequency distributions are highly deviated from normality but have equal variances without running the risk of inflating Type I Error even with outliers present in the samples. The test results on the $\log_e$ transformed mercury data were: $U_{calculated} = 509.5$, $U_\alpha = 573.36$; $n_x = 58$, $n_y = 27$; $p = 0.00494$, two – tailed at 0.05 level of significance. In statistical terms, the test concluded that it was not equally likely that a randomly selected mercury concentration value from the Inukjuak River watershed brook trout samples would be less than or greater than a randomly selected mercury concentration value from Lake Tasialuk brook trout samples, i.e. the two independent the Inukjuak River watershed brook trout and Lake Tasialuk brook trout were selected from populations having different frequency distributions. In plain language, this means there was a significant difference in mercury concentrations of brook trout between the Inukjuak River watershed and Lake Tasialuk at the 0.05 level of significance. Indeed, a "directional" (i.e. one – tailed test) for which U_α = 608.73 and the p – value became 0.00988 further led to the conclusion that the mercury concentration in brook trout from the Inukjuak River watershed was higher than that from Lake Tasialuk at the 0.05 level of significance.

The Health Canada's mercury safety guideline for commercial fish consumption (0.5 µg / g w.w.) is often used as the reference point to define the notions of high vs. low mercury levels in fish (Health Canada 2007). In fact, a more stringent mercury guideline of 0.2 µg / g w.w. was put forward in 1979 by the Medical Services Branch of Health Canada for subsistence fish consumption. This guideline was instituted as a "safety consumption limit" for people eating "large quantities of fish" (Wheatley 1979) and is still "unofficially" recognized by Health Canada today. However, the quantities of fish that are considered as "large" were not defined in this guideline. The Tukey's trimeans of all three fish species from both the Inukjuak River watershed and Lake Tasialuk (Table 4.) were below the 0.5 µg / g w.w. guideline. However, trimeans for lake trout from both locations were above 0.2 µg / g w.w. Table 5 shows the number of fish of the three species from the entire 259 fish analyzed exceeding the two mercury guidelines.

Table 5. The number of fish of the three species from the entire 259 fish analyzed exceeding the two mercury guidelines.

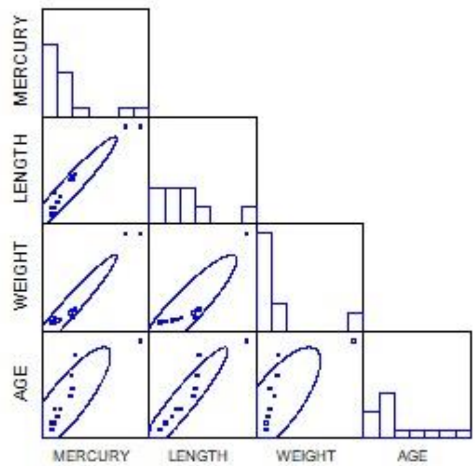
Location	Fish species	Number of fish exceeding mercury guideline	
		≥ 0.2 µg / g w.w.	≥ 0.5 µg / g w.w.
Inukjuak River watershed	Lake trout	10	3
	Brook trout	13	1
	Lake whitefish	12	0
Lake Tasialuk	Lake trout	33	4
	Brook trout	1	0
	Lake whitefish	0	0
Station 5.1 (control)	Lake trout	4	0
	Brook trout	0	0
	Lake whitefish	0	0

Fish Growth and Mercury Concentration

It is well known that mercury bioaccumulation in fish often increases as the fish grow older (and often bigger). Positive correlations between mercury concentration in tissues and fish growth have been demonstrated in a number of species. The relationships (dependence) between mercury concentration and fish growth (measured as age, fork length and weight) in terms of their directions and strength were determined using the robust nonparametric Spearman's rank correlation. The method assessed how well the dependence between mercury concentration and each of the three growth parameters be described using a monotonic function. Figures 5 to 11 show the spearman's correlation matrices of fish from the Inukjuak River watershed, Lake Tasialuk and sub-station 5.1 (control). Strong positive correlations ($p \leq 0.01$) were found between mercury concentration and all three growth parameters (fork length, weight and age) for lake trout, brook trout and lake whitefish from Inukjuak River watershed. This was also true for lake trout and brook trout from Lake Tasialuk ($p \leq 0.01$). Mercury concentration in lake trout from sub-station 5.1 also positively correlated with all three growth parameters ($0.01 < p \leq 0.05$). Fork length and weight of lake whitefish from sub-station 5.1 were also positively correlated with mercury concentration ($0.01 < p \leq 0.05$). A strong positive correlation ($p \leq 0.01$) between mercury concentration and age of lake whitefish from sub-station 5.1 was also evident. Scatterplots of mercury vs. age were shown in figures 12 to 18.

Figure 5. Spearman correlation matrix of lake trout from Inukjuak River watershed

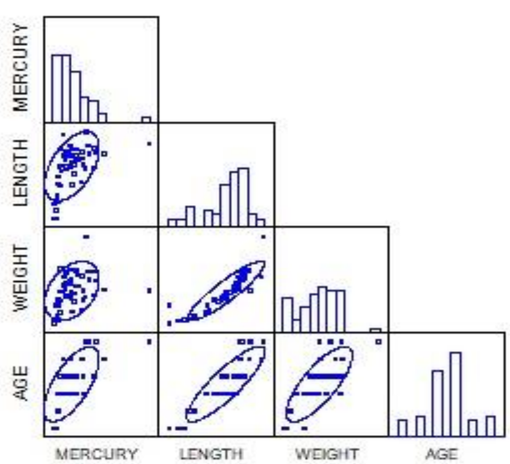
	MERCURY	LENGTH	WEIGHT	AGE
MERCURY	1.000			
LENGTH	0.941	1.000		
WEIGHT	0.875	0.977	1.000	
AGE	0.945	0.993	0.972	1.000



Number of observations: 13

Figure 6. Spearman correlation matrix of brook trout from Inukjuak River watershed

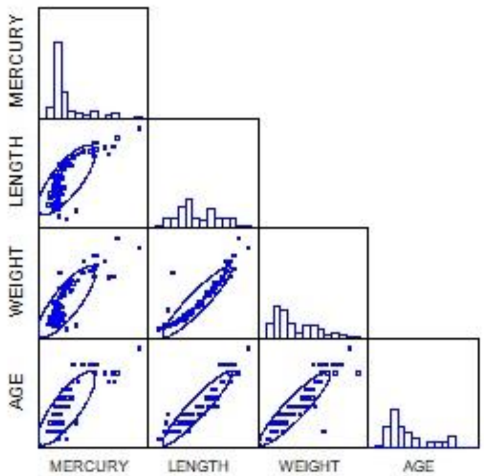
	MERCURY	LENGTH	WEIGHT	AGE
MERCURY	1.000			
LENGTH	0.648	1.000		
WEIGHT	0.562	0.935	1.000	
AGE	0.696	0.862	0.775	1.000



Number of observations: 54

Figure 7. Spearman correlation matrix of lake whitefish from Inukjuak River watershed

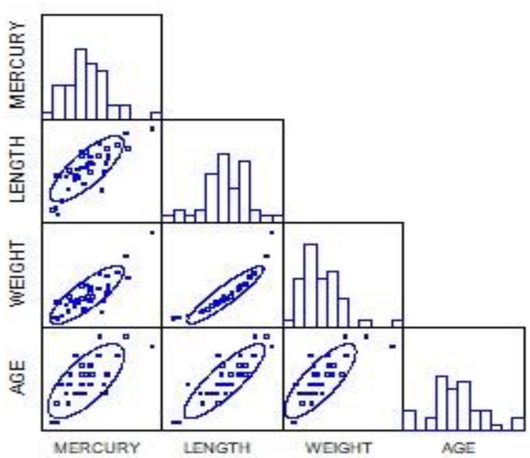
	MERCURY	LENGTH	WEIGHT	AGE
MERCURY	1.000			
LENGTH	0.724	1.000		
WEIGHT	0.713	0.939	1.000	
AGE	0.706	0.929	0.904	1.000



Number of observations: 93

Figure 8. Spearman correlation matrix of lake trout from Lake Tasialuk

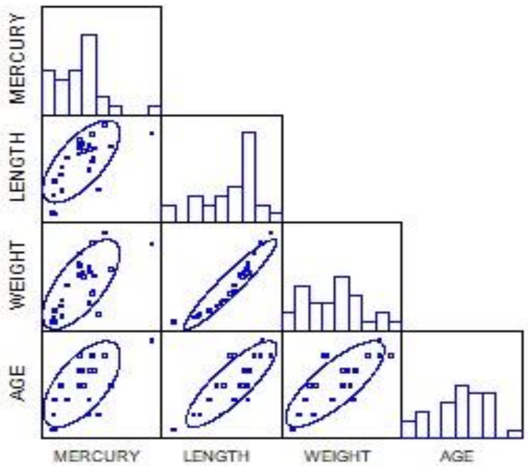
	MERCURY	LENGTH	WEIGHT	AGE
MERCURY	1.000			
LENGTH	0.746	1.000		
WEIGHT	0.728	0.992	1.000	
AGE	0.658	0.817	0.801	1.000



Number of observations: 35

Figure 9. Spearman correlation matrix of brook trout from Lake Tasialuk

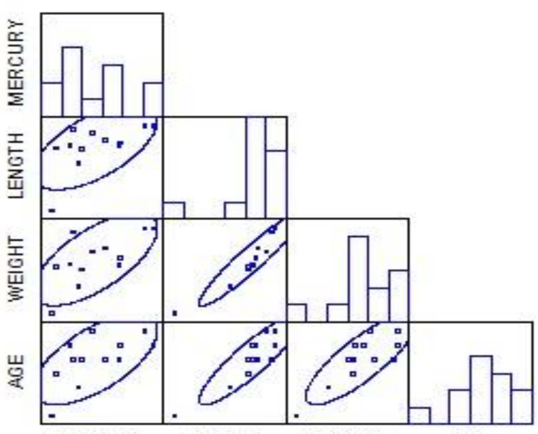
	MERCURY	LENGTH	WEIGHT	AGE
MERCURY	1.000			
LENGTH	0.591	1.000		
WEIGHT	0.571	0.979	1.000	
AGE	0.588	0.779	0.767	1.000



Number of observations: 26

Figure 10. Spearman correlation matrix of lake trout from sub-station 5.1

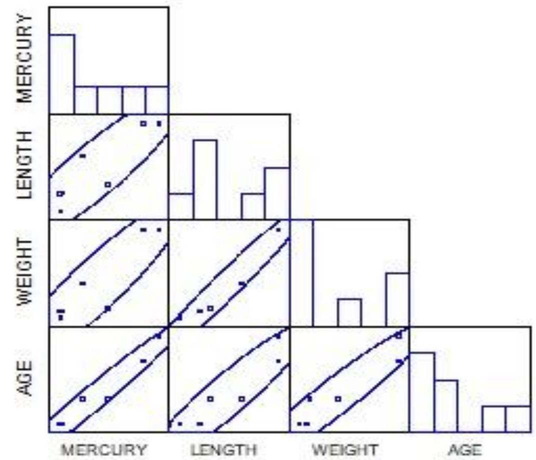
	MERCURY	LENGTH	WEIGHT	AGE
MERCURY	1.000			
LENGTH	0.684	1.000		
WEIGHT	0.669	0.991	1.000	
AGE	0.650	0.775	0.743	1.000



Number of observations: 12

Figure 11. Spearman correlation matrix of lake whitefish from sub-station 5.1

	MERCURY	LENGTH	WEIGHT	AGE
MERCURY	1.000			
LENGTH	0.919	1.000		
WEIGHT	0.847	0.964	1.000	
AGE	0.954	0.944	0.944	1.000



Number of observations: 7

Figure 12. Scatterplot of mercury vs. age for lake trout from Inukjuak River watershed

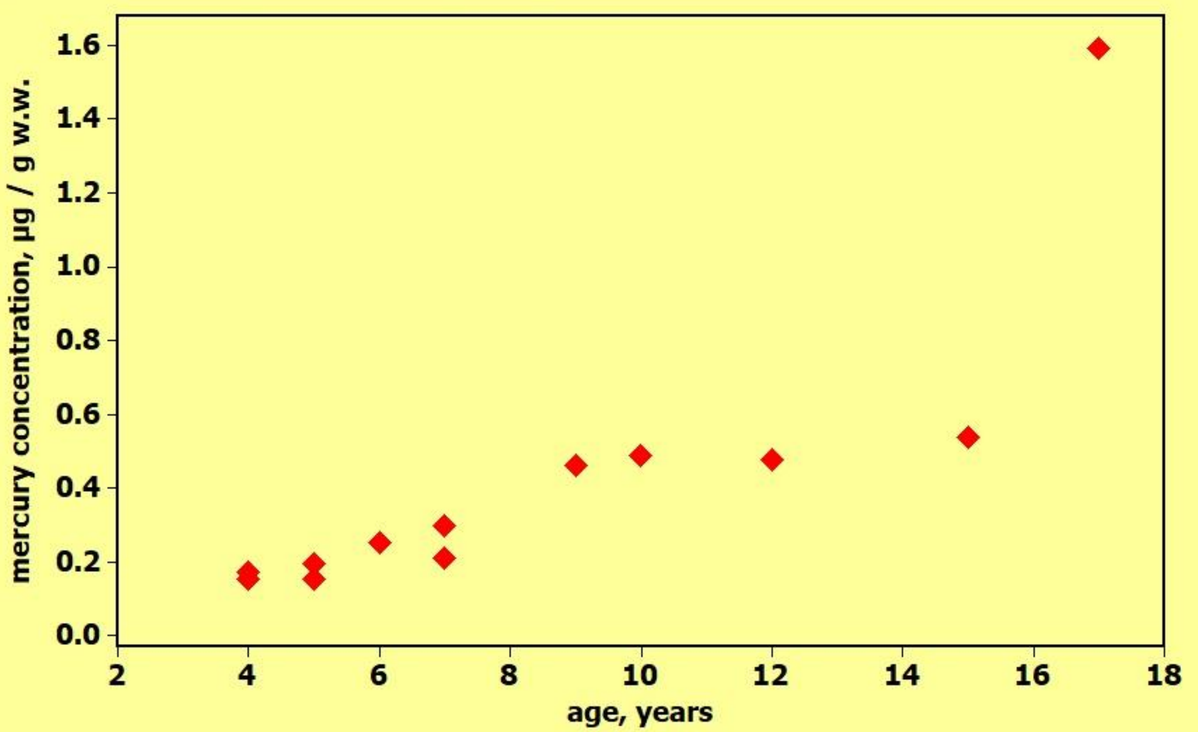


Figure 13. Scatterplot of mercury vs. age for brook trout from Inukjuak River watershed

