MEMO

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SUBJECT: Technical Memo – Supplemental Human Health Risk Assessment (HHRA) - 2024 Fish and Seal Mercury Data

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Supplemental Human Health Risk Assessment (HHRA) - 2024 Fish and Seal Mercury Data

1.0 Introduction

As part of ongoing efforts to continually update predictions regarding the potential for methylmercury (MeHg) levels to increase in Muskrat Falls study area aquatic biota, and the potential for increased MeHg exposure among human consumers of locally harvested aquatic country foods, this report presents the outcomes of human health risk assessment (HHRA) of 2024 aquatic EEM program data on MeHg concentrations in harvested fish and seal species.

Previous HHRA work conducted within the Muskrat Falls HHRA Program (i.e., Dillon, 2016a,b; 2018) focused on the assessment and characterization of baseline and predicted future MeHg exposure and risk. In addition, since 2021 (the first operational year following full reservoir filling and commencement of power generation), there have been annual HHRA reports similar to what is presented herein, that provide predicted human health risk estimates due to MeHg exposure, for each operational year where aquatic EEM program data were collected. The annual HHRA report for monitoring/operational year 2023 also included MeHg risk estimates for each of the partial inundation years, prior to the commencement of power generation (i.e., 2017 to 2020).

The prediction of MeHg exposure and human health risk in relation to the 2024 aquatic EEM data utilizes and builds upon the modelling framework developed within the comprehensive 2016 final baseline HHRA (i.e., Dillon, 2016b), and also incorporates and/or builds upon the outcomes of the various modelling studies, field programs, EEM data evaluations, and other studies that were conducted by independent technical experts throughout 2017 and 2018, and that are described in Dillon (2018) and various other documents posted to the NL Hydro website: https://nlhydro.com/about-us/publications/environmental-reports-for-the-lower-churchill-project/human-health-risk-assessment/.

The Muskrat Falls Human Health Risk Assessment Program was initiated in 2013 and has been ongoing since that time. Key elements and milestones of the Human Health Program have been described in previous documentation (in particular, Dillon (2018; 2016b)) and in other documents posted to the above websites. This memo does not elaborate on information that is covered in detail within previous HHRA program documents.

It is acknowledged that while all Muskrat Falls study area HHRA studies to date focus on MeHg exposures, and the potential human health risks associated with such exposures, Muskrat Falls study area fish and seal mercury concentration data are primarily measured and expressed as total mercury (THg) concentrations, rather than MeHg concentrations. It is very common (for reasons relating to practicality and efficiency) to measure THg rather than MeHg in comprehensive mercury environmental monitoring programs. In the baseline HHRA (Dillon, 2016b), and the Dillon (2018) assessment of potential future MeHg exposures and risks, it was conservatively assumed that the THg present in fish and seal muscle tissue (meat) was comprised of 100% MeHg, and that the THg present in seal liver was comprised of 40% MeHg (based on literature review conducted during the baseline HHRA program and on empirical study area ringed seal tissue THg and MeHg data that were collected in support of the baseline HHRA). These assumptions continue to apply herein and were applied in all previous annual HHRA reports dating back to 2021.

Recent (i.e., 2024) seal liver and muscle THg and MeHg analyses and revisiting of previously collected seal liver and muscle MeHg data (2016, 2017 and 2018) confirm that the assumed MeHg proportions of THg for seal liver and muscle tissue, within the HHRA program, are appropriate and continue to be conservative assumptions that overestimate MeHg exposure and risk. These data are provided in Attachment A to this report and were also described in a recent technical memo from the HHRA program (i.e. Dillon, 2025). Seal muscle tissue THg and MeHg data confirm the HHRA program assumption that generally all (100%) of the THg in seal muscle tissue is present as MeHg. Seal liver MeHg and THg data show that the assumed 40% MeHg proportion of THg is higher than has been measured in any seal liver sample to date. Thus, the 40% MeHg assumption continues to intentionally overestimate the central tendency %MeHg of THg for all seals combined. The degree of overestimation was/is marginal for pups but is substantial for non-pups. These data suggest that assuming THg in seal liver is 40% MeHg remains a reasonable and accurate assumption for seal pup livers (and continues to marginally overestimate the central tendency measured MeHg% in pup livers), but considerably overestimates the MeHg% of THg in non-pup livers. Seal muscle and liver tissue MeHg analysis will occur again on the 2025 seal muscle and liver samples.

For the sake of simplicity and consistency, this memo mainly refers to MeHg concentrations in fish and seal (even though the mercury concentrations are reported as THg), and MeHg exposures and risks, unless specifically referring directly to the fish and seal aquatic EEM datasets, which report THg.

2.0 Potential MeHg Exposures and Risks Within the Muskrat Falls Study Area – 2024 Aquatic EEM Data

This section addresses potential MeHg exposures that may be incurred by study area community members due to the harvesting and consumption of fish and seal, and the potential health risks that may be anticipated as a result of such exposures. Assessment of potential MeHg exposures and risks, based on the 2024 aquatic EEM program data, is supplemental to the final baseline HHRA (Dillon, 2016b), the prediction of potential future MeHg exposures and risks that were presented in Dillon (2018), and all previous annual HHRA reports from 2021 onward. The 2024 potential MeHg exposures and risks were estimated using the same exposure and risk model platform developed for the final baseline HHRA, which has been and continues to be applied throughout the Muskrat Falls HHRA Program.

Because the evaluation presented herein is based on measured MeHg concentrations in key fish and seal species from the study area in 2024, the predicted peak MeHg increase factors reported in Table 2-3 of Wood (2018a) for Goose Bay and West Lake Melville were not necessary to apply. While risk estimates based on peak increase factors were presented in prior HHRA annual reports (for years 2021 to 2023), discussions with the Muskrat Falls Monitoring and Health Management Oversight Committee (MHMOC) in December 2024 indicated a desire on the part of the MHMOC to discontinue showing risk estimates associated with the predicted peak MeHg increase factors. Thus, the report herein (and future annual HHRA reports) exclude reference to, and discussion of, the peak MeHg increase factors. Information on the peak increase factors and how they were developed is provided in Dillon (2018) and the references cited within that document. Rationale for excluding the peak increase factors in this and future annual HHRA reports reflects the fact that the number of years with empirical aquatic EEM data available now extend past the period that the peak increase factors were predictive for. In other words, the number of years with operational period monitoring data now go beyond the time frame covered by the predicted peak increase factors. However, annual aquatic EEM reports will continue to compare fish and seal THg data to predicted future peak levels, as these reports have a regulatory requirement to do so.

As previously noted in Dillon (2018) and Wood (2018a,b), brook trout, rainbow smelt and ringed seal (meat and liver) are focused on with respect to the assessment of potential MeHg exposure and risk. These species are the most commonly consumed (as reported in HHRA program diet surveys), are among the most abundant harvested species within the study area, and are the only harvested and consumed species likely to be affected by the Project (i.e., these species are most likely to experience increases in MeHg accumulation within their tissues as a result of the Project). The outcomes of Wood (2018b) and the HHRA Program diet surveys demonstrated that other fish species known to occur within the study area are either not harvested/consumed (based on diet survey results), or, if they are harvested and consumed, are unlikely to be influenced by the Project, given their habitat preferences, distribution, foraging preferences, life history, and prevalence and abundance within study area water bodies. However, burbot were added as a species of interest for the 2023 monitoring year. This was conducted due to observations of an apparently increased abundance of this species within the study area in recent years, compared to baseline years, and the corresponding potential that burbot may be consumed more frequently by study area residents than in the past (based on comments received from Health Canada on previous annual HHRA Technical Memos, as well as discussions with Indigenous stakeholders). Thus, brook trout, rainbow smelt, burbot and ringed seal are the only species that merit consideration at this time within the Muskrat Falls HHRA Program.

Of the study area communities considered in the baseline HHRA (Dillon, 2016b), all but Churchill Falls (CF) merit consideration with respect to current MeHg exposures and risks. CF is excluded from the current HHRA as the fish harvested and consumed by CF residents are extremely unlikely to come from the Muskrat Falls reservoir, areas downstream of the reservoir, Goose Bay or Western Lake Melville (given that the distance between CF and these water bodies is >250 km), and CF residents did not report the consumption of ringed seal meat or liver. Thus, for CF community members, current and future MeHg exposures and risks as a result of the Muskrat Falls Project are expected to equal baseline MeHg exposures and risks.

Throughout the duration of the Muskrat Falls aquatic EEM and HHRA programs, ringed seal meat and liver samples are collected from Lake Melville and provided to WSP by an Inuit hunter during the annual

seal hunt and harvest. Trout, smelt, and burbot muscle tissue samples are collected by WSP personnel from a number of locations considered likely to display effects of the Muskrat Falls Project. These locations include: within the reservoir, below the reservoir, Churchill River main stem, Caroline Brook, Goose Bay (Rabbit Island), Lake Melville (Epinette Point, Mulligan Point), and outer Lake Melville (Trout Cove).

The HHRA of the 2024 aquatic EEM program MeHg data for brook trout, rainbow smelt, burbot and ringed seal meat and liver tissues was conducted using the same model that was developed for the baseline HHRA, used for all annual HHRA reports to date, and which was also utilized in the Dillon (2018) assessment of potential future MeHg exposures and risks. For the HHRA of the 2024 data, MeHg exposure point concentrations (EPCs) were calculated from the brook trout, rainbow smelt, burbot and ringed seal meat and liver MeHg (reported as THg) concentration datasets. All aquatic EEM program MeHg data were provided to Dillon by WSP. Statistical data summaries for the 2024 brook trout, rainbow smelt, burbot and ringed seal meat and liver THg datasets are provided in **Attachment A** to this memo.

All EPCs (which, within the HHRA Program to date, have generally been upper 95% confidence limits on the arithmetic mean, or UCLM95) were calculated using the current version of the U.S. EPA's ProUCL software. EPC calculation was conducted in the same manner as described in Dillon (2016b), and the EPC units are expressed in mg/kg wet weight (ww) of fish (or seal) tissue. An EPC is widely considered to be the concentration of a chemical most likely to be contacted over time, and it is well established that the most appropriate and reliable statistic for an EPC in a HHRA is the upper 95% confidence limit on the arithmetic mean (UCLM95). However, other statistics can also be used as EPCs in HHRAs, if it is not possible to calculate adequately robust UCLM95 values (i.e., valid UCLM95 calculation can depend on various factors such as sample size, number of non-detectable values in a dataset, data QA/QC considerations and outcomes, data distribution types, skewness of the data, variability, and dispersion in the data). EPC calculation output for 2024 brook trout, rainbow smelt, burbot and ringed seal meat and liver MeHg (reported as THg) data is provided in **Attachment A**.

As previously noted, it was conservatively assumed herein, and throughout the HHRA Program to date, that the THg concentrations measured in fish and seal muscle tissue (meat) were comprised of 100% MeHg, and that the THg concentrations in seal liver were comprised of 40% MeHg.

For the calculation of 2024 MeHg exposures and risks, all other sources and rates of MeHg exposure that were evaluated in the baseline HHRA (i.e., other locally harvested country foods that are not influenced by the Muskrat Falls Project, and grocery store foods) remained constant or unchanged from what was assumed for baseline conditions. This was also the approach taken for the estimation of predicted future peak MeHg exposures and risks in Dillon (2018), and in all previous annual HHRA reports. For these "other" country food items and grocery store food items, it is considered very likely that current and future MeHg exposures would be no different from baseline MeHg exposures.