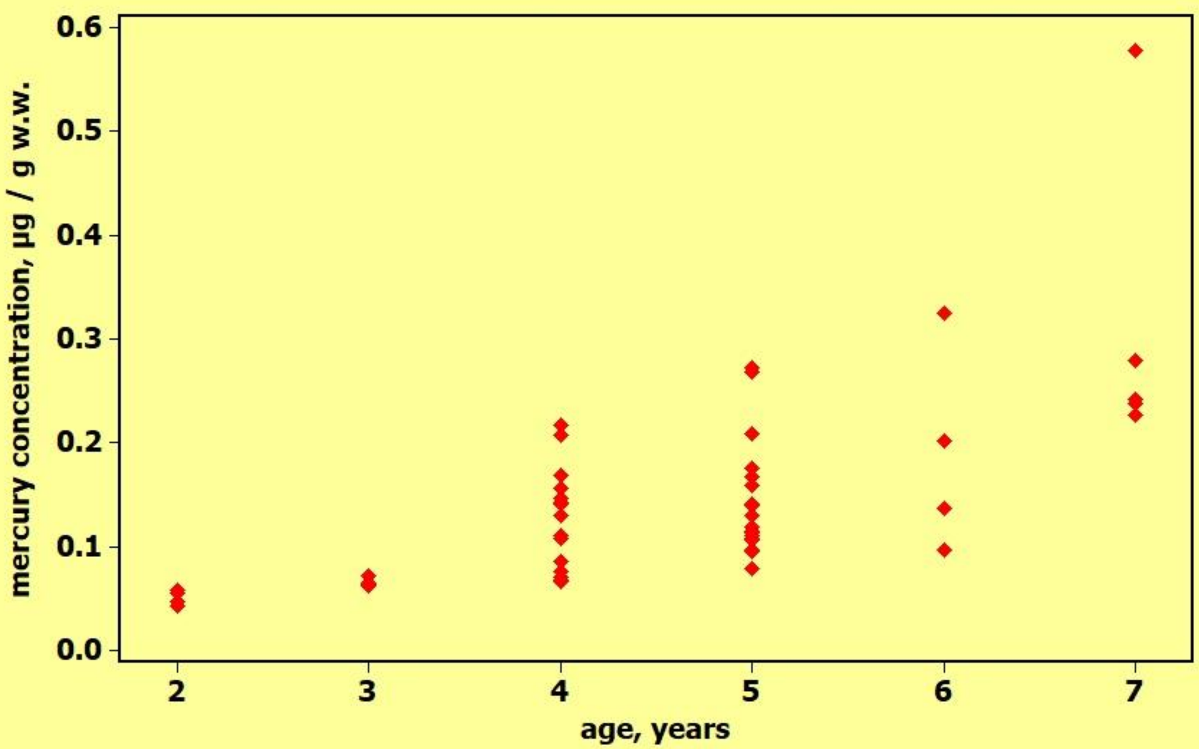


Figure 14. Scatterplot of mercury vs. age for lake whitefish from Inukjuak River watershed