Tables 1a and 1b provide a summary of MeHg EPCs for brook trout, rainbow smelt, burbot and ringed seal meat and liver, for the baseline period, and for Muskrat Falls Project years 2017 to 2024 (calculated from measured aquatic EEM program THg data for these years), where the 2017 to 2020 period represents post-baseline but pre-operational years where the reservoir had been only partially

inundated during this time period and full electrical output was not yet being generated by the Muskrat Falls hydroelectric facility.

In **Table 1b**, ringed seal meat and liver THg data are provided separately for pups and non-pups, as well as for all seals (pups and non-pups) combined. At this time, these data are provided to illustrate the differences in THg (and MeHg) concentrations in pups versus non-pups. However, there continues to be no basis at this time to separate seals into pups and non-pups for HHRA purposes, as it is reported by community members and the MHMOC that both pups and non-pups can be harvested and consumed within some Indigenous organizations and their respective communities, though pups are often reported to be harvested preferentially (this is why there are more tissue THg data for pups than there are for non-pups within the aquatic EEM program to date). Seal tissue sampling typically occurs for seals that have been harvested by Inuit hunters for the community freezer program, and non-pups comprise some of the seals intended for the freezer program in most years. While it has been reported that non-pup seals (particularly older adult seals) are known among the communities to have higher THg levels in their tissues, and tend to be used more for bait (by local trappers) rather than being provided to the community freezer program, the HHRA must assume that harvested seals have the potential to be consumed within the communities, whether pups or non-pups. As such, non-pup seals will continue to be sampled and analyzed for the foreseeable future, and the separation of seal THg data into pups and non-pups will continue to occur and continue to be reviewed.

The 2014-2015 diet survey outcomes did not distinguish pup from non-pup seal meat or liver consumption rates and frequencies, and it is unlikely that most people consuming harvested seal meat or liver would know with certainty whether or not the liver was from a pup or older seal. Planned study area diet survey updates may provide useful information towards determining the appropriateness and representativeness of potentially conducting separate exposure and risk assessments for Hg in seal pups and non-pups. Until such updated diet survey outcomes are available, it remains inappropriate to modify the HHRA model with respect to seal meat or liver consumption patterns.

However, with respect to advice and advisory information related to seal liver consumption, it would be appropriate and possible to provide separate advice/advisory direction for seal pup meat and liver and non-pup meat and liver consumption. Exposure and risk calculations outside of the HHRA model platform may be used as necessary to support the advice or advisory information that will be developed in relation to seal meat and liver consumption.

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Table 1a: Summary of MeHg EPCs: Baseline, 2017-2020 (Partial Flooding), 2021, 2022, 2023, 2024; mg/kg ww

Key Species	Baseline EPC	2017 EPC	2018 EPC	2019 EPC	2020 EPC	2021 EPC	2022 EPC	2023 EPC	2024 EPC
brook trout	0.07; N=340 [max=0.44; 182 mm fish]	0.040; N=106 [max=0.18; 447 mm fish]	0.05; N=118 [max=0.2; 256 mm fish]	0.042; N=72 [max=0.12; 240 mm fish]	0.047; N=115 [max=0.14; 306 and 300 mm fish]	0.074; N=81 [max=0.24; 459 mm fish]	0.034; N=84 [max=0.08; 359 and 252 mm fish]	0.044; N=92 [max=0.12; 330 mm fish]	0.034; N=90 [max=0.13; 390 mm fish]
rainbow smelt	0.12; N=142 [max=0.31; 203 mm fish]	0.048; N=35 [max=0.09; 191 mm fish]	*0.16; N=39 [*max=0.95;154 mm fish] 0.036; N=38 [max=0.09; 169 mm fish]	0.035; N=38 [max=0.08; 178 mm fish]	0.053; N=51 [max=0.19; 170 mm fish]	0.054; N=73 [max=0.12; 154 mm fish]	0.062; N=64 [max=0.16; 187 mm fish]	0.062; N=27 [max=0.13; 202 mm fish]	0.035; N=21 [max=0.07; 172 mm fish]
burbot	0.18; N=29 [max=0.46; 610 mm fish]	Not included in aquatic EEMP THg analyses in 2017	0.05; N=13 [max=0.09; 330 mm fish]	0.06; N=37 [max=0.20; 600 mm fish]	Not included in aquatic EEMP THg analyses in 2020	Not included in aquatic EEMP THg analyses in 2021	Not included in aquatic EEMP THg analyses in 2022	0.18; N=42 [max=0.74; 830 mm fish]	**0.19; N=44 [max=0.74; 830 mm fish]

Notes:

N=sample size (# of samples); max=maximum MeHg concentration.

The baseline period comprised 2010 to 2016.

All EPC units are in mg/kg ww and all EPCS are UCLM95 statistics determined using USEPA ProUCL v5.2 statistical software.

All fish mercury data were measured as THg concentrations (which, in the table, are referred to as MeHg concentrations). For HHRA purposes, it was conservatively assumed that THg measured in fish muscle tissue (meat) was comprised of 100% MeHg.

*One 2018 smelt sample contained a THg concentration of 0.95 mg/kg ww. This concentration is 3 to 10 times higher than all other smelt THg concentrations measured at any time during the aquatic EEM program and skews the EPC value high. While a measured concentration, it is anomalous and is not representative of typical smelt THg concentrations during baseline or operational Project periods. As such, this smelt sample was excluded from HHRA exposure and risk calculations. When this sample is removed, the EPC drops from 0.16 to 0.036 mg/kg ww. The second highest concentration in this 2018 dataset (0.09 mg/kg ww) is roughly 10 times lower than the maximum concentration of 0.95 mg/kg ww.

** Only two burbot were captured in 2024; these two fish were pooled with the 2023 burbot data and EPCs were recalculated to reflect combined 2023 and 2024 burbot THg concentrations.

Table 1b: Summary of MeHg EPCs: Baseline, 2017-2020 (Partial Flooding), 2021, 2022, 2023, 2024; mg/kg ww

Key Species	Baseline EPC	2017 EPC	2018 EPC	2019 EPC	2020 EPC	2021 EPC	2022 EPC	2023 EPC	2024 EPC
ringed seal meat (all seals; pups and non-pups)	0.34; N=159 [max=6.3]	0.17; N=30 [max=0.69]	0.18; N=31 [max=0.56]	0.52; N=34 [max=2.7]	0.16; N=29 [max=0.56]	0.031; N=30 [max=0.08]	0.058; N=30 [max=0.12]	0.086; N=28 [max=0.17]	0.27; N=35 [max=1.2]
ringed seal liver (all seals; pups and non-pups)	9.1; N=145 [max=110]	33.5; N=30 [max=150]	10.3; N=31 [max=35]	8.9; N=33 [max=39]	8.2; N=29 [max=29]	0.30; N=30 [max=0.57]	4.9; N=30 [max=20.5]	0.59; N=28 [max=1.4]	14; N=35 [max=110]
Ringed Seal Meat and Liver Data – Separated into Pups Versus Non-Pups									
ringed seal meat (pups only)	0.08; N=133 [max=0.35]	0.062; N=17 [max=0.11]	<0.05; N=15 [max<0.05]	0.048; N=22 [max=0.1]	0.08; N=19 [max=0.19]	0.031; N=30 [max=0.08]; only pups harvested in 2021	0.052; N=27 [max=0.10]	0.086; N=28 [max=0.17]; only pups harvested in 2023	0.12; N=25 [max=0.34]
ringed seal meat (non-pups only)	1.5; N=26 [max=6.3]	0.32; N=13 [max=0.69]	0.24; N=16 [max=0.56]	1.1; N=12 [max=2.7]	0.32; N=10 [max=0.56]	Not calculable as only pups harvested in 2021	Statistical EPC not calculable; N=3 [range: 0.01 – 0.12]	Not calculable as only pups harvested in 2023	0.74; N=10 [max=1.2]
ringed seal liver (pups only)	0.41; N=124 [max=1.8]	0.38; N=17 [max=0.57]	0.26; N=15 [max=0.44]	0.31; N=21 [max=0.59]	0.54; N=19 [max=1.2]	0.30; N=30 [max=0.57]; only pups harvested in 2021	0.48; N=27 [max=1.1]	0.59; N=28 [max=1.4]; only pups harvested in 2023	0.66; N=25 [max=2.0]
ringed seal liver (non-pups only)	41; N=21 [max=110]	75; N=13 [max=150]	16.8; N=16 [max=35]	19.1; N=12 [max=39]	20.4; N=10 [max=29]	Not calculable as only pups harvested in 2021	Statistical EPC not calculable; N=3 [range: 0.13 – 20.5]	Not calculable as only pups harvested in 2023	67; N=10 [max=110]

Notes:

N=sample size (# of samples); max=maximum MeHg concentration.

The baseline period comprised 2010 to 2016.

All EPC units are in mg/kg ww and all EPCS are UCLM95 statistics determined using USEPA ProUCL v5.2 statistical software.

All seal mercury data were measured as THg concentrations (which, in the table, are referred to as MeHg concentrations). For HHRA purposes, it was conservatively assumed that THg measured in seal muscle tissue (meat) was comprised of 100% MeHg, and that THg measured in seal liver was comprised of 40% MeHg.

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It is noted that all brook trout, rainbow smelt and burbot EPCs for the baseline, partial flooding (2017-2020), and operational year (2021, 2022, 2023 and 2024) periods are well below the Health Canada maximum level for mercury in fish of 0.5 mg THg/kg ww fish (https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety/chemical-contaminants/maximum-levels-chemical-contaminants-foods.html#a2). In addition, virtually all (only two exceptions) of the individual trout, smelt, and burbot samples reported in the baseline, 2017, 2018, 2019, 2020, 2021, 2022, 2023, and 2024 THg datasets [N=1098 for trout; N=490 for smelt; N=123 for burbot] are also below 0.5 mg/kg ww. The two exceptions are: i) the anomalous 2018 smelt sample that contained a THg concentration of 0.95 mg/kg ww; and, ii) one 2023 burbot sample that contained a THg concentration of 0.74 mg/kg ww.

From the EPCs presented in **Table 1a,b** and in **Attachment B** (which provides graphs of trout, smelt, burbot and ringed seal meat and liver THg EPCs to date, for all years of the aquatic EEM program, from the baseline period to 2024), data variability and/or data limitations appear to be obscuring potential THg concentration trends in the species of interest, where EPCs from some years are higher or lower than those from previous years, with no clear patterns evident in the data on a year over year basis. EPC graphs for burbot are limited as burbot THg data were not collected in 2017, 2020, 2021 or 2022, and burbot was not reported to be a significant harvested and consumed species in the earlier years (i.e., baseline and partial flooding years) of the aquatic EEM and HHRA programs. Furthermore, only two burbot were captured in the 2024 aquatic EEM program. Thus, it is not possible to discern year over year trends for burbot with the data presently available.

The trends for seal meat and liver THg EPCs are obscured by high data variability, and differing proportions of non-pups in different seal Hg datasets from the various monitoring years. Older seals consistently have higher Hg concentrations in both their muscle (meat) tissue and liver tissue, but particularly within their livers. Datasets for monitoring years with higher proportions of older seals have higher (sometimes considerably higher) THg EPCs than datasets for monitoring years where all harvested seals were pups. THg data since 2021 appears to show an increasing trend in both pup meat and liver THg concentrations. The lack of non-pup THg meat and liver data in some years limits any clear trend discernment for non-pup seals.