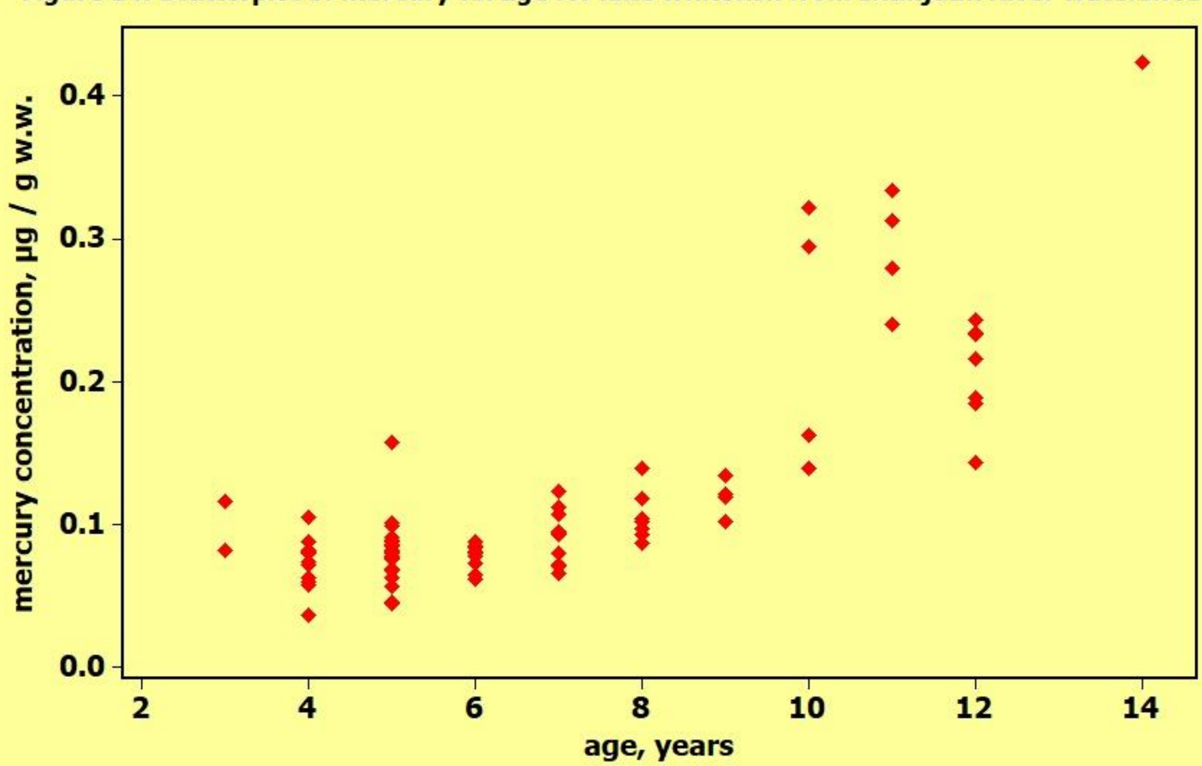


Figure 15. Scatterplot of mercury vs. age for lake trout from Lake Tasialuk

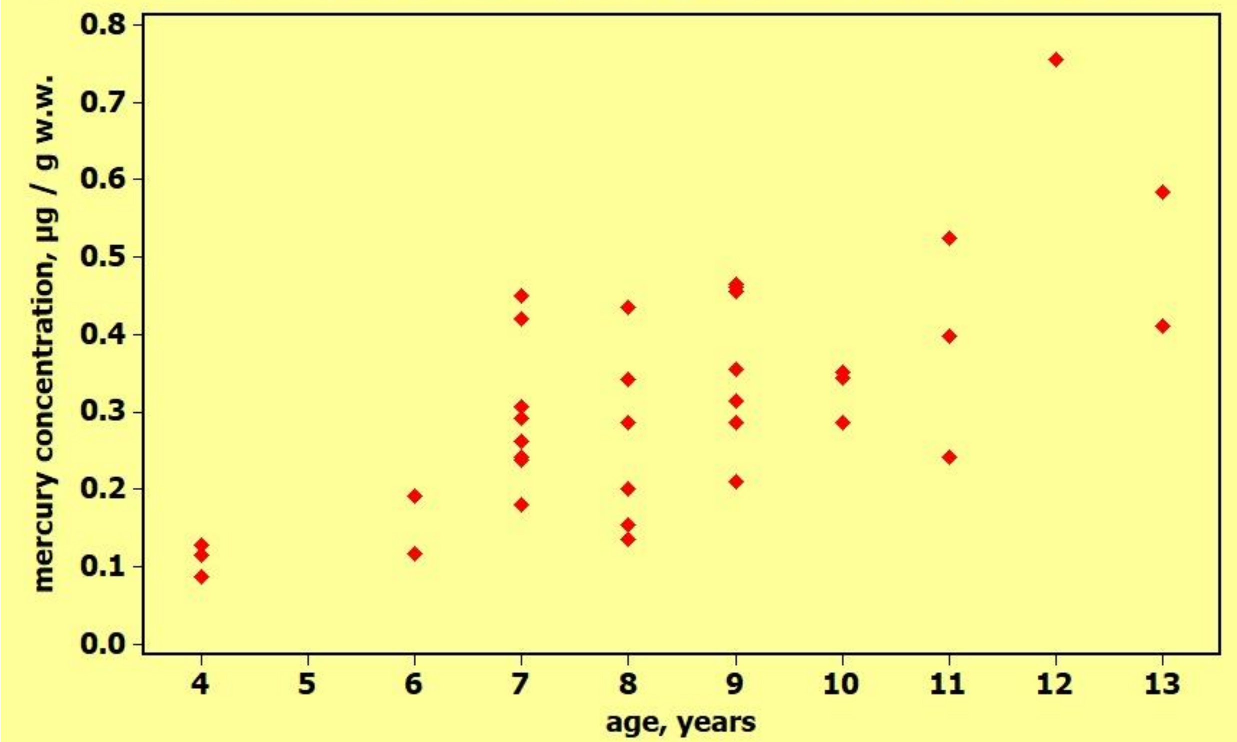


Figure 16. Scatterplot of mercury vs. age for brook trout from Lake Tasialuk

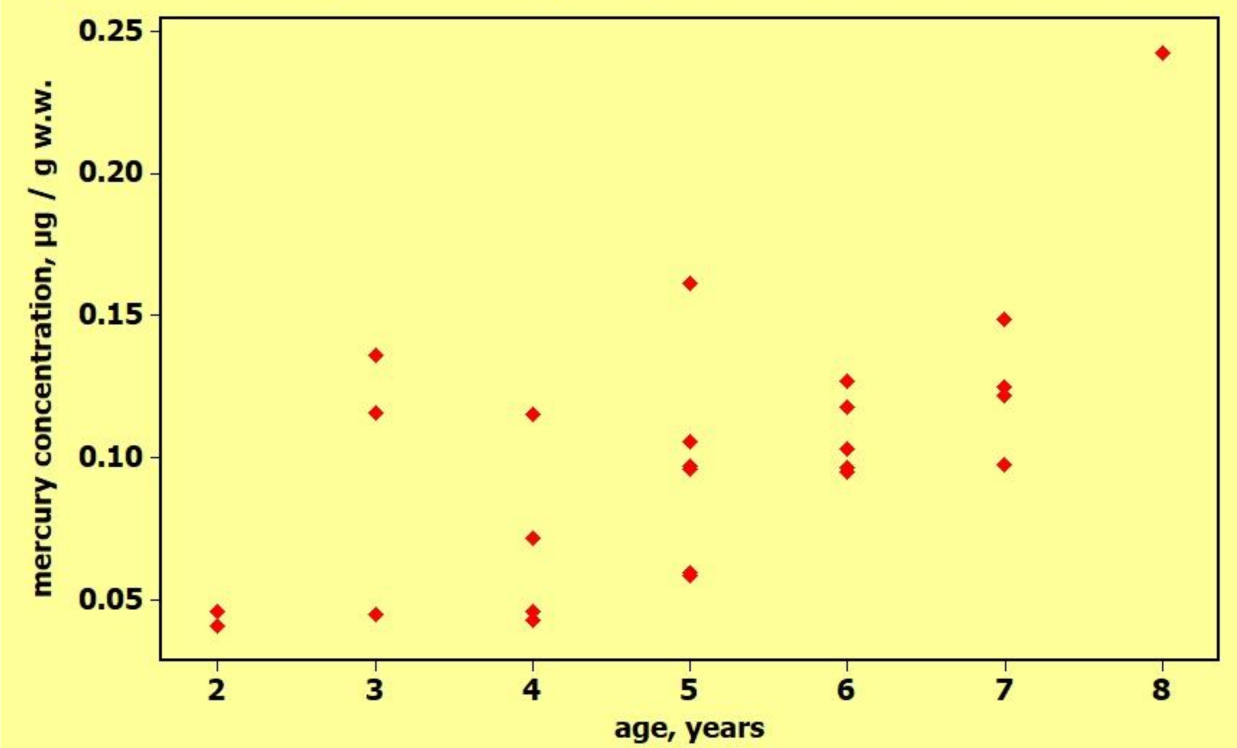


Figure 17. Scatterplot of mercury vs. age for lake trout from sub-station 5.1

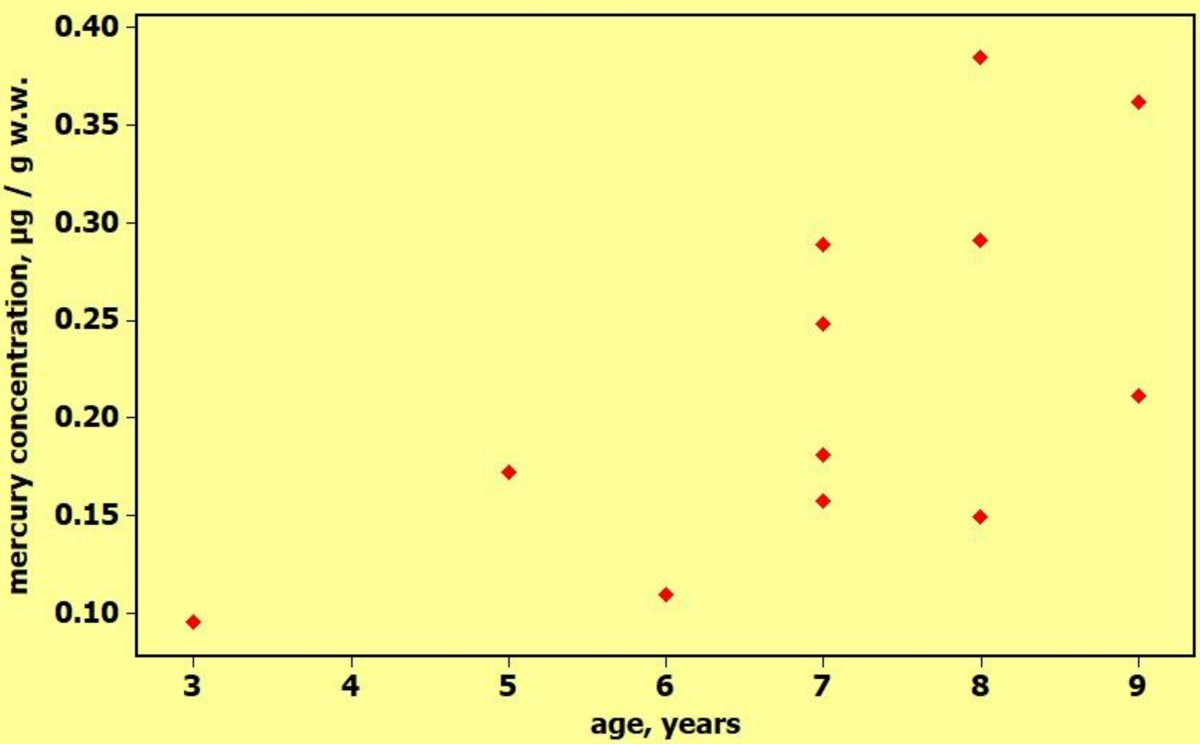
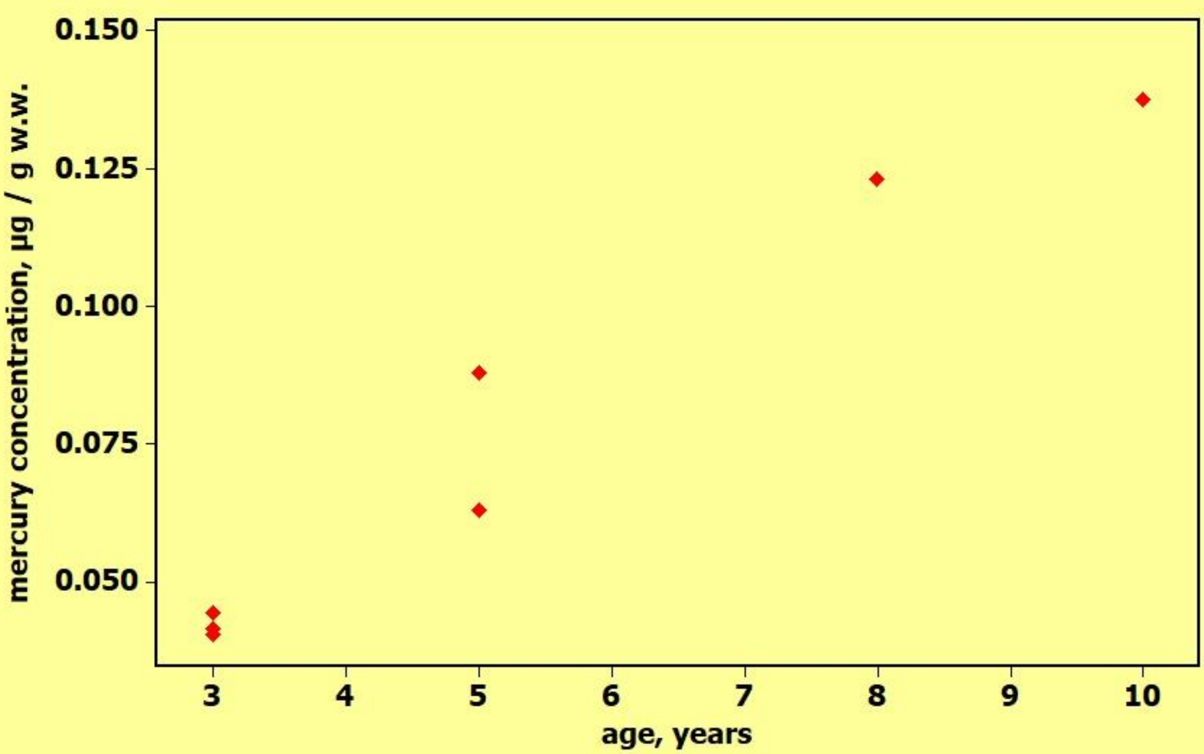


Figure 18. Scatterplot of mercury vs. age for lake whitefish from sub-station 5.1



Linear Regression Models

It was found that $\log_e$ transformation of mercury concentration has readily improved the regression of mercury concentration on fish age by increasing the R^2% which measured the strength of the relationship and how well the linear regression model fitted the data. Analysis of residuals was carried out to ensure the four pre-requisite assumptions for the regression model be met: (1) Equal variances in the residuals were tested using the Goldfeld – Quandt test on sorted standardized residuals (Goldfeld and Quandt 1965); (2) Randomness of the residuals was tested using the Wald – Wolfwitz Runs test on sorted standardized residuals (Magel and Wibowo 1997); (3) Independence of the residuals was tested using the Durbin – Watson test statistic (Durbin and Watson 1950) and (4) Normality of the residuals was tested using the Anderson – Darling test statistic and normality plot of the standardized residuals.

Before analysis of residuals was carried out, the $\log_e$ mercury concentration data sets were checked for the presence of outliers using the standard batch of diagnostic measures: Studentized residuals, Hi – leverage, Cook's distance and DFFITS. No outlier was needed to be removed from the lake trout and brook trout mercury data; however, 26 outliers were needed to be removed from the mercury data set (n =93) of lake whitefish from the Inukjuak River watershed to rendered the data more suitable for the regression model. The presence of outliers for mercury in lake whitefish from the Inukjuak River watershed was clearly shown in the box – and whisker plot (figure 4).

Table 6 summarized the results of the analysis of residuals for the regression of $\log_e$ mercury concentration on fish age of the lake trout, brook trout and lake whitefish from the Inukjuak River watershed, Lake Tasialuk and sub-station 5.1. Log_e transformation has rendered variances of residuals ($p > 0.05$) homogeneous for all cases examined. With the exception of lake whitefish from the Inukjuak River watershed, residuals were random ($p > 0.05$) for all other data sets. The randomness of the sorted standardized residuals tested by the Wald – Wolfowitz Runs test actually tested if the elements of a two – valued data sequence were mutually independent. The p – value ($p = 0.04$) of the residuals of $\log_e$ mercury data of lake whitefish from the Inukjuak

Table 6. Summary of results of analysis of residuals for the regression of log_e mercury concentration on fish age of the lake trout, brook trout and lake whitefish from Inukjuak River watershed, Lake Tasialuk and sub-station 5.1.

Location	Fish species	Number of fish (n)	Test for equal variances Goldfeld – Quandt test Levene test statistic, p - value	Test for randomness Wald – Wolfwitz Runs test, p - value	Test for independence Durbin – Watson test statistic (DW)	Test for normal distribution Anderson – Darling test statistic, p - value
Inukjuak River watershed	Lake trout	13	2.52, 0.141 [a]	0.370 [a]	0.873 [c]	0.1899, 0.879 [a]
	Brook trout	57	0.020, 0.878 [a]	0.909 [a]	2.020 [b]	0.800, 0.046
	Like whitefish	67 *	0.680, 0.412 [a]	0.040	1.652 [b]	0.220, 0.829 [a]
Lake Tasialuk	Lake trout	35	0.480, 0.493 [a]	0.060 [a]	2.387 [b]	0.185, 0.900 [a]
	Brook trout	26	2.620, 0.118 [a]	0.344 [a]	2.146 [b]	0.463, 0.236 [a]
Sub-station 5.1	Lake trout	12	0.060, 0.810 [a]	0.069 [a]	2.071 [b]	0.383, 0.338 [a]
	Lake whitefish	7	3.79, 0.109 [a]	0.224 [a]	2.861 [b]	0.289, 0.510 [a]

[a] , $p > 0.05$, the null hypothesis of the test has to be accepted at 0.05 level of significance.

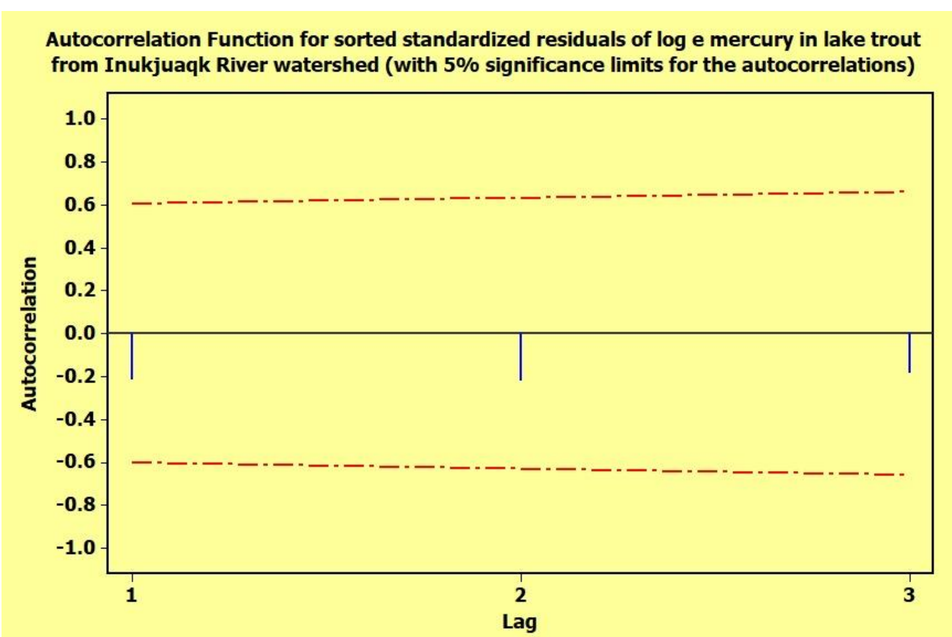
[b], the calculated Durbin – Watson statistic (DW) is higher than both the upper critical value (d_U) and the lower critical value (d_L) for a single predictor and the number of sample (n).

[c] , the calculated Durbin – Watson statistic (DW) is higher than the lower critical value (d_L) but is lower than the upper critical value (d_U) for a single predictor and the number of sample (n).

* , 26 outliers were removed from the log_e mercury concentration in lake whitefish from Inukjuak River watershed data set.

River watershed was not too far below the 0.05 level of significance and was deemed marginally acceptable in the present case since the other three pre – requisite assumptions were met for this data set.

The independence of residuals is probably the most important of the four assumptions. This is because in a linear regression model, it is assumed that residuals are independent of one another, i.e. they are not correlated. Positive correlations between residuals tend to inflate the t – value for the regression coefficient, rendering the independent variables appear significant when they might not be (i.e. inflating the Type I Error). The results of Durbin – Watson test for independence of residuals showed that apart for lake trout from the Inukjuak River watershed, all the rest of the mercury data sets have independent residuals (Table 6). In the case of lake trout from the Inukjuak River watershed, the Durbin – Watson test statistic of 0.873 which was higher than the lower critical value (d_L) but was lower than the upper critical value (d_U) for a single predictor (fish age) and the number of sample (n = 13). The Durbin – Watson test in this case was inconclusive. However, the autocorrelation plot of the sorted standardised residuals below clearly showed that all autocorrelations were within the two standard error confidence bounds. Hence, there was no autocorrelation at and beyond a given lag at 0.05 level of significance. In other words, the autocorrelation plot has confirmed that the sorted standardized residuals of the $\log_e$ mercury concentration data of lake trout from Inukjuak River watershed were independent of one another.



The final pre – requisite assumption that needed to validate the use of the linear regression model was the normality of frequency distribution of standardized residuals. With the exception of brook trout from the Inukjuak River watershed, residuals have highly normal frequency distributions ($p > 0.05$) for all other data sets (Table 6). The p – value ($p = 0.046$) of the standardized residuals of $\log_e$ mercury data of brook trout from Inukjuak River watershed was not too far below the 0.05 level of significance which suggested the frequency distribution was very close to normality. In the present case since the other three pre – requisite assumptions were met for this data set; it was deemed valid to be further analyzed using the linear regression model. Figures 19 to 25 showed residual plots for all the data sets.

Figure 19. Residual plots for log e mercury data of brook trout from Inukjuak River watershed

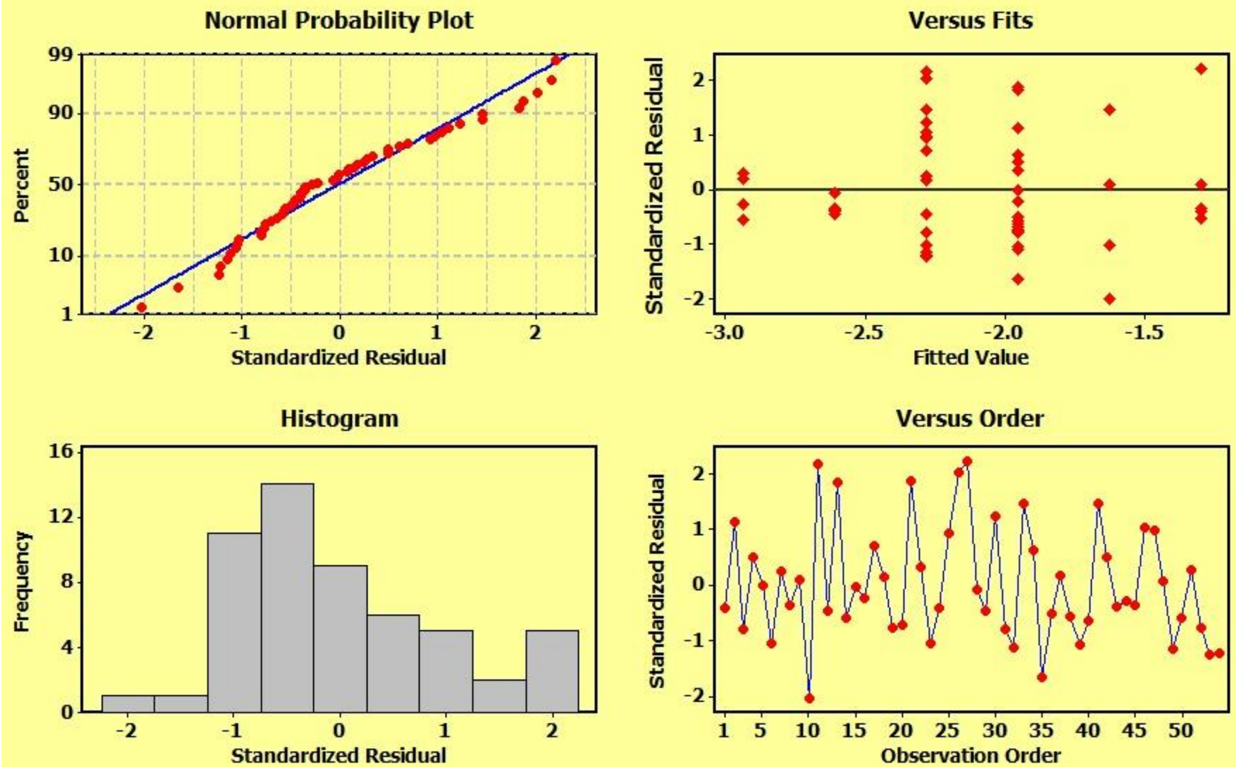


Figure 20. Residual plots for loge mercury data of lake trout from Inukjuak River watershed.