The apparent increasing trend since 2021 for pup meat and liver THg is likely not a Project-related effect. It is well known that increased Hg levels in top predators in a complex estuarine ecosystem takes many years or even decades to become measurable or observable, following increased mercury methylation rates in water and sediments. Rather, the apparent trend most likely reflects naturally high variability in seal Hg concentrations. Furthermore, ringed seals can have very large foraging ranges and their range size changes as a function of age, developmental stage, changes to availability of preferred prey/food resources, and habitat conditions (particularly ice presence and thickness). Limited seal telemetry data for lake Melville (N=7) indicates that Lake Melville seals (classified as only adults or subadults) may spend 36% to 100% of their time in Lake Melville (Brown et al., 2023). However, little can be inferred directly from these observations given the small sample size, the limited duration of the tracking study (roughly 4 to 9 months for the tagged Lake Melville seals), and the limited age categorization. It is known that ringed seal foraging ranges can span hundreds of kilometres and can vary considerably by individual and as a function of local changes to availability of food resources and preferred ice and habitat

conditions (Natureserve Explorer; https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.101700/Pusa_hispida). Thus, it is possible that some of the harvested seals obtained some portion of their Hg exposure from locations other than Lake Melville. Even if seals were spending 100% of their time within Lake Melville and Goose Bay, the lack of significant sustained increases in fish Hg concentrations within the Project-affected water bodies to date, which the seals would be expected to prey upon, suggests that the apparent increase in seal muscle and liver Hg concentrations is most likely due to foraging in areas outside of the Project study area.

2.1   HHRA Outcomes: Evaluation of 2024 MeHg Data

Outcomes of the HHRA of the 2024 MeHg data for brook trout, rainbow smelt, burbot and ringed seal meat and liver generally showed either no change in MeHg hazard quotients relative to the baseline MeHg hazard quotients (the hazard quotient is the primary indicator of potential human health risk in a HHRA), or decreased MeHg hazard quotients relative to the baseline MeHg hazard quotients. Model-predicted hair and blood MeHg concentrations for the assessed human receptors and study area communities followed the same general pattern as the MeHg hazard quotients. **Tables 2 to 5** summarize the changes in these key HHRA outcomes based on the assessment of 2024 brook trout, rainbow smelt, burbot and ringed seal meat and liver MeHg data, relative to baseline, 2017, 2018, 2019, 2020, 2021, 2022 and 2023 HHRA outcomes.

As previously noted in the previous annual HHRA reports, hazard quotients for all receptors in all study area communities, from 2017 to 2023, were either similar to, or less than, the baseline hazard quotients. The only exceptions to that were documented in the 2023 annual HHRA report (which also included risk estimates for the partial flooding years 2017-2020). In two of the partial flooding years (2017 and 2019), hazard quotients slightly exceeded the baseline hazard quotient values in Happy Valley-Goose Bay (HVGB) and North West River/Mud Lake (NWR/ML) for some human receptor types (i.e., 2019 male and female toddler, male and female teen (male teen in NWR/ML only though), and infant with teen mother; and, 2017 male and female child, male and female adult, female teen (HVGB only), infant with adult mother, and infant with teen mother (in NWR/ML only)).

In the 2024 monitoring year, some hazard quotient values for some receptors in HVGB and NWR/ML also exceed the baseline hazard quotients for such receptors (i.e., 2024 male and female adult receptors and infant receptor with adult mother in both HVGB and NWR/ML). For these receptors, the 2024 hazard quotients only very slightly exceed the baseline hazard quotients.

The higher hazard quotients in 2017, 2019 and 2024 in HVGB and NWR/ML (which are the study area communities with relatively high Inuit self-identification and higher rates and frequencies of ringed seal consumption) are attributed to higher ringed seal liver and/or meat THg concentrations in these monitoring years, relative to baseline and other monitoring years, that are due to a higher number of non-pup seals being included in the seal harvest during those years. As noted in the previous section, older seals have higher meat and liver THg concentrations than pups; thus, monitoring years with a greater number of non-pups have higher EPCs in the HHRAs, and correspondingly higher hazard quotients.

In Sheshatshiu, monitoring year hazard quotients have not exceeded the baseline hazard quotients in any year from 2017 to 2024. This is primarily due to seal not being a common dietary item in this community; thus, the changes in MeHg exposure since baseline are largely a function of varying Hg levels in brook trout, rainbow smelt, and potentially burbot.

As was the case for all previous operational monitoring years and partial flooding years, the HHRA of the 2024 MeHg data does not alter any of the conclusions made within the baseline HHRA, and the results presented in **Tables 2 to 5** should be considered in the same context and perspective that was provided in the final baseline HHRA report (i.e., Dillon, 2016b).

Specifically, the HHRA outcomes suggest a low to negligible potential for human health risk resulting from MeHg exposures in any partial flooding or operational year of the Muskrat Falls Project to date, and the calculated MeHg exposures and risks are similar to what would be expected in numerous communities in North America where food consumption patterns comprise the ingestion of both store-bought foods and country food items that are of aquatic origin. HHRA outcomes also do not indicate a need for corrective action or risk management, such as specific consumption advisories, at this time. However, standard precautionary recommendations as per those made in Dillon (2016b) and Dillon (2018) continue to be considered prudent to apply. For example, despite the conservatism and the high likelihood that the HHRA substantially overestimates MeHg exposures and risks to nursing mothers, breast-feeding infants, females of child-bearing age and the developing fetus, standard universal advice that pregnant women, nursing mothers and women of child-bearing age avoid, restrict or temporarily cease their consumption of certain country and store-bought food items that tend to be elevated in MeHg, is prudent, and should apply within the study area communities. It must be recognized that this well-established precautionary advice applies to pregnant women, nursing mothers and women of child-bearing age anywhere, and is not made for the study area communities because of HHRA outcomes in any of the partial flooding or operational monitoring years.

It must also be recognized that there are numerous and universally well-established benefits (to both the infant and mother) of breast-feeding, and HHRA outcomes indicate no reason whatsoever for there to be concerns regarding breast-feeding in relation to the levels of MeHg exposure within study area communities. In general, breast-feeding should never be stopped due to fears over chemical exposure unless specifically recommended by a physician. The benefits of breast-feeding far outweigh the potential health risks from chemical exposure in the overwhelmingly vast majority of cases. Given the HHRA outcomes, and recognizing the inherent conservatism and tendency for the HHRA approaches to overestimate exposure and risk, there is no cause for concern in relation to potential infant MeHg exposures that may be incurred via breast-feeding. Thus, any new or soon-to-be mothers within the study area communities should continue to be encouraged to breast-feed their infants and young toddlers, if they are able to. Following the standard universal precautionary measures for MeHg will further reduce what is an already low to negligible potential for significant MeHg exposure and risk.

In addition (as noted previously in Dillon, 2016a,b and Dillon, 2018, and all prior annual HHRA reports), it is prudent to continue to recommend to those study area residents that consume ringed seal meat and liver, that only younger ringed seals (i.e., pups) be harvested for human consumption (as older seals frequently have higher THg and MeHg concentrations in both their muscle and liver tissue). This recommendation was initially made in 2016, during the baseline HHRA period, when Project-related effects could not have occurred. Typically, it is the younger seals that are preferentially harvested (based

on information from a number of study area residents who engage in seal harvesting), but encouraging this practice would likely reduce the Hg exposures that may be incurred from seal meat and liver consumption.

Consumption advice and advisory educational materials are currently being prepared for the study area communities through activities coordinated by the Health Education Working Group (HEWG) of the Muskrat Falls Monitoring and Health Management Oversight Committee. The findings of annual aquatic EEM and HHRA reports support the preparation of these educational materials.

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TABLE 2a: SUMMARY OF METHYLMERCURY (MeHg) HAZARD QUOTIENTS (HQs) FOR MUSKRAT FALLS STUDY AREA EXPOSURE/CONSUMPTION SCENARIOS (COMMUNITIES) – BASELINE, 2017-2020, 2021, 2022, 2023, 2024: HAPPY VALLEY-GOOSE BAY (HVGB)

Human Receptor Type	HQ Type	Baseline	2017 (partial flooding)	2018 (partial flooding)	2019 (partial flooding)	2020 (partial flooding)	2021(op.)	2022 (op.)	2023 (op.)	2024 (op.)
M Toddler	HQ1	**1.3**	**1.1**	**1.1**	**1.34**	**1.1**	**1.1**	**1.1**	**1.1**	**1.2**
	HQ2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	HQ3	0.64	0.57	0.56	0.67	0.56	0.53	0.53	0.54	0.60
M Child	HQ1	**1.5**	**1.6**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
	HQ2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	HQ3	0.77	0.8	0.73	0.75	0.75	0.73	0.74	0.73	0.76
M Teen	HQ1	**1.2**	**1.2**	**1.1**	**1.2**	**1.1**	0.99	1.0	1.0	**1.1**
	HQ2	0.25	0.25	0.22	0.25	0.23	0.21	0.21	0.21	0.24
	HQ3	NA	NA	NA	NA	NA	NA	NA	NA	NA
M Adult	HQ1	**2.5**	**3.0**	**2.4**	**2.5**	**2.4**	**2.1**	**2.3**	**2.2**	**2.6**
	HQ2	0.53	0.64	0.51	0.53	0.51	0.45	0.48	0.46	0.54
	HQ3	NA	NA	NA	NA	NA	NA	NA	NA	NA
F Toddler	HQ1	**1.4**	**1.2**	**1.2**	**1.4**	**1.2**	**1.1**	**1.1**	**1.2**	**1.3**
	HQ2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	HQ3	0.68	0.60	0.60	0.72	0.60	0.57	0.56	0.58	0.64
F Child	HQ1	**1.6**	**1.7**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.6**
	HQ2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	HQ3	0.79	0.82	0.76	0.77	0.77	0.75	0.76	0.75	0.78
F Teen	HQ1	**1.3**	**1.3**	**1.2**	**1.3**	**1.2**	**1.1**	**1.1**	**1.1**	**1.3**
	HQ2	0.28	0.28	0.25	0.29	0.26	0.24	0.24	0.24	0.27
	HQ3	0.65	0.66	0.60	0.67	0.60	0.56	0.57	0.57	0.64
F Adult	HQ1	**3.0**	**3.6**	**2.9**	**2.9**	**2.8**	**2.6**	**2.7**	**2.6**	**3.0**

Human Receptor Type	HQ Type	Baseline	2017 (partial flooding)	2018 (partial flooding)	2019 (partial flooding)	2020 (partial flooding)	2021(op.)	2022 (op.)	2023 (op.)	2024 (op.)
	HQ2	0.63	0.77	0.61	0.63	0.60	0.54	0.57	0.55	0.65
	HQ3	**1.5**	**1.8**	**1.4**	**1.5**	**1.4**	**1.3**	**1.3**	**1.3**	**1.5**
Infant with F Teen Mother	HQ1	**2.6**	**2.6**	**2.3**	**2.6**	**2.4**	**2.2**	**2.2**	**2.2**	**2.5**
	HQ3	**1.3**	**1.3**	**1.2**	**1.3**	**1.2**	**1.1**	**1.1**	**1.1**	**1.2**
Infant with F Adult Mother	HQ1	**5.8**	**7.1**	**5.6**	**5.8**	**5.5**	**5.0**	**5.3**	**5.0**	**6.0**
	HQ3	**2.9**	**3.5**	**2.8**	**2.9**	**2.8**	**2.5**	**2.6**	**2.5**	**3.0**

Notes:

M=Male; F=Female; 'op.' denotes operational year of the Muskrat Falls Project; 'partial flooding' indicates the years where the reservoir was not fully inundated and/or power generation was not yet occurring.