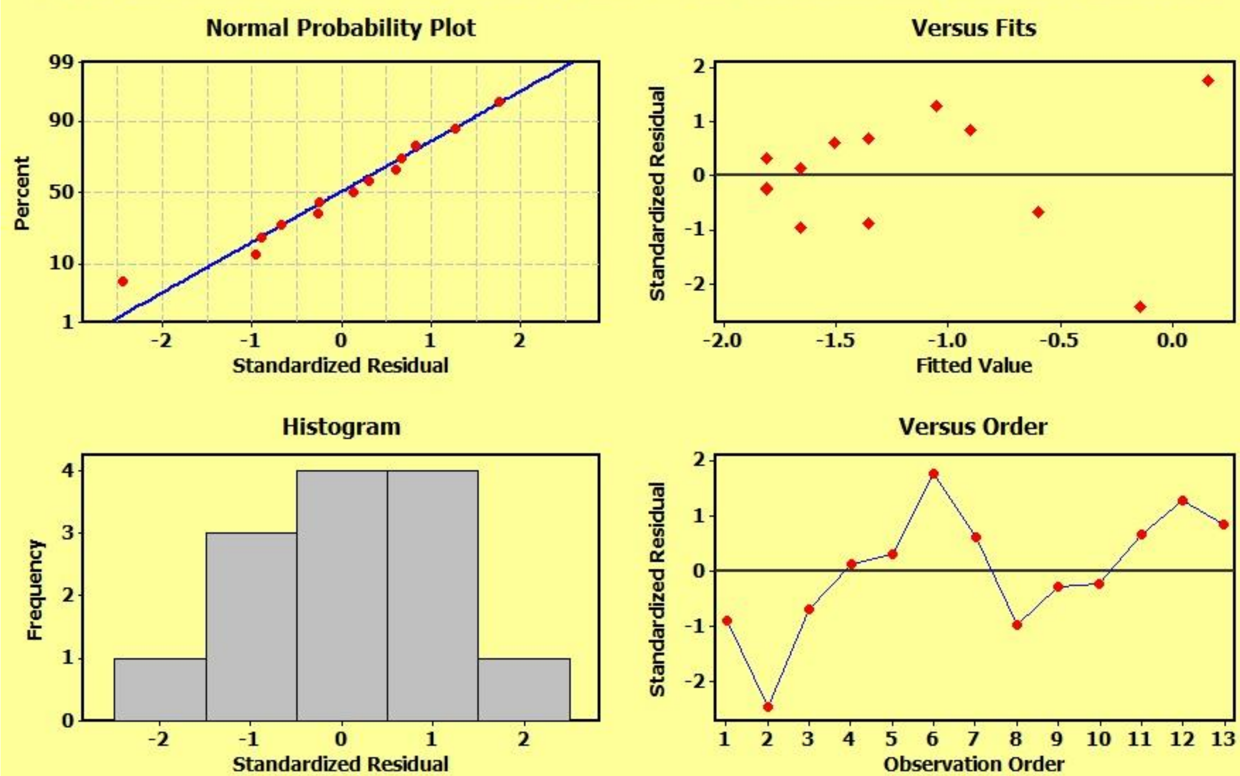


Figure 21. Residual plot for log e mercury data of lake whitefish from Inukjuak River watershed

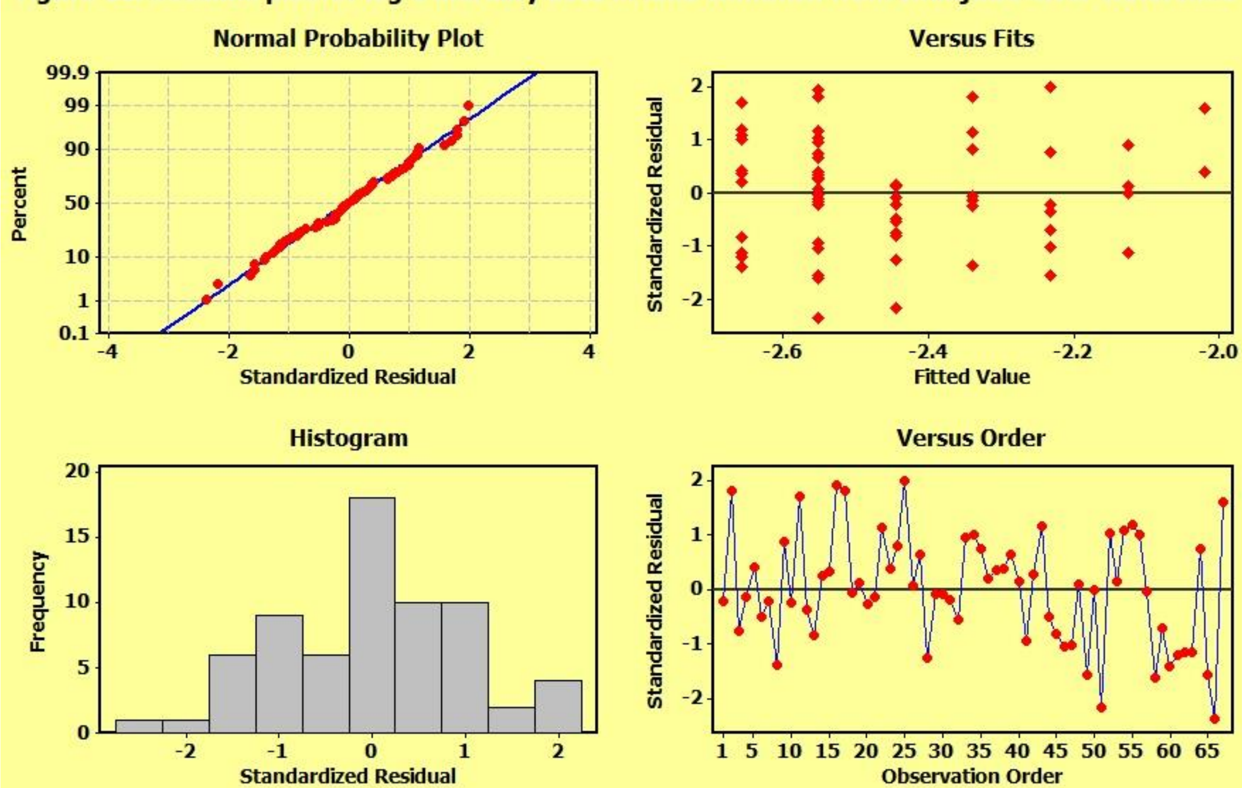


Figure 22. Residual plots for loge mercury data of brook trout from Lake Tasialuk

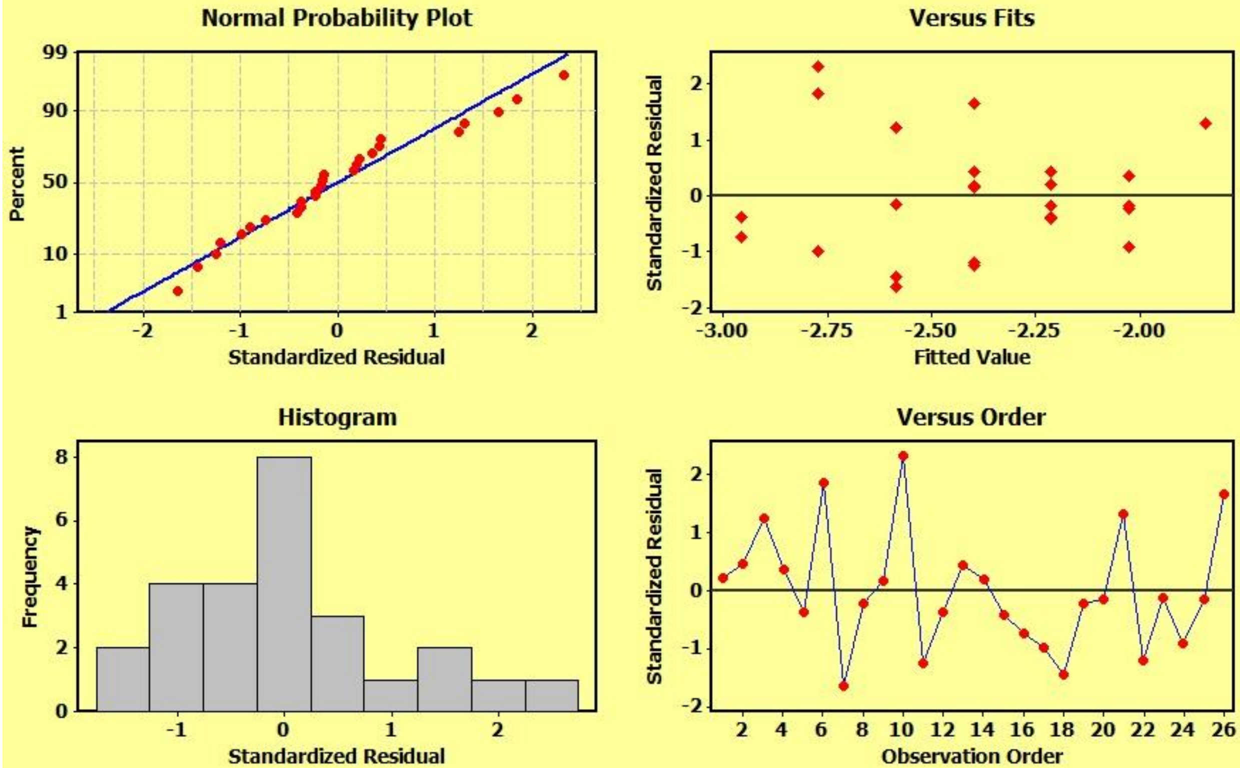


Figure 23. Residual plots for loge mercury data of lake trout from Lake Tasialuk

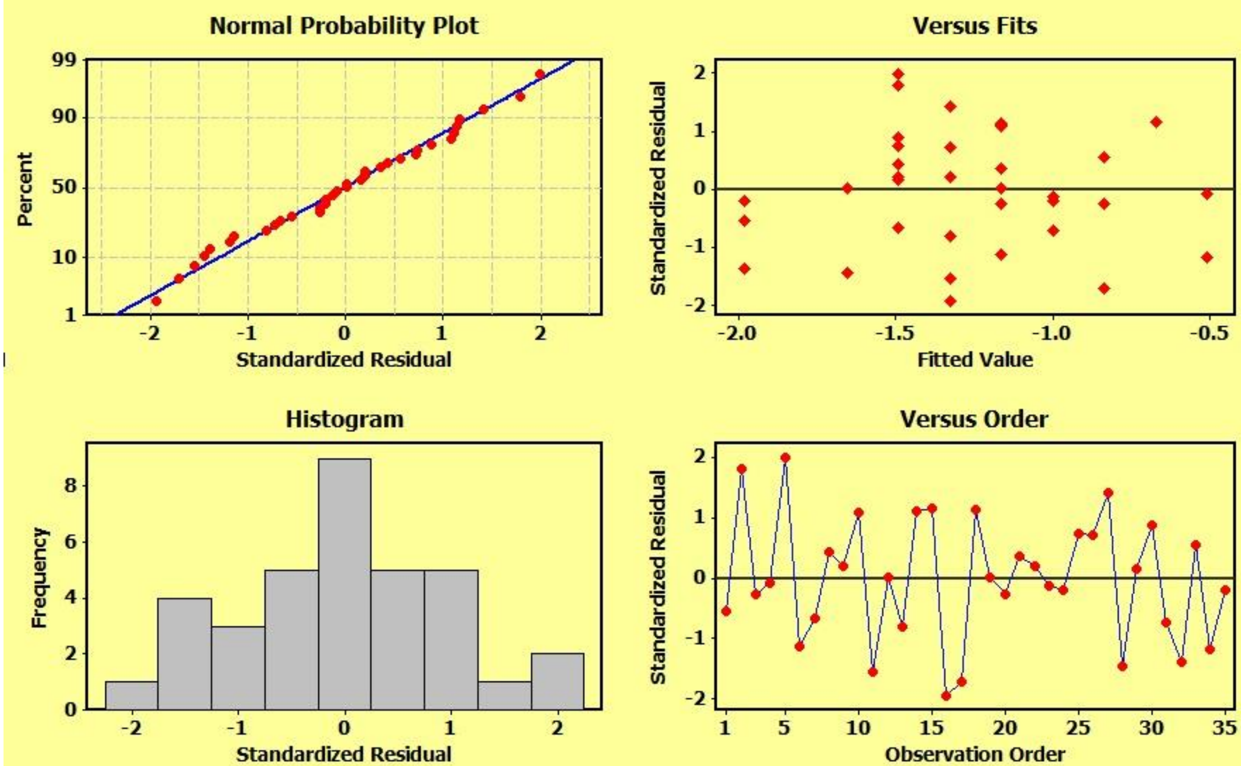


Figure 24. Residual plots for loge mercury data of lake trout from sub-station 5.1