HQ values are rounded to two significant figures. HQ values are unitless.

Bolded values indicate exceedance of target HQ value of 1.0.

HQ1 refers to HQ based on use of the U.S. EPA (2001a,b) and NRC (2000) TRV (See Dillon, 2016b).

HQ2 refers to HQ based on use of the Health Canada (2010c; 2007) TRV for the general adult population (See Dillon, 2016b). This TRV was also applied to M and F teen receptors (>12 to <20 years).

HQ3 refers to HQ based on use of the Health Canada (2010c; 2007) TRV for women of child-bearing age (considered to be both teen and adult life stages) and children <12 years of age (See Dillon, 2016b).

NA=not applicable for a given receptor; due to application of the gender and age-specific TRVs for MeHg from Health Canada.

TABLE 2b: SUMMARY OF METHYLMERCURY (MeHg) HAZARD QUOTIENTS (HQs) FOR MUSKRAT FALLS STUDY AREA EXPOSURE/CONSUMPTION SCENARIOS (COMMUNITIES) – BASELINE, 2017-2020, 2021, 2022, 2023, 2024: SHESHATSHIU (SH)

Human Receptor Type	HQ Type	Baseline	2017 (partial flooding)	2018 (partial flooding)	2019 (partial flooding)	2020 (partial flooding)	2021 (op.)	2022 (op.)	2023 (op.)	2024 (op.)
M Toddler	HQ1	1.0	0.97	0.98	0.97	0.98	1.0	0.97	0.98	0.96
	HQ2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	HQ3	0.50	0.49	0.49	0.48	0.49	0.50	0.48	0.49	0.48
M Child	HQ1	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**
	HQ2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	HQ3	0.71	0.70	0.70	0.69	0.70	0.70	0.70	0.70	0.69
M Teen	HQ1	0.95	0.93	0.93	0.93	0.93	0.94	0.93	0.93	0.93
	HQ2	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	HQ3	NA	NA	NA	NA	NA	NA	NA	NA	NA
M Adult	HQ1	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**
	HQ2	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
	HQ3	NA	NA	NA	NA	NA	NA	NA	NA	NA
F Toddler	HQ1	**1.1**	1.0	1.0	1.0	1.0	**1.1**	1.0	1.0	1.0
	HQ2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	HQ3	0.54	0.52	0.52	0.52	0.52	0.53	0.52	0.52	0.51
F Child	HQ1	**1.5**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**
	HQ2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	HQ3	0.73	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.71
F Teen	HQ1	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**
	HQ2	0.23	0.23	0.23	0.22	0.23	0.23	0.23	0.23	0.22
	HQ3	0.54	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
F Adult	HQ1	**2.5**	**2.5**	**2.5**	**2.4**	**2.5**	**2.5**	**2.5**	**2.5**	**2.4**
	HQ2	0.53	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
	HQ3	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**

Human Receptor Type	HQ Type	Baseline	2017 (partial flooding)	2018 (partial flooding)	2019 (partial flooding)	2020 (partial flooding)	2021 (op.)	2022 (op.)	2023 (op.)	2024 (op.)
Infant with F Teen Mother	HQ1	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**
	HQ3	**1.1**	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Infant with F Adult Mother	HQ1	**4.9**	**4.8**	**4.8**	**4.8**	**4.8**	**4.8**	**4.8**	**4.8**	**4.8**
	HQ3	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**

Notes:

M=Male; F=Female; 'op.' denotes operational year of the Muskrat Falls Project; 'partial flooding' indicates the years where the reservoir was not fully inundated and/or power generation was not yet occurring.

HQ values are rounded to two significant figures. HQ values are unitless.

Bolded values indicate exceedance of target HQ value of 1.0.

HQ1 refers to HQ based on use of the U.S. EPA (2001a,b) and NRC (2000) TRV (See Dillon, 2016b).

HQ2 refers to HQ based on use of the Health Canada (2010c; 2007) TRV for the general adult population (See Dillon, 2016b). This TRV was also applied to M and F teen receptors (>12 to <20 years).

HQ3 refers to HQ based on use of the Health Canada (2010c; 2007) TRV for women of child-bearing age (considered to be both teen and adult life stages) and children <12 years of age (See Dillon, 2016b).

NA=not applicable for a given receptor; due to application of the gender and age-specific TRVs for MeHg from Health Canada.

TABLE 2c: SUMMARY OF METHYLMERCURY (MeHg) HAZARD QUOTIENTS (HQs) FOR MUSKRAT FALLS STUDY AREA EXPOSURE/CONSUMPTION SCENARIOS (COMMUNITIES) – BASELINE, 2017-2020, 2021, 2022, 2023, 2024: NORTHWEST RIVER (NWR) AND MUD LAKE (ML)

Human Receptor Type	HQ Type	Baseline	2017 (partial flooding)	2018 (partial flooding)	2019 (partial flooding)	2020 (partial flooding)	2021 (op.)	2022 (op.)	2023 (op.)	2024 (op.)
M Toddler	HQ1	1.5	1.4	1.4	1.6	1.4	1.3	1.3	1.3	1.5
	HQ2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	HQ3	0.77	0.7	0.69	0.80	0.7	0.66	0.66	0.67	0.73
M Child	HQ1	1.6	1.7	1.5	1.6	1.6	1.5	1.5	1.5	1.6
	HQ2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	HQ3	0.80	0.83	0.77	0.78	0.78	0.76	0.77	0.76	0.79
M Teen	HQ1	1.2	1.2	1.1	1.2	1.1	1.0	1.0	1.0	1.2
	HQ2	0.25	0.26	0.23	0.26	0.23	0.22	0.22	0.22	0.25
	HQ3	NA	NA	NA	NA	NA	NA	NA	NA	NA
M Adult	HQ1	2.5	3.1	2.4	2.5	2.4	2.2	2.3	2.2	2.6
	HQ2	0.54	0.65	0.52	0.53	0.51	0.46	0.49	0.47	0.55
	HQ3	NA	NA	NA	NA	NA	NA	NA	NA	NA
F Toddler	HQ1	1.6	1.5	1.5	1.7	1.5	1.4	1.4	1.4	1.6
	HQ2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	HQ3	0.82	0.74	0.74	0.86	0.74	0.71	0.70	0.72	0.78
F Child	HQ1	1.7	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6
	HQ2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	HQ3	0.83	0.86	0.79	0.80	0.80	0.78	0.79	0.78	0.82
F Teen	HQ1	1.4	1.4	1.2	1.4	1.2	1.2	1.2	1.2	1.3
	HQ2	0.29	0.29	0.26	0.30	0.27	0.25	0.25	0.25	0.28
	HQ3	0.68	0.68	0.62	0.70	0.63	0.58	0.60	0.59	0.66
F Adult	HQ1	3.0	3.7	2.9	3.0	2.9	2.6	2.7	2.6	3.1
	HQ2	0.64	0.78	0.62	0.64	0.61	0.55	0.58	0.56	0.66
	HQ3	1.5	1.8	1.5	1.5	1.4	1.3	1.4	1.3	1.5

Human Receptor Type	HQ Type	Baseline	2017 (partial flooding)	2018 (partial flooding)	2019 (partial flooding)	2020 (partial flooding)	2021 (op.)	2022 (op.)	2023 (op.)	2024 (op.)
Infant with F Teen Mother	HQ1	**2.6**	**2.7**	**2.4**	**2.7**	**2.4**	**2.3**	**2.3**	**2.3**	**2.6**
	HQ3	**1.3**	**1.3**	**1.2**	**1.4**	**1.2**	**1.1**	**1.2**	**1.2**	**1.3**
Infant with F Adult Mother	HQ1	**5.9**	**7.1**	**5.7**	**5.9**	**5.6**	**5.1**	**5.4**	**5.1**	**6.0**
	HQ3	**2.9**	**3.6**	**2.8**	**2.9**	**2.8**	**2.5**	**2.7**	**2.6**	**3.0**

Notes:

M=Male; F=Female; 'op.' denotes operational year of the Muskrat Falls Project; 'partial flooding' indicates the years where the reservoir was not fully inundated and/or power generation was not yet occurring.

HQ values are rounded to two significant figures. HQ values are unitless.

Bolded values indicate exceedance of target HQ value of 1.0.

HQ1 refers to HQ based on use of the U.S. EPA (2001a,b) and NRC (2000) TRV (See Dillon, 2016b).

HQ2 refers to HQ based on use of the Health Canada (2010c; 2007) TRV for the general adult population (See Dillon, 2016b). This TRV was also applied to M and F teen receptors (>12 to <20 years).

HQ3 refers to HQ based on use of the Health Canada (2010c; 2007) TRV for women of child-bearing age (considered to be both teen and adult life stages) and children <12 years of age (See Dillon, 2016b).

NA=not applicable for a given receptor; due to application of the gender and age-specific TRVs for MeHg from Health Canada.

TABLE 3a: SUMMARY OF PREDICTED HAIR MeHg CONCENTRATIONS (mg/kg ww) FOR HUMAN RECEPTORS ASSESSED IN THE HHRA – BASELINE, 2017-2020, 2021, 2022, 2023, 2024: HAPPY VALLEY-GOOSE BAY (HVGB)

Receptor	Baseline	2017 (partial flooding)	2018 (partial flooding)	2019 (partial flooding)	2020 (partial flooding)	2021 (op.)	2022 (op.)	2023 (op.)	2024 (op.)
M Toddler	1.4	1.3	1.3	1.5	1.3	1.2	1.2	1.2	1.3
M Child	1.7	1.8	1.7	1.7	1.7	1.6	1.7	1.7	1.7
M Teen	1.3	1.3	1.2	1.3	1.2	1.1	1.1	1.1	1.3
M Adult	2.8	3.4	2.7	2.8	2.7	2.4	2.6	2.4	2.9
F Toddler	1.5	1.4	1.3	1.6	1.4	1.3	1.3	1.3	1.4
F Child	1.8	1.9	1.7	1.7	1.7	1.7	1.7	1.7	1.8
F Teen	1.5	1.5	1.4	1.5	1.4	1.3	1.3	1.3	1.4
F Adult	**3.4**	**4.1**	**3.2**	**3.3**	**3.2**	**2.9**	**3.0**	**2.9**	**3.4**
Pregnant F Teen	1.0	1.0	0.9	1.0	0.9	0.9	0.9	0.9	1.0
Pregnant F Adult	**2.3**	**2.8**	**2.3**	**2.3**	**2.2**	2.0	**2.1**	2.0	**2.4**

Notes:

M=Male; F=Female; 'op.' denotes operational year of the Muskrat Falls Project; 'partial flooding' indicates the years where the reservoir was not fully inundated and/or power generation was not yet occurring.

Bolded values denote an exceedance over the applicable "no action" Health Canada hair guidance value(s) for THg/MeHg (2 mg/kg ww for pregnant F; F 0-49 yrs; M≤18 yrs; and, 5 mg/kg ww for F≥50 yrs; M >18 yrs).

TABLE 3b: SUMMARY OF PREDICTED HAIR MeHg CONCENTRATIONS (mg/kg ww) FOR HUMAN RECEPTORS ASSESSED IN THE HHRA – BASELINE, 2017-2020, 2021, 2022, 2023, 2024: SHESHATSHIU (SH)

Receptor	Baseline	2017 (partial flooding)	2018 (partial flooding)	2019 (partial flooding)	2020 (partial flooding)	2021 (op.)	2022 (op.)	2023 (op.)	2024 (op.)
M Toddler	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
M Child	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
M Teen	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0
M Adult	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
F Toddler	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
F Child	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
F Teen	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
F Adult	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**
Pregnant F Teen	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Pregnant F Adult	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9

Notes:

M=Male; F=Female; 'op.' denotes operational year of the Muskrat Falls Project; 'partial flooding' indicates the years where the reservoir was not fully inundated and/or power generation was not yet occurring.

Bolded values denote an exceedance over the applicable "no action" Health Canada hair guidance value(s) for THg/MeHg (2 mg/kg ww for pregnant F; F 0-49 yrs; M≤18 yrs; and, 5 mg/kg ww for F≥50 yrs; M >18 yrs).

TABLE 3c: SUMMARY OF PREDICTED HAIR MeHg CONCENTRATIONS (mg/kg ww) FOR HUMAN RECEPTORS ASSESSED IN THE HHRA – BASELINE, 2017-2020,2021, 2022, 2023, 2024: NORTHWEST RIVER (NWR) AND MUD LAKE (ML)

Receptor	Baseline	2017 (partial flooding)	2018 (partial flooding)	2019 (partial flooding)	2020 (partial flooding)	2021 (op.)	2022 (op.)	2023 (op.)	2024 (op.)
M Toddler	1.7	1.6	1.6	1.8	1.6	1.5	1.5	1.5	1.6
M Child	1.8	1.9	1.7	1.8	1.8	1.7	1.7	1.7	1.8
M Teen	1.3	1.4	1.2	1.4	1.2	1.2	1.2	1.2	1.3
M Adult	2.9	3.5	2.8	2.8	2.7	2.5	2.6	2.5	2.9
F Toddler	1.9	1.7	1.7	1.9	1.7	1.6	1.6	1.6	1.8
F Child	1.9	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8
F Teen	1.5	1.5	1.4	1.6	1.4	1.3	1.3	1.3	1.5
F Adult	**3.4**	**4.1**	**3.3**	**3.4**	**3.3**	**2.9**	**3.1**	**3.0**	**3.5**
Pregnant F Teen	1.0	1.0	1.0	1.1	1.0	0.9	0.9	0.9	1.0
Pregnant F Adult	**2.4**	**2.9**	**2.3**	**2.4**	**2.3**	**2.1**	**2.2**	**2.1**	**2.4**

Notes:

M=Male; F=Female; 'op.' denotes operational year of the Muskrat Falls Project; 'partial flooding' indicates the years where the reservoir was not fully inundated and/or power generation was not yet occurring.

Bolded values denote an exceedance over the applicable "no action" Health Canada hair guidance value(s) for THg/MeHg (2 mg/kg ww for pregnant F; F 0-49 yrs; M≤18 yrs; and, 5 mg/kg ww for F≥50 yrs; M >18 yrs).

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TABLE 4a: SUMMARY OF PREDICTED BLOOD MeHg CONCENTRATIONS (μg/L) FOR HUMAN RECEPTORS ASSESSED IN THE HHRA – BASELINE, 2017-2020, 2021, 2022, 2023, 2024: HAPPY VALLEY-GOOSE BAY (HVGB)

Receptor	Baseline	2017 (partial flooding)	2018 (partial flooding)	2019 (partial flooding)	2020 (partial flooding)	2021 (op.)	2022 (op.)	2023 (op.)	2024 (op.)
M Toddler	5.8	5.1	5.1	6.1	5.1	4.8	4.8	4.9	5.4
M Child	7.0	7.3	6.6	6.8	6.8	6.6	6.7	6.6	6.9
M Teen	5.2	5.2	4.8	5.4	4.8	4.5	4.6	4.6	5.1
M Adult	11.2	13.7	10.8	11.2	10.7	9.7	10.2	9.8	11.6
F Toddler	6.2	5.5	5.4	6.5	5.5	5.1	5.1	5.2	5.8
F Child	7.2	7.5	6.8	6.9	7.0	6.8	6.9	6.8	7.1
F Teen	5.9	6.0	5.4	6.1	5.5	5.1	5.2	5.2	5.8
F Adult	**13.4**	**16.3**	**12.9**	**13.3**	**12.8**	**11.5**	**12.2**	**11.7**	**13.8**
Pregnant F Teen	4.0	4.1	3.7	4.1	3.7	3.5	3.5	3.5	3.9
Pregnant F Adult	**9.4**	**11.4**	**9.0**	**9.3**	**8.9**	**8.1**	**8.5**	**8.1**	**9.6**

Notes:

M=Male; F=Female; 'op.' denotes operational year of the Muskrat Falls Project; 'partial flooding' indicates the years where the reservoir was not fully inundated and/or power generation was not yet occurring.

Bolded values denote an exceedance over the applicable "no action" Health Canada blood guidance value(s) for MeHg (8 μg/L for pregnant F; F 0-49 yrs; M≤18 yrs; and, 20 μg/L for F≥50 yrs; M>18 yrs).

TABLE 4b: SUMMARY OF PREDICTED BLOOD MeHg CONCENTRATIONS (µg/L) FOR HUMAN RECEPTORS ASSESSED IN THE HHRA – BASELINE, 2017-2020, 2021, 2022, 2023, 2024: SHESHATSHIU (SH)

Receptor	Baseline	2017 (partial flooding)	2018 (partial flooding)	2019 (partial flooding)	2020 (partial flooding)	2021 (op.)	2022 (op.)	2023 (op.)	2024 (op.)
M Toddler	4.6	4.4	4.4	4.4	4.4	4.5	4.4	4.4	4.4
M Child	6.5	6.3	6.3	6.3	6.3	6.4	6.3	6.3	6.3
M Teen	4.3	4.2	4.2	4.2	4.2	4.3	4.2	4.2	4.2
M Adult	9.4	9.3	9.3	9.3	9.3	9.4	9.3	9.3	9.3
F Toddler	4.9	4.7	4.7	4.7	4.7	4.8	4.7	4.7	4.7
F Child	6.6	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
F Teen	4.9	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
F Adult	**11.3**	**11.1**	**11.1**	**11.1**	**11.1**	**11.2**	**11.1**	**11.1**	**11.1**
Pregnant F Teen	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.2
Pregnant F Adult	7.9	7.7	7.7	7.7	7.8	7.8	7.8	7.8	7.7

Notes:

M=Male; F=Female; 'op.' denotes operational year of the Muskrat Falls Project; 'partial flooding' indicates the years where the reservoir was not fully inundated and/or power generation was not yet occurring.

Bolded values denote an exceedance over the applicable "no action" Health Canada blood guidance value(s) for MeHg (8 µg/L for pregnant F; F 0-49 yrs; M≤18 yrs; and, 20 µg/L for F≥50 yrs; M>18 yrs).

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TABLE 4c: SUMMARY OF PREDICTED BLOOD MeHg CONCENTRATIONS (µg/L) FOR HUMAN RECEPTORS ASSESSED IN THE HHRA – BASELINE, 2017-2020, 2021, 2022, 2023, 2024: NORTHWEST RIVER (NWR) AND MUD LAKE (ML)

Receptor	Baseline	2017 (partial flooding)	2018 (partial flooding)	2019 (partial flooding)	2020 (partial flooding)	2021 (op.)	2022 (op.)	2023 (op.)	2024 (op.)
M Toddler	7.0	6.3	6.2	7.3	6.3	6.0	5.9	6.1	6.6
M Child	7.3	7.5	6.9	7.0	7.1	6.9	7.0	6.9	7.2
M Teen	5.4	5.4	5.0	5.5	5.0	4.7	4.7	4.7	5.3
M Adult	11.4	13.9	11.0	11.4	10.9	9.9	10.4	9.9	11.7
F Toddler	7.5	6.7	6.7	7.8	6.7	6.4	6.3	6.5	7.0
F Child	7.5	7.8	7.1	7.2	7.3	7.1	7.2	7.1	7.4
F Teen	6.1	6.2	5.6	6.3	5.7	5.3	5.4	5.4	6.0
F Adult	**13.6**	**16.6**	**13.2**	**13.6**	**13.0**	**11.8**	**12.4**	**11.9**	**14.0**
Pregnant F Teen	4.2	4.2	3.8	4.3	3.9	3.6	3.7	3.7	4.1
Pregnant F Adult	**9.5**	**11.5**	**9.2**	**9.5**	**9.1**	**8.2**	**8.7**	**8.3**	**9.8**

Notes:

M=Male; F=Female; 'op.' denotes operational year of the Muskrat Falls Project; 'partial flooding' indicates the years where the reservoir was not fully inundated and/or power generation was not yet occurring.

Bolded values denote an exceedance over the applicable "no action" Health Canada blood guidance value(s) for MeHg (8 µg/L for pregnant F; F 0-49 yrs; M≤18 yrs; and, 20 µg/L for F≥50 yrs; M>18 yrs).

TABLE 5: SUMMARY OF PREDICTED FETAL BLOOD MeHg CONCENTRATIONS (µg/L) – BASELINE, 2017-2020, 2021, 2022, 2023, 2024

Community	Predicted Fetal Blood Concentration (µg/L) Based on Pregnant Female Teen	Predicted Fetal Blood Concentration (µg/L) Based on Pregnant Female Adult
Happy Valley-Goose Bay (HVGB)		
Baseline	6.9	**15.9**
2017 (partial flooding)	6.9	**19.4**
2018 (partial flooding)	6.3	**15.3**
2019 (partial flooding)	7.1	**15.8**
2020 (partial flooding)	6.3	**15.2**
2021 (op.)	5.9	**13.7**
2022 (op.)	6.0	**14.4**
2023 (op.)	6.0	**13.8**
2024 (op.)	6.7	**16.3**
Sheshatshiu (SH)		
Baseline	5.6	**13.4**
2017 (partial flooding)	5.5	**13.2**
2018 (partial flooding)	5.5	**13.2**
2019 (partial flooding)	5.5	**13.1**
2020 (partial flooding)	5.6	**13.2**
2021 (op.)	5.6	**13.2**
2022 (op.)	5.5	**13.2**
2023 (op.)	5.6	**13.2**
2024 (op.)	5.5	**13.1**
North West River (NWR) and Mud Lake (ML)		

Community	Predicted Fetal Blood Concentration (µg/L) Based on Pregnant Female Teen	Predicted Fetal Blood Concentration (µg/L) Based on Pregnant Female Adult
Baseline	7.1	**16.2**
2017 (partial flooding)	7.1	**19.6**
2018 (partial flooding)	6.5	**15.6**
2019 (partial flooding)	7.3	**16.1**
2020 (partial flooding)	6.6	**15.5**
2021 (op.)	6.1	**13.9**
2022 (op.)	6.2	**14.7**
2023 (op.)	6.2	**14.1**
2024 (op.)	6.9	**16.6**

Notes:

'op.' denotes operational year of the Muskrat Falls Project; 'partial flooding' indicates the years where the reservoir was not fully inundated and/or power generation was not yet occurring.

Bolded concentrations exceed the Health Canada (Legrand et al., 2010) "no action" blood guidance value of 8 µg/L. Health Canada considers that <8 µg/L of MeHg in maternal blood is protective of the developing fetus as well as infants and young and older children (up to adolescence).