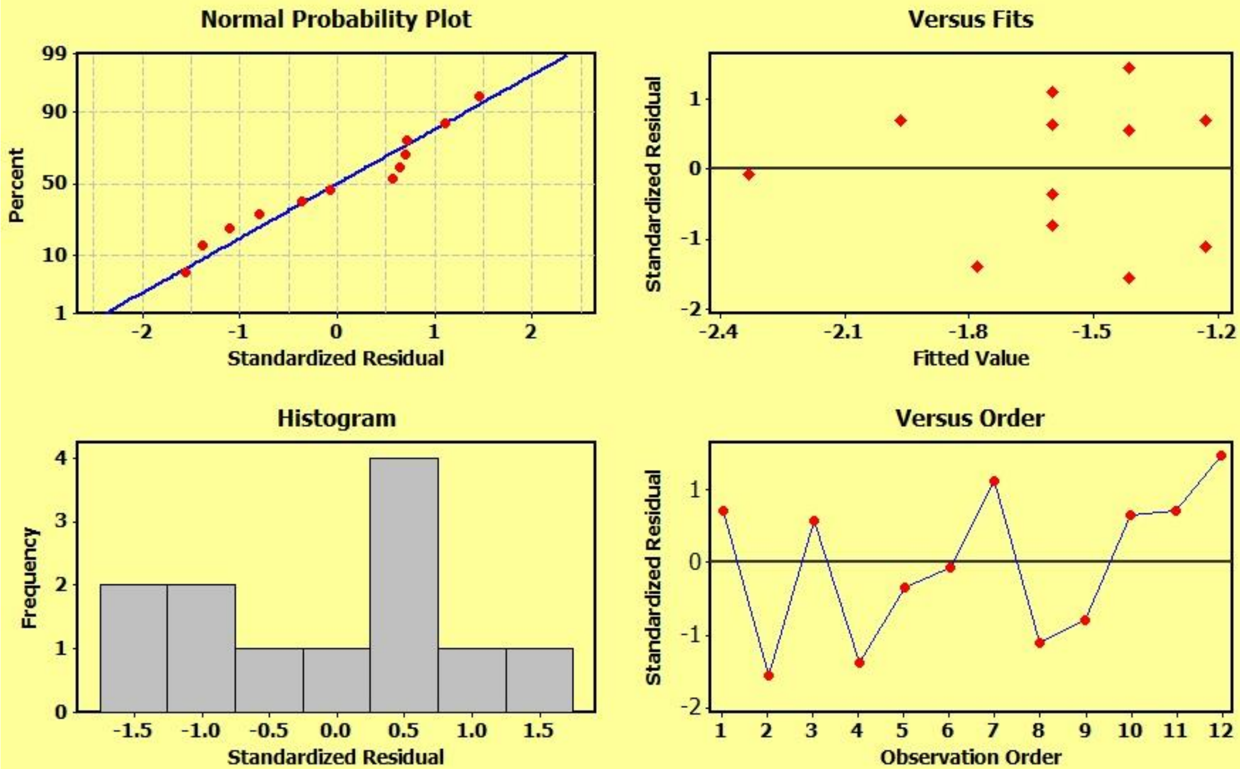
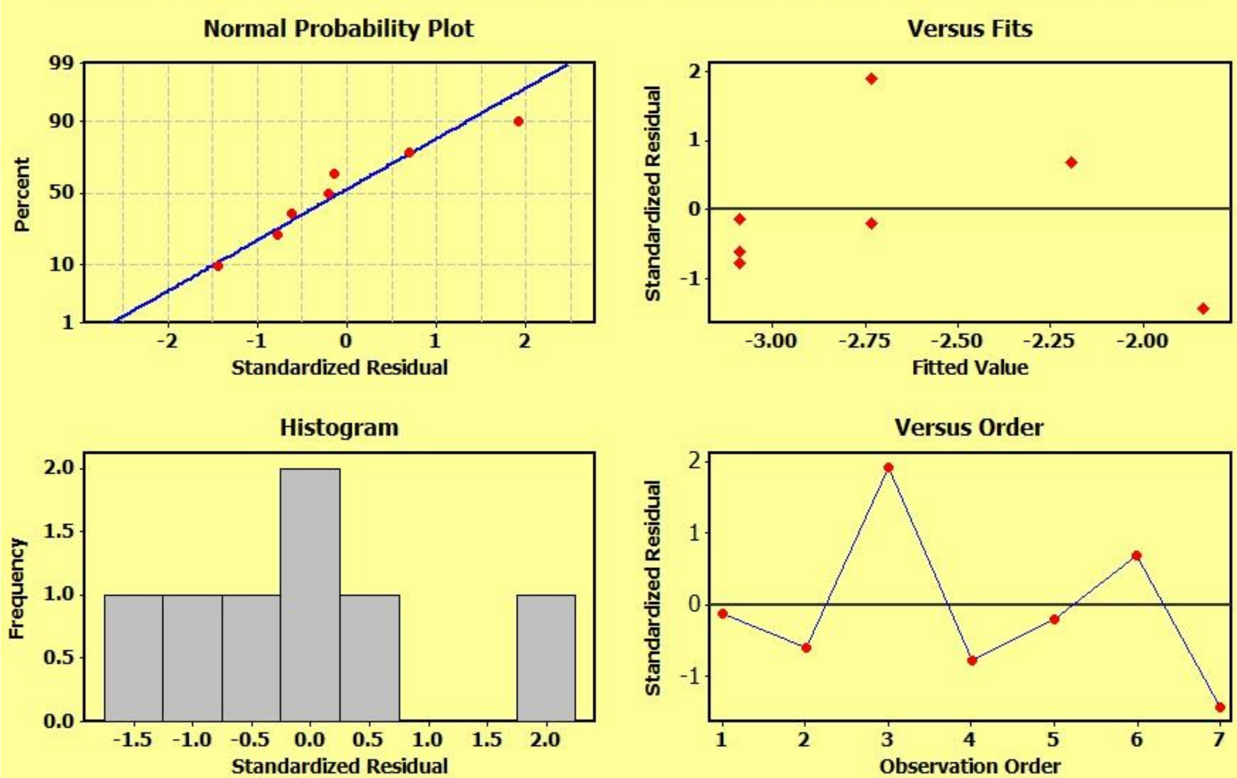


Figure 25. Residual plots of mercury data of lake whitefish from sub-station 5.1



Since all four pre – requisite assumptions to validate the use of the linear regression model by and large have been satisfied, we proceeded with making an attempt to use the linear regression model to help us to estimate the conditional expectation of $\log_e$ mercury concentration in fish given fish age as the predictor:

Regression Analysis: loge mercury in brook trout from Inukjuak River watershed vs age

The regression equation is
log e mercury = - 3.60 + 0.329 age

Predictor	Coef	SE Coef	T	P
Constant	-3.5968	0.1810	-19.87	0.000
age	0.32859	0.03830	8.58	0.000

S = 0.353794   R-Sq = 58.6%   R-Sq(adj) = 57.8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	9.2136	9.2136	73.61	0.000
Residual Error	52	6.5089	0.1252		
Total	53	15.7225			

Durbin-Watson statistic = 2.02034

Regression Analysis: log e mercury in lake trout from Inukjuak River watershed vs age

The regression equation is
log e mercury = - 2.42 + 0.152 age

Predictor	Coef	SE Coef	T	P
Constant	-2.4158	0.1402	-17.23	0.000
age	0.15157	0.01545	9.81	0.000

S = 0.230648   R-Sq = 89.7%   R-Sq(adj) = 88.8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	5.1215	5.1215	96.27	0.000
Residual Error	11	0.5852	0.0532		
Total	12	5.7066			

Durbin-Watson statistic = 0.873397

Regression Analysis: loge mercury in lake whitefish from Inukjuak River watershed vs age

```
The regression equation is
log e mercury = - 3.34 + 0.154 age


Predictor        Coef  SE Coef       T      P
Constant     -3.34123  0.07649  -43.68  0.000
age           0.15406  0.01058   14.57  0.000


S = 0.267070   R-Sq = 70.0%   R-Sq(adj) = 69.7%


Analysis of Variance

Source          DF      SS      MS       F      P
Regression       1  15.139  15.139  212.24  0.000
Residual Error  91   6.491   0.071
Total           92  21.629


Durbin-Watson statistic = 1.50660
```

Regression Analysis: log e mercury in brook trout from Lake Tasialuk vs age

```
The regression equation is
log e mercury = - 3.33 + 0.187 age


Predictor         Coef  SE Coef       T      P
Constant       -3.3327   0.2284  -14.59  0.000
age            0.18658  0.04288    4.35  0.000


S = 0.353174   R-Sq = 44.1%   R-Sq(adj) = 41.8%


Analysis of Variance

Source          DF      SS      MS      F      P
Regression       1  2.3617  2.3617  18.93  0.000
Residual Error  24  2.9936  0.1247
Total           25  5.3553


Durbin-Watson statistic = 2.14601
```

Regression Analysis: log e mercury in lake trout from Lake Tasialuk vs age

The regression equation is
log e mercury = - 2.64 + 0.164 age

Predictor	Coef	SE Coef	T	P
Constant	-2.6372	0.2328	-11.33	0.000
age	0.16388	0.02696	6.08	0.000

S = 0.353514   R-Sq = 52.8%   R-Sq(adj) = 51.4%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	4.6160	4.6160	36.94	0.000
Residual Error	33	4.1241	0.1250		
Total	34	8.7401			

Durbin-Watson statistic = 2.38684

Regression Analysis: loge mercury in lake trout from sub-station 5.1 vs age

The regression equation is
loge mercury = - 2.89 + 0.184 age

Predictor	Coef	SE Coef	T	P
Constant	-2.8858	0.4215	-6.85	0.000
age	0.18401	0.05864	3.14	0.011

S = 0.331736   R-Sq = 49.6%   R-Sq(adj) = 44.6%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	1.0835	1.0835	9.85	0.011
Residual Error	10	1.1005	0.1100		
Total	11	2.1840			

Durbin-Watson statistic = 2.07144

Regression Analysis: loge mercury in lake whitefish from sub-station 5.1

```
The regression equation is
loge mercury = - 3.63 + 0.180 age


Predictor      Coef  SE Coef       T      P
Constant    -3.6315   0.1488  -24.41  0.000
age         0.17959  0.02536    7.08  0.001


S = 0.170911   R-Sq = 90.9%   R-Sq(adj) = 89.1%


Analysis of Variance

Source          DF      SS      MS      F      P
Regression       1  1.4652  1.4652  50.16  0.001
Residual Error   5  0.1461  0.0292
Total            6  1.6113


Durbin-Watson statistic = 2.86087
```

The absolute value of the regression coefficient (Coef) indicated the change of the mean response (i.e. log $_e$ mercury concentration) per unit increase of the predictor (i.e. fish age). The p – values of the regression coefficient were 0.000 in all cases which indicated that the relationships between fish age and log $_e$ mercury concentration were significant. The very high R -Square (adj.) and R – Square values in all cases which indicated that high percentage of the variances in the log $_e$ mercury concentration could be explained by fish age in the regression model. The T – statistic and its p – value tested the significance of each of the two coefficients (i.e. they indicated whether a relationship exists between each independent variable (constant and fish age) and the log $_e$ mercury concentration). In all the cases, the absolute values of both T – statistic were high and both the p – values were well below 0.05 level of significance which indicated that both the constant and fish age have a highly significant relationship with log $_e$ mercury concentration. The analysis of variance tested the "overall" significance of the regression model. It tested whether the R – Square was significantly different from zero. The high absolute values of F and the p – values less than the 0.05 level of significance for all cases further confirmed a true relationship existed between fish age and log $_e$ mercury concentration, i.e. the fit of the overall model was significantly different from chance. To test if the slopes of the regression lines were significantly different from zero, we calculated a t – statistic by dividing the regression coefficient (Coef) of fish age by the standard error of the regression coefficient (SE Coef). In all cases, the absolute values of this t – statistic were higher than the critical value at 0.05 level of significance; hence the slopes of all the regression lines were significantly different from zero. Figures 26 to 32 showed the regression lines of $\log_e$ mercury concentration on fish age and their 95% confidence intervals for all the cases studied.

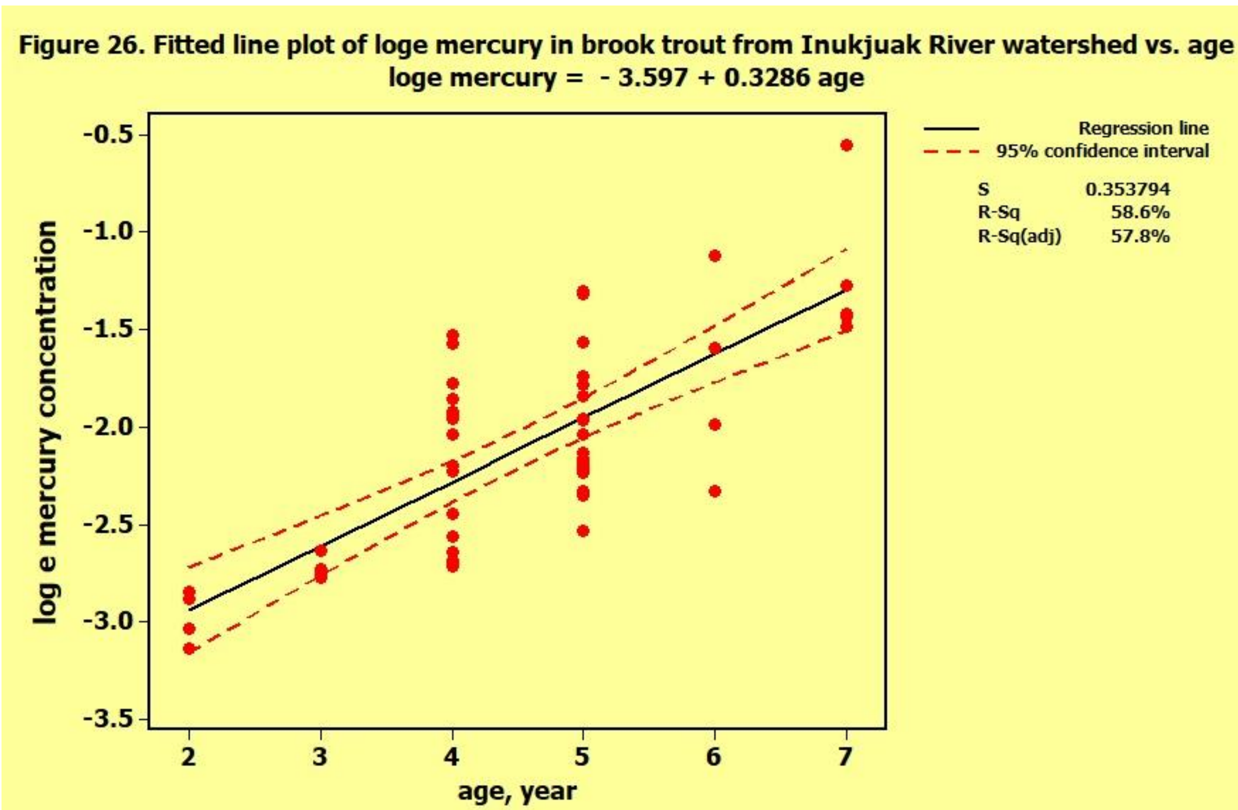


Figure 27. Fitted line plot of log e mercury in lake trout from Inukjuak River watershed vs. age
log e mercury = - 2.416 + 0.1516 age

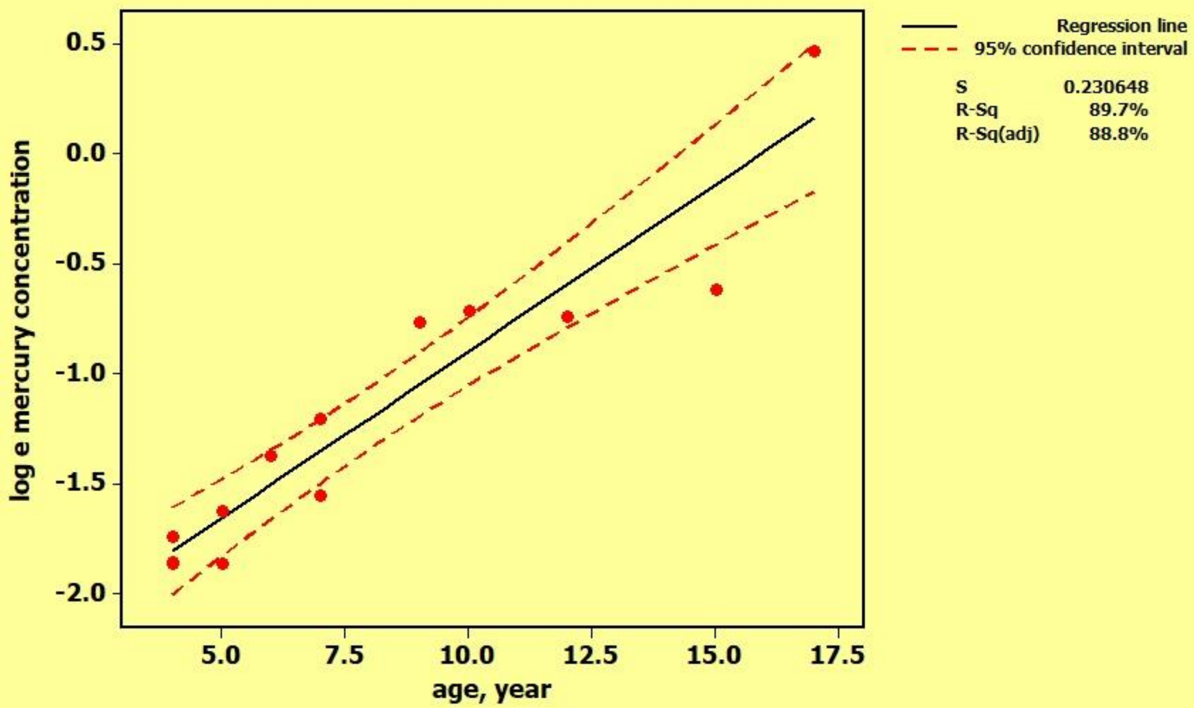


Figure 28. Fitted line plot of log e mercury in lake whitefish from Inukjuak River watershed vs. age
log e mercury = - 3.085 + 0.1066 WF age