MEMO

3.0   Uncertainties, Limitations and Conservative Assumptions

As described in detail previously in the baseline HHRA report (Dillon, 2016b), due to a number of uncertainties and data variability, the HHRA methodology and model utilizes many conservative assumptions and approaches, which result in highly conservative and protective HHRA outcomes that intentionally overestimate human exposure to MeHg and inorganic Hg within the Muskrat Falls study area communities, by what is believed to be a substantial degree. In any HHRA, the magnitude of hazard quotient values (and other HHRA outcomes) must be balanced against the conservative assumptions and approaches used to estimate exposure and risk, as well as against the other lines of evidence (LOEs) evaluated in the HHRA. Intentionally overestimating exposure and risk is a common and necessary feature of all HHRAs, and is in keeping with a number of standard regulatory precautionary approaches and guiding principles used routinely in risk assessments and environmental impact assessments.

Section 4.0 of the baseline HHRA report (Dillon, 2016b) describes the key uncertainties, limitations and conservative assumptions in the overall HHRA methodology and model that has been used since the baseline period, and which continues to be applied. The status of these uncertainties and limitations, and their impact on HHRA outcomes, remains unchanged. However, one key current source of uncertainty is that the consumption rates and frequencies applied within the HHRA model remain based on 2014-2015 diet survey outcomes in the study area communities. Since over 10 years have elapsed since these surveys were conducted, it is possible that 2014-2015 diet survey outcomes no longer adequately represent current country food harvesting and consumption patterns (particularly with respect to fish and seal) within the Muskrat Falls study area communities. It is noted that planning is in progress for some communities and/or Indigenous organizations within the study area to conduct new or updated dietary surveys. These new surveys may yield outcomes that could inform the HHRA program and help ensure that consumption rates and frequencies utilized in the HHRA program for local country foods are accurate and representative of current dietary patterns within the study area communities.

This source of uncertainty was originally noted in the baseline HHRA (Dillon, 2016b) where it was acknowledged that there was uncertainty associated with the outcomes of the baseline diet surveys, and that future follow-up dietary surveys may be necessary to refine estimates of country food consumption patterns among the study area communities, and/or to account for potential future changes to study area country food consumption patterns.

4.0   References Cited

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Attachment A: 2024 Brook Trout, Rainbow Smelt, Burbot and Ringed Seal (Meat and Liver) Data Summaries and Statistical Output

date	location	area	species	length	weight	sex	gonad_weight	thg
2024-08-09	Rabbit Island	GB	BK	332	376.8	M		0.05
2024-08-09	Rabbit Island	GB	BK	216	112.4	M		0.02
2024-08-09	Rabbit Island	GB	BK	208	106	M		0.01
2024-08-09	Rabbit Island	GB	BK	364	452.4	F	1.7	0.02
2024-08-09	Rabbit Island	GB	BK	352	461.7	IM		0.02
2024-08-09	Rabbit Island	GB	BK	277	230.7	F	0.7	0.01
2024-08-09	Rabbit Island	GB	BK	260	196.9	F		0.01
2024-08-09	Rabbit Island	GB	BK	191	191.6	F	1.5	0.02
2024-08-09	Rabbit Island	GB	BK	252	173.6	F	7.4	0.02
2024-08-09	Rabbit Island	GB	BK	256	177.1	F	10.4	0.04
2024-08-09	Rabbit Island	GB	BK	189	65.6	M		0.01
2024-08-09	Rabbit Island	GB	BK	267	237.6	IM		0.02
2024-08-09	Rabbit Island	GB	BK	183	71	M		0.01
2024-08-09	Rabbit Island	GB	BK	190	76.4	M		0.01
2024-08-09	Rabbit Island	GB	BK	190	73.4	M		0.02
2024-08-09	Rabbit Island	GB	BK	160	44.4	M		0.01
2024-08-09	Rabbit Island	GB	BK	183	66.7	IM		0.01
2024-08-09	Rabbit Island	GB	BK	197	86.4	IM		0.01
2024-08-09	Rabbit Island	GB	BK	168	48.1	M		0.01
2024-08-10	Rabbit Island	GB	BK	185	55	M		0.02
2024-08-13	Epinette Point	LM	BK	535	2069.4	M	44.4	0.04
2024-08-13	Epinette Point	LM	BK	478	1368	M	34.4	0.07
2024-08-13	Epinette Point	LM	BK	490	1677.9	M	38	0.06
2024-08-13	Epinette Point	LM	BK	296	265.9	IM		0.05
2024-08-13	Epinette Point	LM	BK	320	390.5	IM		0.01
2024-08-13	Epinette Point	LM	BK	419	977.6	F	34.1	0.10
2024-08-13	Epinette Point	LM	BK	282	282.7	IM		0.02
2024-08-13	Epinette Point	LM	BK	348	565.5	IM		0.01
2024-08-13	Epinette Point	LM	BK	357	517	F	14.4	0.02
2024-08-13	Epinette Point	LM	BK	210	103	IM		0.01
2024-08-13	Epinette Point	LM	BK	190	70.4	IM		0.01
2024-08-13	Epinette Point	LM	BK	300	291.7	F	7.5	0.04
2024-08-13	Epinette Point	LM	BK	397	786.4	F	21.4	0.03
2024-08-13	Epinette Point	LM	BK	352	552.4	IM		0.02
2024-08-13	Epinette Point	LM	BK	357	365.8	IM		0.02
2024-08-13	Epinette Point	LM	BK	330	389.7	IM		0.02
2024-08-13	Epinette Point	LM	BK	270	159.2	IM		0.06
2024-08-13	Epinette Point	LM	BK	222	125.5	IM		0.01
2024-08-13	Epinette Point	LM	BK	255	187.1	IM		0.02
2024-08-13	Epinette Point	LM	BK	207	96.1	IM		0.02
2024-08-13	Epinette Point	LM	BK	208	102.9	IM		0.03
2024-08-13	Epinette Point	LM	BK	228	129.4	IM		0.01
2024-08-13	Epinette Point	LM	BK	198	79.8	IM		0.02
2024-08-15	Trout Cove	OM	BK	156	35	IM		0.02
2024-08-15	Trout Cove	OM	BK	152	35	IM		0.01
2024-08-15	**Trout Cove**	**OM**	**BK**	**143**	**26**	**IM**		**0.01**
2024-08-15	Trout Cove	OM	BK	163	37	IM		0.01
2024-08-15	**Trout Cove**	**OM**	**BK**	**147**	**35**	**IM**		**0.01**
2024-08-15	Trout Cove	OM	BK	407	856	IM		0.02
2024-08-15	Trout Cove	OM	BK	469	1290	F	44	0.08
2024-08-15	Trout Cove	OM	BK	438	991	IM		0.03
2024-08-15	Trout Cove	OM	BK	387	670	F	13	0.01
2024-08-15	Trout Cove	OM	BK	372	632	F	14	0.01
2024-08-15	Trout Cove	OM	BK	372	622	F	12	0.01
2024-08-15	Trout Cove	OM	BK	298	336	F		0.01
2024-08-15	Trout Cove	OM	BK	260	205	F		0.01
2024-08-15	Trout Cove	OM	BK	258	214	M		0.02
2024-08-15	Trout Cove	OM	BK	320	393	M		0.01
2024-08-15	Trout Cove	OM	BK	232	152	IM		0.01
2024-08-15	Trout Cove	OM	BK	188	80	F	6	0.01
2024-08-15	Trout Cove	OM	BK	232	135	F		0.01
2024-08-15	**Trout Cove**	**OM**	**BK**	**125**	**20**	**IM**		**0.01**
2024-08-15	**Trout Cove**	**OM**	**BK**	**146**	**32**	**IM**		**0.01**
2024-08-15	Trout Cove	OM	BK	286	281	F		0.01
2024-08-15	Trout Cove	OM	BK	380	609	M	20	0.03
2024-08-15	Trout Cove	OM	BK	243	155	IM		0.02
2024-08-15	Trout Cove	OM	BK	248	176	F	23	0.02
2024-08-15	Trout Cove	OM	BK	390	610	F	25	0.13
2024-08-15	Trout Cove	OM	BK	366	572	M		0.05
2024-08-15	Trout Cove	OM	BK	290	270	F	15	0.03
2024-08-15	Trout Cove	OM	BK	270	229	IM		0.02
2024-08-15	Trout Cove	OM	BK	245	156	F	11	0.02

2024 BROOK TROUT THg DATA (mg THg/kg ww fish)

Summary Statistics (Excel)

N	90	**Correlation Coefficient (length vs THg)**
min	0.01 <0.01	0.405365
max	0.13	
arithmean	0.03	
median	0.02	
# nd	10	
freq. nd (%)	11.11111	

General Statistics on Uncensored Full Data

Date/Time of Computation	ProUCL 5.2 2025-04-09 10:03:57 AM
User Selected Options	
From File	WorkSheet.xls
Full Precision	ON

From File: WorkSheet.xls

General Statistics for Uncensored Dataset

Variable	NumObs	# Missing	Minimum	Maximum	Mean	Geo-Mean	SD	SEM	MAD/0.67!	Skewness	CV
C0	90	0	0.01	0.13	0.028778	0.021565	0.025432	0.002681	0.014826	2.051172	0.883749

Percentiles for Uncensored Dataset

Variable	NumObs	# Missing	10%ile	20%ile	25%ile(Q1	50%ile(Q2	75%ile(Q3	80%ile	90%ile	95%ile	99%ile
C0	90	0	0.01	0.01	0.01	0.02	0.04	0.042	0.06	0.0755	0.1211

Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 2025-04-09 10:04:43 AM
From File	WorkSheet.xls
Full Precision	ON
Confidence Coefficient	0.95

C0

Raw Statistics

Number of Valid Observations	90
Number of Distinct Observations	12
Minimum	0.01
Maximum	0.13
Mean of Raw Data	0.028778
Standard Deviation of Raw Data	0.025432
Khat	1.882578
Theta hat	0.015286
Kstar	1.827233
Theta star	0.015749
Mean of Log Transformed Data	-3.83667
Standard Deviation of Log Transformed Data	0.728158

Normal GOF Test Results

Correlation Coefficient R	0.854323
Approximate Shapiro Wilk Test Statistic	0.729446
Approximate Shapiro Wilk P Value	0
Lilliefors Test Statistic	0.290562
Lilliefors Critical (0.0500000) Value	0.093577
Data not Normal at (0.0500000) Significance Level	

Gamma GOF Test Results

Correlation Coefficient R	0.967481
A-D Test Statistic	4.796134
A-D Critical (0.0500000) Value	0.766624
K-S Test Statistic	0.24231

2024-08-15	Trout Cove	OM	BK	217	104	M	2	0.02
2024-10-05		BM	BK	296	224.9	IM	<0.1	0.02
2024-10-13		BM	BK	280	189.9	IM	<0.1	0.04
2024-10-13		BM	BK	253	134.1	F	4.6	0.05
2024-10-13		BM	BK	295	224	IM	<0.1	0.04
2024-10-13		BM	BK	310	274	F	15.8	0.12
2024-10-13		BM	BK	226	127.8	IM	<0.1	0.07
2024-10-13		BM	BK	204	85.9	IM	<0.1	0.03
2024-10-13		BM	BK	264	163.1	F	8.4	0.06
2024-10-13		BM	BK	222	112.9	IM	<0.1	0.11
2024-10-13		BM	BK	278	221.9	F	27.5	0.05
2024-10-15		BM	BK	346	389.5			0.05
2024-10-15		BM	BK	244	121.6			0.04
2024-10-15		BM	BK	276	205.5	F	14.8	0.05
2024-10-15		BM	BK	250	158.8			0.06
2024-10-24		BM	BK	222	98.8	IM	<0.1	0.02
2024-10-25		BM	BK	238	147.1	IM	<0.1	0.04
2024-10-26		BM	BK	215	82.3	IM		0.02