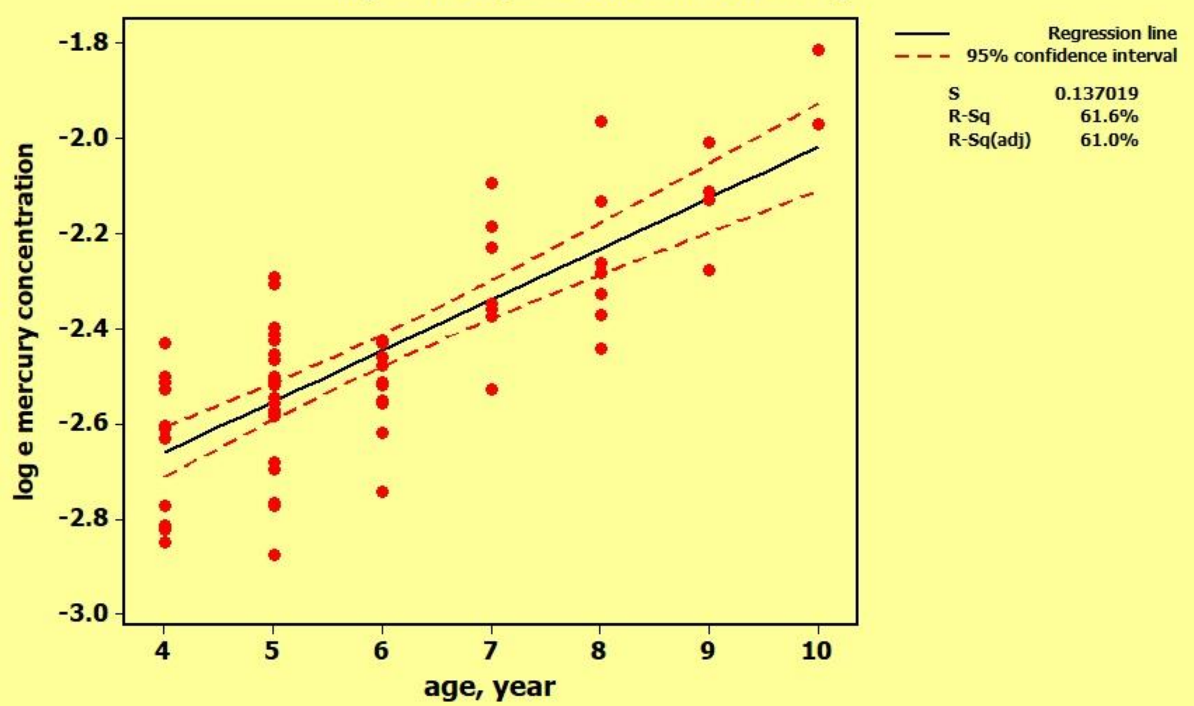


Figure 29. Fitted line plot of log e mercury in brook trout from Lake Tasialuk vs. age

log e mercury = - 3.333 + 0.1866 age

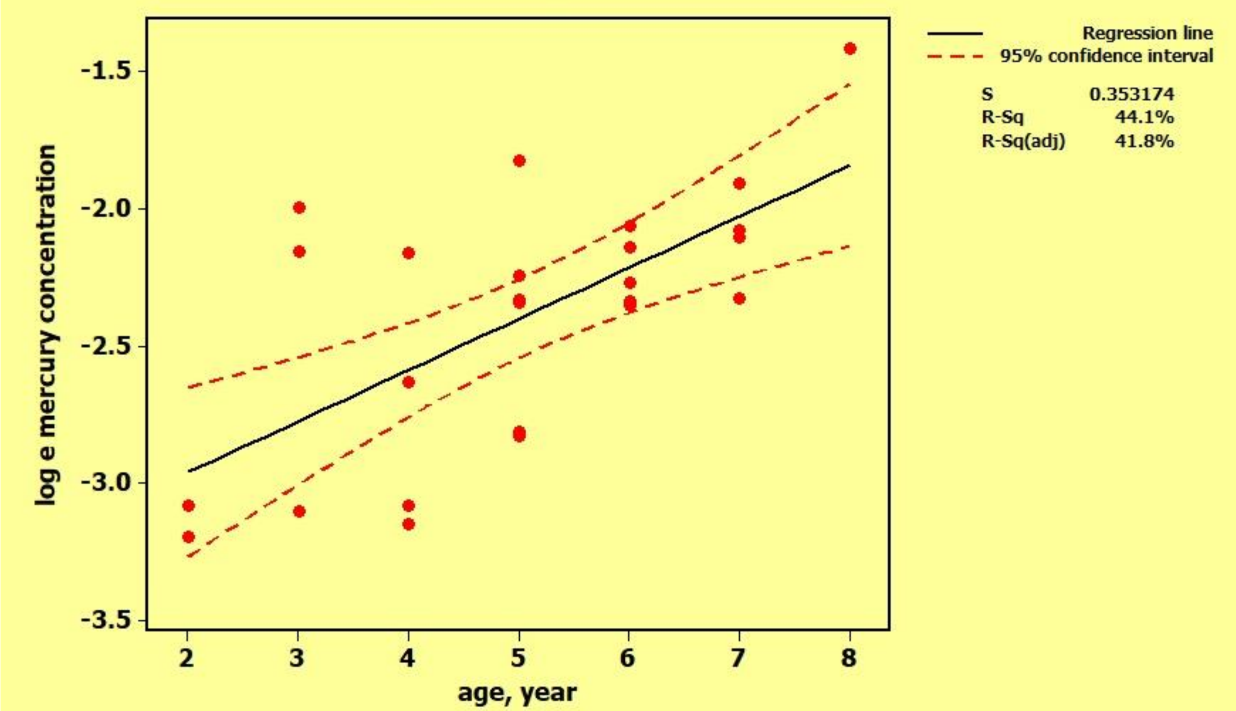


Figure 30. Fitted line plot of log e mercury in lake trout from Lake Tasialuk vs. age

log e mercury = - 2.637 + 0.1639 age

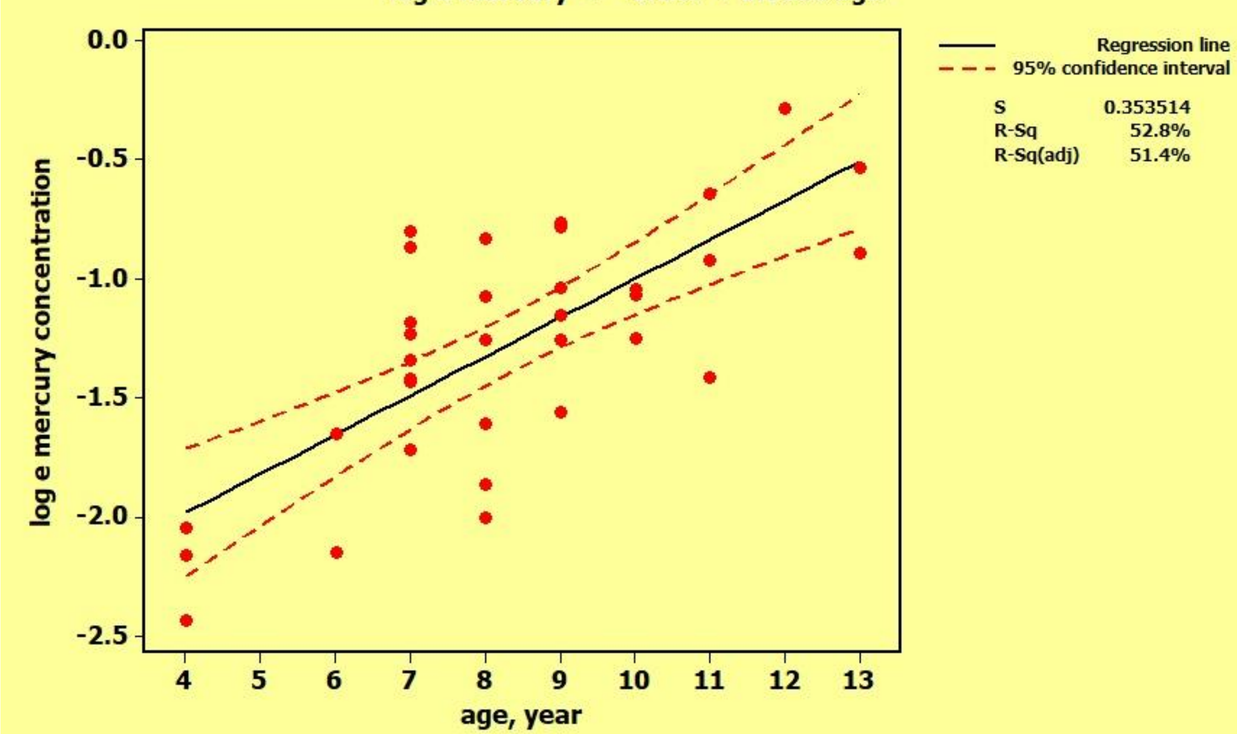


Figure 31. Fitted line plot of log e mercury in lake trout from sub-station 5.1 vs. age

log e mercury = - 2.886 + 0.1840 age

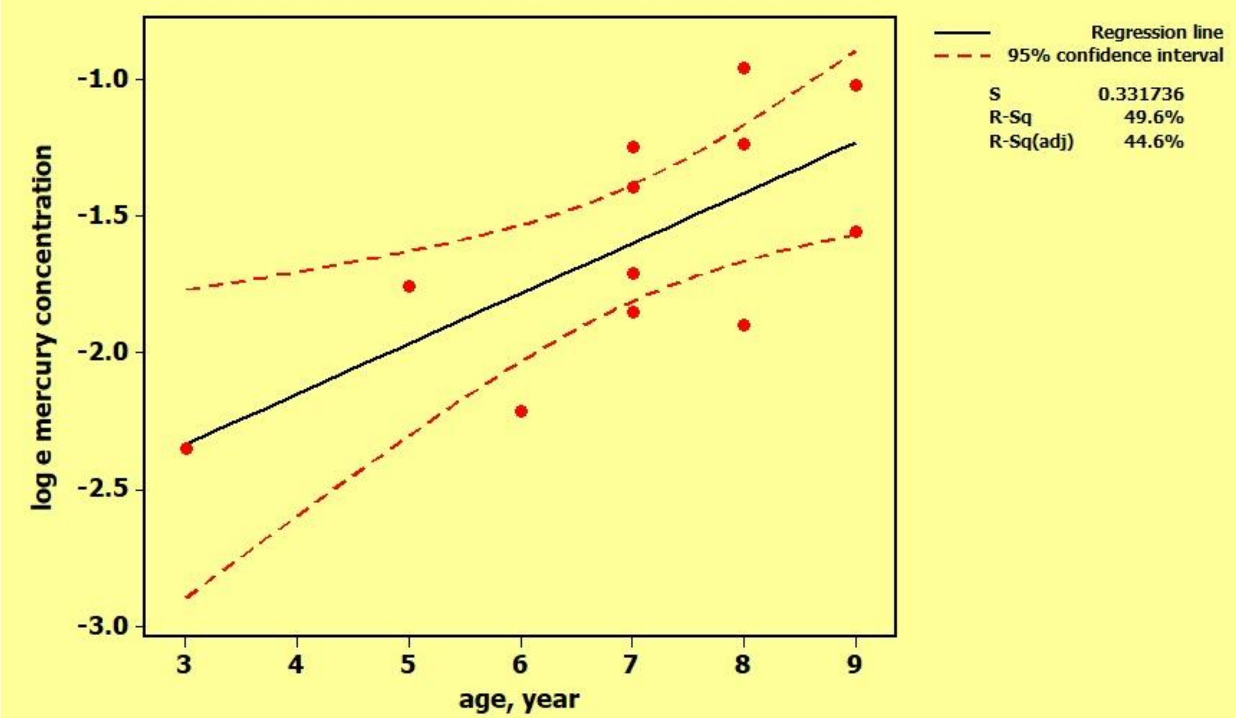


Figure 32. Fitted line plot of log e mercury in lake whitefish from sub-station 5.1 vs. age

log e mercury = - 3.631 + 0.1796 age

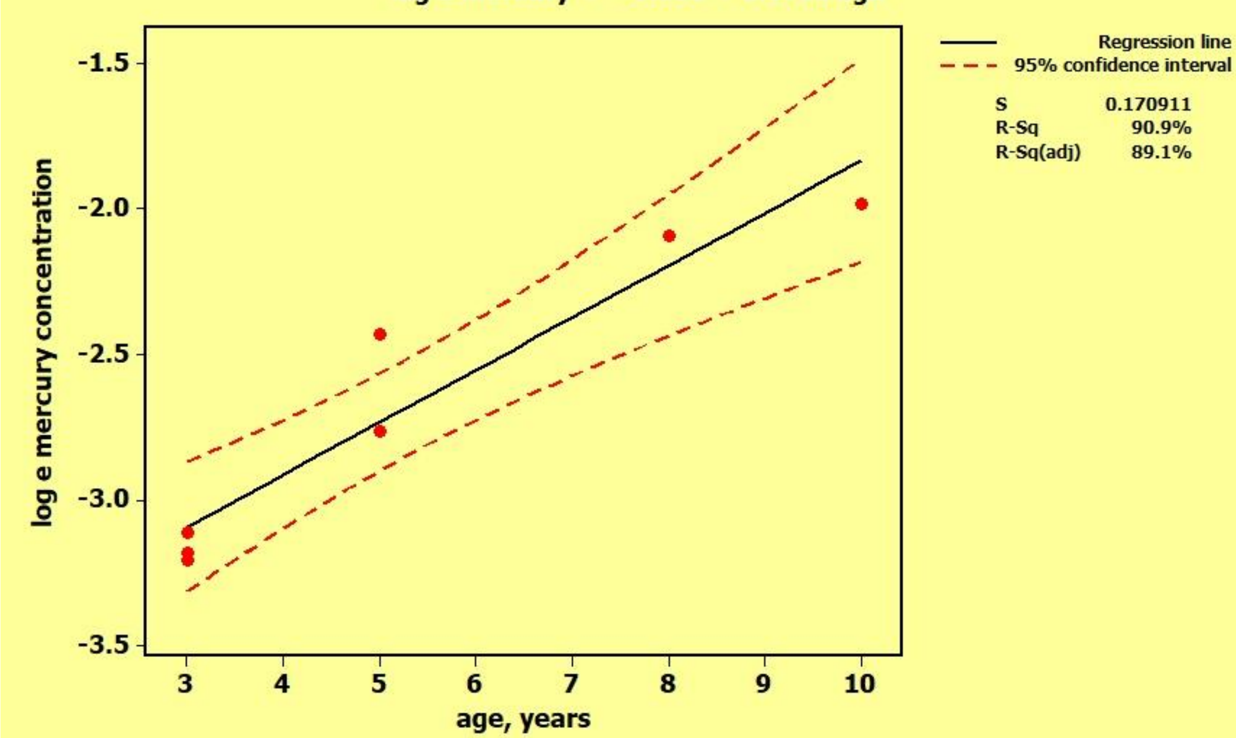


Table 7. Mercury concentration ranges of fish of "standard" ages estimated using the 95% confidence intervals of the linear regression fits.

Location	Fish species	"Standard" fish age*, years	Mercury concentration range estimated using the 95% confidence intervals, µg / g w.w.
Inukjuak River watershed	Brook trout	5	0.128 – 0.157
	Lake trout	4	0.134 – 0.200
	Lake whitefish	5	0.072 – 0.082
Lake Tasialuk	Brook trout	5	0.079 – 0.105
	Lake trout	7	0.195 – 0.260
Substation 5.1	Lake whitefish	3	0.036 – 0.057
	Lake trout	7	0.163 – 0.250

* , the most abundant age of the species in that watershed.

Using the 95% confidence intervals from figures 26 to 32, the mercury concentration ranges that the mean mercury concentration of fish of the "standard" age has a chance of 95% to fall within were calculated (Table 7).

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Wheatley, B. (1979). *Methylmercury in Canada: Exposure of Indian and Inuit residents to methylmercury in the Canadian environment*. Mercury Program Findings to December 31, 1978. Medical Services Branch, Health and Welfare Canada, Ottawa, Ontario. 200pp.

Appendix A

SOP 004M CVAAS Operation Parameters

Method Name: SOP004M

Define Element

Method Description : SOP004M

Spectrometer
Element : Hg
Wavelength (nm) : 253.65
Slit Width (nm) : 0.7

Signal
Type : AA   Measurement : Peak Height   Smoothing : 19 points

---

Settings

Read Parameters
Time (sec) : 22.0   Delay Time (sec) : 4.0   BOC Time (sec) : 3

Replicates ... Same for All Samples : 2

Lamp Current
Use value entered in Lamp Setup window

FIAS

Operation
Cell Temperature (C) : 100
Sample Volume (uL) : 500
Use Amalgam? No

Step	Time (sec)	Pump 1 Speed	Pump 2 Speed	Valve Position	Remotes 2	3	4	5	6	7	8	9	10
Prefill	13	110	0	Fill									
1	15	110	0	Fill									
2	20	110	0	Inject									

Read Step : 2
Steps to Repeat : 1 to 1
Number of Repeats : 0

Autosampler

Wash Frequency : Only after solutions exceeding limit
Limit : Concentration (Calib. units) > 0.1 ug/L
Wash Location : 0
Normal Cycles : 1
Use FIAS steps: 1 to 1

Calibration Equation and Units

Equation : Linear Through Zero
Maximum Decimal Places : 3   Maximum Significant Figures : 4
Calibration Units : ug/L

Method Name: SOP004M

Sample Units : ug/L

Calibration Standard Concentrations

	ID	Concentration	A/S Loc
Calib Blank	calib blank		1
Reslope Std.	5.00 ppb	5.000	5
Standard 1	0.625 ppb	0.625	2
Standard 2	1.250 ppb	1.250	3
Standard 3	2.500 ppb	2.500	4
Standard 4	5.000 ppb	5.000	5
Standard 5	10.000 ppb	10.000	6

Initial Calibration Options

When opening this method manually:
  Clear calibration curve(s) and construct a new calib curve.

When using this method in a multimethod sequence:
  Start by constructing new calibration curves.

Calibration Check

Correlation coefficient checking is not enabled in this method.

Recalibration

Recalibration Type : Reslope
Frequency ... Every 18 samples

Analyze standards at end of analysis is not enabled in this method.

Precision Checks

Precision checking is not enabled in this method.

Beyond Calibration Range

Beyond calibration range checking is not enabled in this method.

Matrix Recovery

Matrix recovery checking is not enabled in this method.

Sample Limits

Not Enabled

QC Sample Definition

QC	Sample ID	A/S Loc	Count as Sample	Subtract Reagent Blank
QC 1	dorm2 1/2 0.211g	6	No	No
QC 2	dolt2 1/2 0.210g	7	No	No

QC Sample Concentrations and Limits

QC 1: dorm2 1/2 0.211g　　Concentration Units: Calibration

Analyte	Units	Conc	Lower Limit	Upper Limit
Hg 253.65	ug/L	5.93	5.337	6.523

QC 2: dolt2 1/2 0.210g　　Concentration Units: Calibration

Analyte	Units	Conc	Lower Limit	Upper Limit
Hg 253.65	ug/L	2.72	2.448	2.992

Schedule for QC Analyses

QC	Sample ID	After Init Cal	After Recal	Periodic	Freq	At End
QC 1	dorm2 1/2 0.211g	No	No	No	1	No
QC 2	dolt2 1/2 0.210g	No	No	No	1	No

Periodic Timing of Analyses
  Frequency ... Same for all QC's : 1
  Count : Samples

Failure Actions for After-Calibration QC's

QC	Sample ID	Times to Retry QC	When All Tries Fail	Additional Message
QC 1	(Not Scheduled)			
QC 2	(Not Scheduled)			

Failure Actions for Periodic QC's

		Times to	When All	Additional

Method Name: SOP004M

QC	Sample ID	Retry QC	Tries Fail	Message
QC 1	(Not Scheduled)			
QC 2	(Not Scheduled)			

Failure Actions for At-End QC's

QC	Sample ID	Times to Retry QC	When All Tries Fail	Additional Message
QC 1	(Not Scheduled)			
QC 2	(Not Scheduled)			

Maximum Retries After QC Failure

After a group of standards or unknowns has been reanalyzed 1 times, then Continue

---

Options

Include in Results Display and Printed Log:

Headers:
 * Analytical Header
 * Method Header (Short)
 * Sample Header (Short)
   Start each sample on a new page

Sample Data Items:
 * Replicate Data
 * Means and Statistics
   Transient Peak Plots (Last)
 * Over Calibration Message (110%)

Summary Items:
   Analysis List
 * Matrix Test Reports
 * Calibration Summary
   Calibration Curves

Save with Results:
 * Transient Peak Profiles

Remarks:

Appendix B

Fish Bio – data

(provided by Pesca Environnement & Innergex Renewable Energy Inc.)

Habitat	# sub-station ID	# Fish ID	Common Name	Total Length (mm)	Fork length (mm)	Weight (g)	Sex_(MFX)	Maturity
Inukjuak River	1.1	1	Lake trout	388	360	512	F	2
Inukjuak River	1.1	2	Brook trout	405	390	628	F	3
Inukjuak River	1.1	3	Brook trout	431	320	298	F	4
Inukjuak River	1.1	4	Brook trout	252	248	159	F	4
Inukjuak River	1.1	5	Brook trout	390	375	640	M	3
Inukjuak River	1.1	6	Brook trout	390	380	542	F	4
Inukjuak River	1.1	7	Brook trout	270	260	185	F	3
Inukjuak River	1.1	8	Brook trout	405	390	643	F	4
Inukjuak River	1.1	9	Brook trout	325	315	340	M	3
Inukjuak River	1.1	10	Brook trout	370	360	528	F	4
Inukjuak River	1.1	11	Brook trout	381	367	567	M	4
Inukjuak River	1.1	12	Brook trout	380	430	565	F	3
Inukjuak River	1.1	13	Brook trout	320	309	331	M	4
Inukjuak River	1.1	14	Brook trout	310	300	293	M	3
Inukjuak River	1.1	15	Brook trout	320	310	348	M	3
Inukjuak River	1.1	16	Brook trout	375	365	606	F	4
Inukjuak River	1.1	17	Brook trout	365	355	489	F	4
Inukjuak River	1.1	18	Brook trout	380	370	524	M	3
Inukjuak River	1.1	19	Brook trout	360	350	479	M	3
Inukjuak River	1.1	20	Brook trout	355	350	472	M	4
Inukjuak River	1.1	21	Brook trout	355	350	472	M	4
Inukjuak River	1.1	22	Brook trout	360	350	496	M	3
Inukjuak River	1.1	23	Brook trout	315	305	331	M	3
Inukjuak River	1.1	24	Brook trout	395	380	621	M	3
Inukjuak River	1.1	25	Brook trout	330	320	374	M	3
Inukjuak River	1.1	26	Lake whitefish	405	370	692	M	2
Inukjuak River	1.1	27	Lake whitefish	505	475	1117	F	3
Inukjuak River	1.1	28	Lake whitefish	445	405	889	F	3
Inukjuak River	1.1	29	Lake whitefish	300	275	248	M	2
Inukjuak River	1.1	30	Lake whitefish	320	290	280	F	2
Inukjuak River	1.1	31	Lake whitefish	285	260	226	F	2
Inukjuak River	1.1	32	Lake whitefish	370	340	497	F	2
Inukjuak River	1.1	33	Lake whitefish	370	340	497	F	2
Inukjuak River	1.1	34	Lake whitefish	365	330	462	M	2
Inukjuak River	1.1	35	Lake whitefish	425	390	738	M	2
Inukjuak River	1.1	36	Lake whitefish	306	279	245	F	2
Inukjuak River	1.1	37	Landlocked atlantic salmon	255	236	150	X	1
Inukjuak River	2.1	38	Lake whitefish	260	235	1055	F	2
Inukjuak River	2.1	39	Lake whitefish	586	532	1501	M	3
Inukjuak River	2.1	40	Lake whitefish	403	370	666	F	3
Inukjuak River	2.1	41	Lake whitefish	510	458	1256	M	3
Inukjuak River	2.1	42	Lake whitefish	260	236	150	X	1
Inukjuak River	2.1	43	Brook trout	330	315	391	F	3
Inukjuak River	2.1	44	Lake whitefish	303	298	312	F	4
Inukjuak River	2.1	45	Lake whitefish	295	265	229	M	2
Inukjuak River	2.1	46	Longnose sucker	422	400	882	F	8
Inukjuak River	2.1	47	Longnose sucker	420	397	992	M	8
Inukjuak River	2.1	48	Brook trout	18	-	<1	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	49	Lake trout	518	474	1144	F	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	50	Lake trout	503	462	1065	F	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	51	Lake trout	280	260	156	X	1

Habitat	# sub-station ID	# Fish ID	Common Name	Total Length (mm)	Fork length (mm)	Weight (g)	Sex_(MFX)	Maturity
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	52	Lake trout	244	222	111	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	53	Lake trout	244	222	111	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	54	Brook trout	195	189	71	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	55	Brook trout	323	316	318	F	4
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	56	Brook trout	360	344	402	M	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	57	Brook trout	410	396	407	F	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	58	Lake whitefish	311	278	216	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	59	Lake whitefish	335	304	338	F	2
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	60	Lake whitefish	315	273	228	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	61	Lake whitefish	375	336	442	F	2
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	62	Lake whitefish	398	358	622	F	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	63	Lake whitefish	420	377	683	M	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	64	Lake whitefish	420	377	683	M	3
Inukjuak River	1.1	65	Brook trout	200	190	70	F	2
Inukjuak River	1.1	66	Brook trout	210	200	82	X	1
Inukjuak River	1.1	67	Brook trout	300	290	276	F	3
Inukjuak River	1.1	68	Brook trout	355	340	422	F	4
Inukjuak River	1.1	69	Brook trout	365	355	471	M	2
Inukjuak River	1.1	70	Brook trout	370	360	415	F	3
Inukjuak River	1.1	71	Brook trout	390	375	596	M	3
Inukjuak River	1.1	72	Brook trout	394	378	654	F	3
Inukjuak River	1.1	73	Brook trout	379	368	598	F	4
Inukjuak River	1.1	74	Lake whitefish	427	386	783	M	3
Inukjuak River	1.1	75	Lake whitefish	537	494	1663	F	3
Inukjuak River	1.1	76	Lake whitefish	467	424	921	M	3
Inukjuak River	1.1	77	Lake whitefish	482	444	1261	M	3
Inukjuak River	1.1	78	Lake whitefish	419	381	643	X	X
Inukjuak River	1.1	79	Lake whitefish	426	387	757	M	3
Inukjuak River	1.1	80	Lake whitefish	329	299	377	M	2
Inukjuak River	1.1	81	Lake whitefish	333	301	321	F	2
Inukjuak River	1.1	82	Lake whitefish	339	305	353	M	2
Inukjuak River	1.1	83	Lake whitefish	323	294	330	X	X
Inukjuak River	1.1	84	Lake whitefish	331	299	343	F	2
Inukjuak River	1.1	85	Lake whitefish	310	281	275	F	2
Inukjuak River	1.1	86	Lake whitefish	343	312	402	M	2
Inukjuak River	1.1	87	Lake whitefish	328	298	332	F	2
Inukjuak River	1.1	88	Lake whitefish	278	255	212	F	3
Inukjuak River	1.1	89	Lake whitefish	330	290	300	F	2
Inukjuak River	1.1	90	Lake whitefish	270	240	162	X	1
Inukjuak River	1.1	91	Lake whitefish	270	240	162	X	1
Inukjuak River	1.1	92	Brook trout	135	130	240	X	1
Inukjuak River	2.2	93	Longnose sucker	395	380	779	M	8
Inukjuak River	2.2	94	Longnose sucker	415	395	856	F	3
Inukjuak River	2.2	95	Longnose sucker	430	415	945	F	3
Inukjuak River	2.2	96	Longnose sucker	430	405	908	M	8
Inukjuak River	2.2	97	Longnose sucker	455	435	1111	M	8
Inukjuak River	2.2	98	Longnose sucker	435	405	891	M	3
Inukjuak River	2.2	99	Longnose sucker	440	420	954	F	9
Inukjuak River	2.2	100	Longnose sucker	425	405	849	M	8
Inukjuak River	2.2	101	Longnose sucker	425	405	925	F	9
Inukjuak River	2.2	102	Longnose sucker	420	395	897	F	3
Inukjuak River	2.2	103	Longnose sucker	395	375	782	F	9