K-S Critical(0.0500000) Value	0.09556
Data not Gamma Distributed at (0.0500000) Significance Level	

Lognormal GOF Test Results

Correlation Coefficient R	0.936971
Approximate Shapiro Wilk Test Statistic	0.854153
Approximate Shapiro Wilk P Value	1.48E-12
Lilliefors Test Statistic	0.209936
Lilliefors Critical (0.0500000) Value	0.093577
Data not Lognormal at (0.0500000) Significance Level	

Non-parametric GOF Test Results

Data do not follow a discernible distribution at (0.0500000) Level of Significance

UCL Statistics for Uncensored Full Data Sets

User Selected Options

Date/Time of Computation	ProUCL 5.2 2025-04-09 10:05:51 AM
From File	WorkSheet.xls
Full Precision	ON
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	90	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	0.01	Mean	0.028778
Maximum	0.13	Median	0.02
SD	0.0254323	Std. Error of Mean	0.002681
Coefficient of Variation	0.8837493	Skewness	2.051172

Normal GOF Test

Shapiro Wilk Test Statistic	0.7294462	Shapiro Wilk GOF Test
1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.2905619	Lilliefors GOF Test
1% Lilliefors Critical Value	0.1082147	Data Not Normal at 1% Significance Level
Data Not Normal at 1% Significance Level		

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.0332337	95% Adjusted-CLT UCL (Chen-1995)	0.033807
		95% Modified-t UCL (Johnson-1978)	0.03333

Gamma GOF Test

A-D Test Statistic	4.7961339	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.7666242	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.2423099	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.0955598	Data Not Gamma Distributed at 5% Significance Level
Data Not Gamma Distributed at 5% Significance Level		

Gamma Statistics

k hat (MLE)	1.8825783	k star (bias corrected MLE)	1.827233
Theta hat (MLE)	0.0152864	Theta star (bias corrected MLE)	0.015749
nu hat (MLE)	338.86409	nu star (bias corrected)	328.902
MLE Mean (bias corrected)	0.0287778	MLE Sd (bias corrected)	0.021289
		Approximate Chi Square Value (0.05)	287.8825
Adjusted Level of Significance	0.0473333	Adjusted Chi Square Value	287.263

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.0328782	95% Adjusted Gamma UCL	0.032949

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.8541531	Shapiro Wilk Lognormal GOF Test
10% Shapiro Wilk P Value	1.48E-12	Data Not Lognormal at 10% Significance Level

Lilliefors Test Statistic		0.2099364	Lilliefors Lognormal GOF Test	
10% Lilliefors Critical Value		0.0856307	Data Not Lognormal at 10% Significance Level	
Data Not Lognormal at 10% Significance Level				

Lognormal Statistics

Minimum of Logged Data	-4.60517	Mean of logged Data	-3.83667
Maximum of Logged Data	-2.040221	SD of logged Data	0.728158

Assuming Lognormal Distribution

95% H-UCL	0.0328887	90% Chebyshev (MVUE) UCL	0.035176
95% Chebyshev (MVUE) UCL	0.0384221	97.5% Chebyshev (MVUE) UCL	0.042928
99% Chebyshev (MVUE) UCL	0.0517793		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

Selected UCL is arithmetic mean of
non-parametric UCL estimates,
where alpha=0.05:

95% CLT UCL	0.0331873	95% BCA Bootstrap UCL	0.033889	
95% Standard Bootstrap UCL	0.0331173	95% Bootstrap-t UCL	0.033678	<mark>0.03447031</mark>
95% Hall's Bootstrap UCL	0.0336246	95% Percentile Bootstrap UCL	0.033333	
90% Chebyshev(Mean, Sd) UCL	0.0368202	95% Chebyshev(Mean, Sd) UCL	0.040463	
97.5% Chebyshev(Mean, Sd) UCL	0.0455194	99% Chebyshev(Mean, Sd) UCL	0.055451	

Suggested UCL to Use

95% Student's-t UCL	0.0332337		rejected as data distribution is non-parametric

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

date	location	area	species	length	weight	sex	gonad_weight	thg
2024-08-09	Rabbit Island	GB	RS	96	5.9	IM		0.01
2024-08-09	Rabbit Island	GB	RS	92	5.7	IM		0.04
2024-08-09	Rabbit Island	GB	RS	110	10	IM		0.01
2024-08-10	Rabbit Island	GB	RS	127	13.3	IM		0.05
2024-08-10	Rabbit Island	GB	RS	153	27.8	IM		0.02
2024-08-10	Rabbit Island	GB	RS	177	39.3	IM		0.03
2024-08-10	Rabbit Island	GB	RS	172	34.5	IM		0.04
2024-08-10	Rabbit Island	GB	RS	158	29.5	IM		0.03
2024-08-10	Rabbit Island	GB	RS	88	4.5	IM		0.01
2024-08-10	Rabbit Island	GB	RS	153	31.8	IM		0.04
2024-08-10	Rabbit Island	GB	RS	172	42.5	IM		0.07
2024-08-10	Rabbit Island	GB	RS	170	32.4	IM		0.02
2024-08-10	Rabbit Island	GB	RS	165	36.4	IM		0.03
2024-08-10	Rabbit Island	GB	RS	148	24	IM		0.02
2024-08-10	Rabbit Island	GB	RS	72	2.8	IM		0.02
2024-08-10	Rabbit Island	GB	RS	168	27.9	IM		0.03
2024-08-15	Trout Cove	OM	RS	140	28	IM		0.03
2024-08-15	Trout Cove	OM	RS	161	36	IM		0.02
2024-08-15	Trout Cove	OM	RS	176	42	IM		0.04
2024-08-15	Trout Cove	OM	RS	150	30	IM		0.03
2024-08-15	Trout Cove	OM	RS	170	46	IM		0.03

2024 RAINBOW SMELT THg DATA (mg THg/kg ww fish)

Summary Statistics (Excel)

			Correlation Coefficient (length vs THg)	
N	21			
min	0.01	<0.01	0.41178	
max	0.07			
arithmean	0.03			
median	0.03			
# nd	1			
freq. nd (%)	4.761905			

General Statistics on Uncensored Full Data

Date/Time of Computation	ProUCL 5.2 2025-04-09 11:33:38 AM
User Selected Options	
From File	WorkSheet.xls
Full Precision	ON

From File: WorkSheet.xls

General Statistics for Uncensored Dataset

Variable	NumObs	# Missing	Minimum	Maximum	Mean	Geo-Mean	SD	SEM	MAD/0.675	Skewness	CV
C0	21	0	0.01	0.07	0.029524	0.0262373	0.01431	0.003123	0.014826	0.9968467	0.484677

Percentiles for Uncensored Dataset

Variable	NumObs	# Missing	10%ile	20%ile	25%ile(Q1	50%ile(Q2)	75%ile(Q3	80%ile	90%ile	95%ile	99%ile
C0	21	0	0.01	0.02	0.02	0.03	0.04	0.04	0.04	0.05	0.066

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 2025-04-09 11:36:12 AM
From File	WorkSheet.xls
Full Precision	ON
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	21	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	0.01	Mean	0.0295238
Maximum	0.07	Median	0.03
SD	0.01431	Std. Error of Mean	0.0031226
Coefficient of Variation	0.484677	Skewness	0.9968467

Normal GOF Test

Shapiro Wilk Test Statistic	0.900769	Shapiro Wilk GOF Test	
1% Shapiro Wilk Critical Value	0.873	Data appear Normal at 1% Significance Level	
Lilliefors Test Statistic	0.201012	Lilliefors GOF Test	
1% Lilliefors Critical Value	0.219	Data appear Normal at 1% Significance Level	

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL   95% UCLs (Adjusted for Skewness)

Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 2025-04-09 11:35:18 AM
From File	WorkSheet.xls
Full Precision	ON
Confidence Coefficient	0.95

C0

Raw Statistics

Number of Valid Observations	21
Number of Distinct Observations	6
Minimum	0.01
Maximum	0.07
Mean of Raw Data	0.029524
Standard Deviation of Raw Data	0.01431
Khat	4.396567
Theta hat	0.006715
Kstar	3.800232
Theta star	0.007769
Mean of Log Transformed Data	-3.64057
Standard Deviation of Log Transformed Data	0.51844

Normal GOF Test Results

Correlation Coefficient R	0.945437
Shapiro Wilk Test Statistic	0.900769
Shapiro Wilk Critical (0.0500000) Value	0.908
Approximate Shapiro Wilk P Value	0.033462
Lilliefors Test Statistic	0.201012
Lilliefors Critical (0.0500000) Value	0.1881

Data not Normal at (0.0500000) Significance Level

Gamma GOF Test Results

Correlation Coefficient R	0.969842
A-D Test Statistic	0.67866
A-D Critical (0.0500000) Value	0.746511
K-S Test Statistic	0.195638
K-S Critical(0.0500000) Value	0.190165

Data follow Appr. Gamma Distribution at (0.0500000) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.956174
Shapiro Wilk Test Statistic	0.912301
Shapiro Wilk Critical (0.0500000) Value	0.908
Approximate Shapiro Wilk P Value	0.057722

95% Student's-t UCL	0.034909	95% Adjusted-CLT UCL (Chen-1995)	0.0353858	Lilliefors Test Statistic	0.221036
		95% Modified-t UCL (Johnson-1978)	0.0350226	Lilliefors Critical (0.0500000) Value	0.1881

Data appear Approximate_Lognormal at (0.0500000) Significance Level

Gamma GOF Test

A-D Test Statistic	0.67866	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.746511	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.195638	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.190165	Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.396567	k star (bias corrected MLE)	3.8002319
Theta hat (MLE)	0.006715	Theta star (bias corrected MLE)	0.0077689
nu hat (MLE)	184.6558	nu star (bias corrected)	159.60974
MLE Mean (bias corrected)	0.029524	MLE Sd (bias corrected)	0.0151449
		Approximate Chi Square Value (0.05)	131.40176
Adjusted Level of Significance	0.0383	Adjusted Chi Square Value	129.43715

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.035862	95% Adjusted Gamma UCL	0.036406

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.912301	Shapiro Wilk Lognormal GOF Test
10% Shapiro Wilk Critical Value	0.923	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.221036	Lilliefors Lognormal GOF Test
10% Lilliefors Critical Value	0.1726	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-4.60517	Mean of logged Data	-3.640573
Maximum of Logged Data	-2.65926	SD of logged Data	0.5184399

Assuming Lognormal Distribution

95% H-UCL	0.037868	90% Chebyshev (MVUE) UCL	0.040319
95% Chebyshev (MVUE) UCL	0.045085	97.5% Chebyshev (MVUE) UCL	0.0516992
99% Chebyshev (MVUE) UCL	0.064692		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	0.03466	95% BCA Bootstrap UCL	0.0357143
95% Standard Bootstrap UCL	0.034649	95% Bootstrap-t UCL	0.0362089
95% Hall's Bootstrap UCL	0.037298	95% Percentile Bootstrap UCL	0.0347619
90% Chebyshev(Mean, Sd) UCL	0.038892	95% Chebyshev(Mean, Sd) UCL	0.0431349
97.5% Chebyshev(Mean, Sd) UCL	0.049024	99% Chebyshev(Mean, Sd) UCL	0.0605932