Habitat	# sub-station ID	# Fish ID	Common Name	Total Length (mm)	Fork length (mm)	Weight (g)	Sex_(MFX)	Maturity
Inukjuak River	2.2	104	Longnose sucker	410	390	849	F	9
Inukjuak River	2.2	105	Longnose sucker	420	400	828	M	8
Inukjuak River	2.2	106	Longnose sucker	395	370	721	F	8
Inukjuak River	2.2	107	Longnose sucker	355	335	339	F	8
Inukjuak River	2.2	108	Longnose sucker	330	310	413	F	3
Inukjuak River	2.2	109	Longnose sucker	380	365	649	F	3
Inukjuak River	2.2	110	Longnose sucker	310	290	330	F	2
Inukjuak River	2.2	111	Longnose sucker	280	270	249	F	2
Inukjuak River	2.2	112	Longnose sucker	275	260	230	M	2
Inukjuak River	2.2	113	Longnose sucker	250	240	191	X	1
Inukjuak River	2.2	114	Longnose sucker	165	150	53	X	1
Inukjuak River	2.2	115	Longnose sucker	160	155	46	X	1
Inukjuak River	2.2	116	Longnose sucker	170	160	44	X	1
Inukjuak River	2.2	117	Longnose sucker	170	160	45	X	1
Inukjuak River	2.2	118	Lake whitefish	310	282	262	M	2
Inukjuak River	2.2	119	Lake whitefish	335	313	379	F	2
Inukjuak River	2.2	120	Lake whitefish	374	341	479	F	2
Inukjuak River	2.2	121	Lake whitefish	329	297	351	F	2
Inukjuak River	2.2	122	Lake whitefish	308	279	278	M	2
Inukjuak River	2.2	123	Lake whitefish	323	293	312	M	2
Inukjuak River	2.2	124	Lake whitefish	343	213	387	M	2
Inukjuak River	2.2	125	Lake whitefish	318	284	263	F	2
Inukjuak River	2.2	126	Lake whitefish	335	304	362	F	2
Inukjuak River	2.2	127	Lake whitefish	234	208	126	F	3
Inukjuak River	2.2	128	Lake whitefish	298	269	240	F	2
Inukjuak River	2.2	129	Lake whitefish	407	369	667	F	3
Inukjuak River	2.2	130	Lake whitefish	512	460	991	M	3
Inukjuak River	2.2	131	Lake whitefish	512	460	991	M	3
Inukjuak River	2.2	132	Brook trout	457	438	1021	M	3
Inukjuak River	2.2	133	Brook trout	331	319	389	M	3
Inukjuak River	2.2	134	Brook trout	378	366	609	M	3
Inukjuak River	2.2	135	Brook trout	365	354	622	F	4
Inukjuak River	2.1	136	Longnose sucker	315	300	401	X	-
Inukjuak River	2.1	137	Longnose sucker	417	392	210	F	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	138	Lake whitefish	194	175	52	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	139	Lake whitefish	207	188	67	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	140	Lake whitefish	431	395	865	M	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	141	Lake whitefish	426	388	782	F	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	142	Lake whitefish	484	439	1060	M	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	143	Lake whitefish	438	404	801	F	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	144	Lake whitefish	379	345	527	F	2
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	145	Lake whitefish	317	286	244	F	2
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	146	Lake whitefish	320	291	271	X	-
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	147	Lake whitefish	246	223	125	F	2
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	148	Lake whitefish	246	223	125	F	2
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	149	Brook trout	358	342	459	F	4
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	150	Brook trout	358	342	459	F	4
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	151	Lake trout	855	785	7285	F	4
Lake Qattaakuluup Tasinga (Inukjuak River)	3.1	152	Lake trout	855	785	7285	F	4
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	153	Brook trout	218	210	101	F	2
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	154	Brook trout	191	182	69	F	2
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	155	Brook trout	223	212	108	X	1

Habitat	# sub-station ID	# Fish ID	Common Name	Total Length (mm)	Fork length (mm)	Weight (g)	Sex_(MFX)	Maturity
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	156	Brook trout	265	251	162	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	157	Brook trout	348	331	384	F	4
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	158	Brook trout	378	368	520	M	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	159	Brook trout	378	368	520	M	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	160	Lake trout	327	298	277	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	161	Lake trout	280	256	165	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	162	Lake trout	238	222	120	F	2
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	163	Lake trout	230	210	94	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	164	Lake trout	360	330	357	F	2
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	165	Lake trout	480	438	864	F	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	166	Lake trout	485	448	458	M	4
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	167	Lake trout	485	448	458	M	4
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	168	Lake whitefish	237	216	114	F	2
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	169	Lake whitefish	252	230	137	F	2
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	170	Lake whitefish	275	250	167	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	171	Lake whitefish	285	259	216	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	172	Lake whitefish	327	296	385	M	2
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	173	Lake whitefish	305	276	273	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	174	Lake whitefish	363	331	446	F	2
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	175	Lake whitefish	489	443	1093	M	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	176	Lake whitefish	498	451	1193	M	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	177	Lake whitefish	474	430	970	F	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	178	Lake whitefish	459	419	867	F	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	179	Lake whitefish	416	374	687	F	3
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	180	Lake whitefish	243	222	122	X	1
Lake Qattaakuluup Tasinga (Inukjuak River)	3.2	181	Lake whitefish	468	424	978	M	3
Lake Tasialuk (Control)	4.1	182	Brook trout	355	345	506	F	4
Lake Tasialuk (Control)	4.1	183	Brook trout	355	340	457	F	4
Lake Tasialuk (Control)	4.1	184	Brook trout	370	360	556	M	4
Lake Tasialuk (Control)	4.1	185	Brook trout	450	435	895	F	4
Lake Tasialuk (Control)	4.1	186	Brook trout	113	110	13	X	1
Lake Tasialuk (Control)	4.1	187	Lake trout	420	380	595	F	3
Lake Tasialuk (Control)	4.1	188	Lake trout	235	215	104	X	1
Lake Tasialuk (Control)	4.1	189	Lake trout	320	290	246	F	2
Lake Tasialuk (Control)	4.1	190	Lake trout	475	430	949	M	3
Lake Tasialuk (Control)	4.1	191	Lake trout	565	520	1757	M	4
Lake Tasialuk (Control)	4.2	194	Cisco	320	295	350	F	3
Lake Tasialuk (Control)	4.2	195	Cisco	230	210	101	F	3
Lake Tasialuk (Control)	4.2	196	Cisco	325	300	390	F	3
Lake Tasialuk (Control)	4.2	200	Lake whitefish	410	370	685	F	2
Lake Tasialuk (Control)	4.2	201	Lake trout	440	400	758	M	3
Lake Tasialuk (Control)	4.2	202	Lake trout	400	360	566	F	2
Lake Tasialuk (Control)	4.2	203	Lake trout	375	345	457	F	2
Lake Tasialuk (Control)	4.2	204	Lake trout	415	375	593	F	2
Lake Tasialuk (Control)	4.2	205	Lake trout	365	330	416	X	1
Lake Tasialuk (Control)	4.2	206	Lake trout	495	460	1215	F	4
Lake Tasialuk (Control)	4.2	207	Lake trout	270	245	151	F	2
Lake Tasialuk (Control)	4.2	208	Lake trout	325	295	288	F	2
Lake Tasialuk (Control)	4.2	209	Lake trout	410	370	670	F	2
Lake Tasialuk (Control)	4.2	210	Lake trout	475	430	943	M	3
Lake Tasialuk (Control)	4.2	211	Brook trout	280	270	202	F	3
Lake Tasialuk (Control)	4.3	212	Lake trout	595	540	2377	F	4

Habitat	# sub-station ID	# Fish ID	Common Name	Total Length (mm)	Fork length (mm)	Weight (g)	Sex_(MFX)	Maturity
Lake Tasialuk (Control)	4.3	213	Lake trout	385	345	491	F	2
Lake Tasialuk (Control)	4.3	214	Lake trout	380	350	490	M	2
Lake Tasialuk (Control)	4.3	215	Lake trout	505	460	1176	M	4
Lake Tasialuk (Control)	4.3	216	Lake trout	455	420	867	F	2
Lake Tasialuk (Control)	4.3	217	Lake trout	485	445	985	F	2
Lake Tasialuk (Control)	4.3	218	Lake trout	475	430	878	M	3
Lake Tasialuk (Control)	4.3	219	Lake trout	440	395	655	F	3
Lake Tasialuk (Control)	4.3	220	Lake trout	440	395	655	F	3
Lake Tasialuk (Control)	4.3	221	Lake trout	415	380	622	F	2
Lake Tasialuk (Control)	4.3	222	Lake trout	415	380	622	F	2
Lake Tasialuk (Control)	4.3	223	Lake trout	465	425	900	F	3
Lake Tasialuk (Control)	4.3	224	Lake trout	465	425	900	F	3
Lake Tasialuk (Control)	4.3	225	Lake trout	400	365	547	M	2
Lake Tasialuk (Control)	4.3	226	Lake trout	345	315	336	F	2
Lake Tasialuk (Control)	4.3	227	Lake trout	440	400	750	F	2
Lake Tasialuk (Control)	4.3	228	Lake trout	400	365	538	F	2
Lake Tasialuk (Control)	4.3	229	Lake trout	380	350	521	F	2
Lake Tasialuk (Control)	4.3	230	Lake trout	380	340	527	F	2
Lake Tasialuk (Control)	4.3	231	Lake trout	380	340	527	F	2
Inukjuak River	2.3	232	Brook trout	288	278	297	M	2
Inukjuak River	2.4	233	Brook trout	140	130	27	X	1
Inukjuak River	2.4	234	Brook trout	170	160	54	X	1
Inukjuak River	2.4	235	Brook trout	370	355	559	F	4
Inukjuak River	2.4	236	Brook trout	270	255	242	F	4
Inukjuak River	2.4	237	Brook trout	295	280	285	M	3
Inukjuak River	2.4	238	Lake whitefish	263	237	181	F	2
Inukjuak River	2.4	239	Lake whitefish	230	205	126	X	1
Inukjuak River	2.4	240	Lake whitefish	440	395	801	M	3
Inukjuak River	2.4	242	Lake whitefish	445	405	845	M	4
Inukjuak River	2.4	244	Lake whitefish	355	280	286	F	2
Inukjuak River	2.4	245	Lake whitefish	345	310	356	M	2
Inukjuak River	2.4	246	Lake whitefish	385	345	494	F	2
Inukjuak River	2.4	247	Lake whitefish	370	335	537	F	2
Inukjuak River	2.4	248	Lake whitefish	470	430	914	M	3
Inukjuak River	2.4	249	Lake whitefish	530	475	1357	M	3
Inukjuak River	2.4	250	Lake whitefish	530	475	1357	M	3
Lake Tasialuk (Control)	4.1	251	Brook trout	238	234	128	M	3
Lake Tasialuk (Control)	4.1	252	Brook trout	420	400	790	M	4
Lake Tasialuk (Control)	4.1	253	Brook trout	350	330	477	F	4
Lake Tasialuk (Control)	4.1	254	Brook trout	210	200	90	M	3
Lake Tasialuk (Control)	4.1	255	Brook trout	265	255	168	F	4
Lake Tasialuk (Control)	4.1	256	Brook trout	370	360	567	F	4
Lake Tasialuk (Control)	4.1	257	Brook trout	365	350	466	M	4
Lake Tasialuk (Control)	4.1	258	Brook trout	365	350	466	M	4
Lake Tasialuk (Control)	4.1	259	Brook trout	205	195	72	M	3
Lake Tasialuk (Control)	4.1	260	Brook trout	385	360	586	F	4
Lake Tasialuk (Control)	4.1	261	Brook trout	120	115	16	X	1
Lake Tasialuk (Control)	4.1	262	Brook trout	185	180	62	X	1
Lake Tasialuk (Control)	4.1	263	Brook trout	245	230	125	M	3
Lake Tasialuk (Control)	4.1	264	Brook trout	305	300	296	M	4
Lake Tasialuk (Control)	4.1	265	Brook trout	330	315	320	F	4
Lake Tasialuk (Control)	4.1	266	Brook trout	420	405	788	F	4

Habitat	# sub-station ID	# Fish ID	Common Name	Total Length (mm)	Fork length (mm)	Weight (g)	Sex_(MFX)	Maturity
Lake Tasialuk (Control)	4.1	267	Brook trout	290	280	225	F	3
Lake Tasialuk (Control)	4.1	268	Brook trout	335	315	377	F	4
Lake Tasialuk (Control)	4.1	269	Brook trout	395	380	693	F	4
Lake Tasialuk (Control)	4.1	270	Brook trout	380	365	497	F	4
Lake Tasialuk (Control)	4.1	271	Brook trout	370	355	532	F	4
Lake Tasialuk (Control)	4.1	272	Lake trout	350	315	318	M	2
Lake Tasialuk (Control)	4.1	273	Lake trout	490	445	1022	F	4
Lake Tasialuk (Control)	4.1	274	Lake trout	230	210	105	F	2
Lake Tasialuk (Control)	4.1	275	Lake trout	515	475	1316	F	4
Lake Tasialuk (Control)	4.1	276	Lake trout	525	480	1285	M	4
Lake Tasialuk (Control)	4.4	277	Lake trout	205	190	80	X	1
Lake (Control)	5.1	278	Brook trout	134	131	21	X	1
Lake (Control)	5.1	279	Brook trout	128	124	16	X	1
Lake (Control)	5.1	280	Brook trout	138	134	20	X	1
Lake (Control)	5.1	281	Lake whitefish	258	238	143	F	2
Lake (Control)	5.1	282	Lake whitefish	207	188	64	X	1
Lake (Control)	5.1	283	Lake whitefish	294	260	185	F	2
Lake (Control)	5.1	284	Lake whitefish	259	236	144	F	2
Lake (Control)	5.1	285	Lake whitefish	364	336	511	F	2
Lake (Control)	5.1	286	Lake whitefish	462	422	1206	F	3
Lake (Control)	5.1	287	Lake whitefish	462	422	1206	F	3
Lake (Control)	5.1	288	Lake trout	274	257	162	X	1
Lake (Control)	5.1	289	Lake trout	329	302	274	F	2
Lake (Control)	5.1	290	Lake trout	338	309	308	F	2
Lake (Control)	5.1	291	Lake trout	318	294	263	F	2
Lake (Control)	5.1	292	Lake trout	322	293	247	F	2
Lake (Control)	5.1	293	Lake trout	152	140	28	X	1
Lake (Control)	5.1	294	Lake trout	329	302	269	F	2
Lake (Control)	5.1	295	Lake trout	361	332	338	F	2
Lake (Control)	5.1	296	Lake trout	366	342	437	F	2
Lake (Control)	5.1	297	Lake trout	347	315	356	M	2
Lake (Control)	5.1	298	Lake trout	378	350	454	F	2
Lake (Control)	5.1	299	Lake trout	378	350	454	F	2