Suggested UCL to Use

95% Student's-t UCL	0.034909

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

year	date	location	section	area	species	length	weight	thg
2023	2023-10-09	Edwards Brook	2	AM	BB	770	2900	0.19
2023	2023-10-10	Gull Lake	2	AM	BB	710	2040	0.21
2023	2023-10-20	Gull Lake	2	AM	BB	660	2000.6	0.35
2023	2023-10-20	Gull Lake	2	AM	BB	560	1161.3	0.13
2023	2023-10-20	Gull Lake	2	AM	BB	600	1368.7	0.26
2023	2023-10-22	Pinus Res	2	AM	BB	760	2300	0.26
2023	2023-10-22	Pinus Res	2	AM	BB	700	1893.4	0.28
2023	2023-10-22	Pinus Res	2	AM	BB	620	1287.4	0.2
2023	2023-10-22	Pinus Res	2	AM	BB	620	1610.2	0.22
2023	2023-10-22	Pinus Res	2	AM	BB	720	2204	0.21
2023	2023-09-26	Caroline Brook	1	BM	BB	220	65.5	0.02
2023	2023-09-26	Caroline Brook	1	BM	BB	290	142	0.03
2023	2023-09-26	Caroline Brook	1	BM	BB	260	111.6	0.03
2023	2023-09-26	Caroline Brook	1	BM	BB	270	132	0.04
2023	2023-09-26	Caroline Brook	1	BM	BB	230	57.3	0.04
2023	2023-09-26	Caroline Brook	1	BM	BB	200	51.7	0.01
2023	2023-09-26	Caroline Brook	1	BM	BB	250	99.1	0.02
2023	2023-09-26	Caroline Brook	1	BM	BB	230	76.6	0.01
2023	2023-09-26	Mainstem	1	BM	BB	330	231.1	0.11
2023	2023-09-26	Caroline Brook	1	BM	BB	350	282.7	0.08
2023	2023-09-26	Caroline Brook	1	BM	BB	290	139.6	0.07
2023	2023-09-26	Caroline Brook	1	BM	BB	260	93.7	0.1
2023	2023-09-28	Mainstem	1	BM	BB	341	188	0.39
2023	2023-09-28	Caroline Brook	1	BM	BB	220	58.7	0.04
2023	2023-09-28	Caroline Brook	1	BM	BB	472	464.8	0.14
2023	2023-09-28	Caroline Brook	1	BM	BB	340	273.3	0.14
2023	2023-09-28	Caroline Brook	1	BM	BB	246	76.6	0.03
2023	2023-09-28	Caroline Brook	1	BM	BB	232	63.1	0.02
2023	2023-09-28	Caroline Brook	1	BM	BB	242	80.1	0.06
2023	2023-09-28	Caroline Brook	1	BM	BB	216	48.9	0.03
2023	2023-10-03	Mackenzie River	1	BM	BB	260	105.4	0.1
2023	2023-10-03	Mackenzie River	1	BM	BB	288	81.2	0.08
2023	2023-10-04	Mainstem	1	BM	BB	255	81	0.06
2023	2023-10-04	Mackenzie River	1	BM	BB	235	69.8	0.03
2023	*2023-10-04*	*Mackenzie River*	*1*	*BM*	*BB*	*110*	*7.5*	*0.04*
2023	2023-10-05	Mackenzie River	1	BM	BB	460	671.1	0.15
2023	2023-10-05	Mainstem	1	BM	BB	290	120.1	0.12
2023	2023-10-05	Mackenzie River	1	BM	BB	210	60.3	0.06
2023	2023-10-06	Mainstem	1	BM	BB	280	121.7	0.08
2023	2023-10-06	Mainstem	1	BM	BB	255	90.9	0.04
2023	2023-10-20		2	AM	BB	930	3669	0.47
2023	2023-10-21		2	AM	BB	830	2004	0.74
2024	2024-09-24	Pinus River	2	AM	BB	785	1612.4	0.4
2024	2024-09-24	Pinus River	2	AM	BB	770	2550.7	0.41

2023-2024 POOLED BURBOT THg DATA (mg THg/kg ww fish)

Summary Statistics (Excel)

N	44	**Correlation Coefficient (length vs THg)**
min	0.01	0.830335
max	0.74	
arithmean	0.15	
median	0.09	
# nd	0	
freq. nd (%)	0	

General Statistics on Uncensored Full Data

Date/Time of Computation	ProUCL 5.2 2025-06-11 11:57:42 AM
User Selected Options	
From File	WorkSheet.xls
Full Precision	ON

From File: WorkSheet.xls

General Statistics for Uncensored Dataset

Variable	NumObs	# Missing	Minimum	Maximum	Mean	Geo-Mean	SD	SEM	MAD/0.675	Skewness	CV
C0	44	0	0.01	0.74	0.147727	0.088316	0.153348	0.023118	0.088955	1.854138	1.038049

Percentiles for Uncensored Dataset

Variable	NumObs	# Missing	10%ile	20%ile	25%ile(Q1)	50%ile(Q2)	75%ile(Q3)	80%ile	90%ile	95%ile	99%ile
C0	44	0	0.023	0.03	0.04	0.09	0.21	0.236	0.378	0.4085	0.6239

Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 2025-06-11 11:58:22 AM
From File	WorkSheet.xls
Full Precision	ON
Confidence Coefficient	0.95

C0

Raw Statistics

Number of Valid Observations	44
Number of Distinct Observations	25
Minimum	0.01
Maximum	0.74
Mean of Raw Data	0.147727
Standard Deviation of Raw Data	0.153348
Khat	1.108888
Theta hat	0.133221
Kstar	1.048434
Theta star	0.140903
Mean of Log Transformed Data	-2.42683
Standard Deviation of Log Transformed Data	1.077669

Normal GOF Test Results

Correlation Coefficient R	0.88976	
Shapiro Wilk Test Statistic	0.79994	
Shapiro Wilk Critical (0.0500000) Value	0.944	
Approximate Shapiro Wilk P Value	1.45E-07	
Lilliefors Test Statistic	0.184557	
Lilliefors Critical (0.0500000) Value	0.1322	
Data not Normal at (0.0500000) Significance Level		

Gamma GOF Test Results

Correlation Coefficient R	0.993108
A-D Test Statistic	0.559895
A-D Critical (0.0500000) Value	0.77511
K-S Test Statistic	0.126135
K-S Critical(0.0500000) Value	0.136918
Data appear Gamma Distributed at (0.0500000) Significance Level	

Lognormal GOF Test Results

Correlation Coefficient R	0.990982
Shapiro Wilk Test Statistic	0.968152
Shapiro Wilk Critical (0.0500000) Value	0.944
Approximate Shapiro Wilk P Value	0.38244
Lilliefors Test Statistic	0.109727
Lilliefors Critical (0.0500000) Value	0.1322
Data appear Lognormal at (0.0500000) Significance Level	

UCL Statistics for Uncensored Full Data Sets

User Selected Options

Date/Time of Computation	ProUCL 5.2 2025-06-11 11:59:07 AM
From File	WorkSheet.xls
Full Precision	ON
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	44	Number of Distinct Observations	25
		Number of Missing Observations	0
Minimum	0.01	Mean	0.147727
Maximum	0.74	Median	0.09
SD	0.153348	Std. Error of Mean	0.023118
Coefficient of Variation	1.038049	Skewness	1.854138

Normal GOF Test

Shapiro Wilk Test Statistic	0.79994	Shapiro Wilk GOF Test	
1% Shapiro Wilk Critical Value	0.924	Data Not Normal at 1% Significance Level	
Lilliefors Test Statistic	0.184557	Lilliefors GOF Test	
1% Lilliefors Critical Value	0.1542	Data Not Normal at 1% Significance Level	
Data Not Normal at 1% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.18659	95% Adjusted-CLT UCL (Chen-1995)	0.192658
		95% Modified-t UCL (Johnson-1978)	0.187667

Gamma GOF Test

A-D Test Statistic	0.559895	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.77511	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.126135	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.136918	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	1.108888	k star (bias corrected MLE)	1.048434
Theta hat (MLE)	0.133221	Theta star (bias corrected MLE)	0.140903
nu hat (MLE)	97.58218	nu star (bias corrected)	92.26219
MLE Mean (bias corrected)	0.147727	MLE Sd (bias corrected)	0.144275
		Approximate Chi Square Value (0.05)	71.11192

Adjusted Level of Significance	0.044546	Adjusted Chi Square Value	70.48249

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.191665	95% Adjusted Gamma UCL	0.193376

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.968152	Shapiro Wilk Lognormal GOF Test
10% Shapiro Wilk Critical Value	0.952	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.109727	Lilliefors Lognormal GOF Test
10% Lilliefors Critical Value	0.1216	Data appear Lognormal at 10% Significance Level
Data appear Lognormal at 10% Significance Level		

Lognormal Statistics

Minimum of Logged Data	-4.60517	Mean of logged Data	-2.42683
Maximum of Logged Data	-0.30111	SD of logged Data	1.077669

Assuming Lognormal Distribution

95% H-UCL	0.236279	90% Chebyshev (MVUE) UCL	0.244602
95% Chebyshev (MVUE) UCL	0.285325	97.5% Chebyshev (MVUE) UCL	0.341848
99% Chebyshev (MVUE) UCL	0.452875		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	0.185753	95% BCA Bootstrap UCL	0.193636
95% Standard Bootstrap UCL	0.18556	95% Bootstrap-t UCL	0.196941
95% Hall's Bootstrap UCL	0.199457	95% Percentile Bootstrap UCL	0.188182
90% Chebyshev(Mean, Sd) UCL	0.217082	95% Chebyshev(Mean, Sd) UCL	0.248497
97.5% Chebyshev(Mean, Sd) UCL	0.2921	99% Chebyshev(Mean, Sd) UCL	0.377749

Suggested UCL to Use

95% Adjusted Gamma UCL	0.193376

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ALL SEALS

Sample.Year	Project Phase	Sample ID	Zone	Easting	Northing	Weight (kg)	Length.cm	Blubber (cm)	THg (muscle)	THg (liver)	MeHg Muscle (ng/g)	MeHg Liver (ng/g)	dC13	dN15	Age	Age Estimate	life_stage	#nonpups/year
2024	Reservoir	2024_RS01	21	323881	5953650	27.24	72	4	0.03	0.10	36.00	23.00					pup	10
2024	Reservoir	2024_RS02	21	326132	5953569	29.51	76	4	0.04	0.20		43.00					pup	
2024	Reservoir	2024_RS03	21	327113	5949788	29.51	74	4	0.08	0.63		76.00					pup	
2024	Reservoir	2024_RS04	21	330285	5949676	31.78	80	3	0.08	0.87	128.00	130.00					pup	
2024	Reservoir	2024_RS05	21	330355	5949755	38.59	84	4	0.02	0.20		26.00					pup	
2024	Reservoir	2024_RS06	21	330283	5949752	29.51	79	4	0.05	0.36	51.00	57.00					pup	
2024	Reservoir	2024_RS07	21	330283	5949752	29.51	76	5	0.05	0.49		9.00					pup	
2024	Reservoir	2024_RS08	21	329338	5951404	31.78	75	5	0.03	0.33		53.00					pup	
2024	Reservoir	2024_RS09	21	334971	5955148	27.24	73	4	0.02	0.16	21.00	27.00					pup	
2024	Reservoir	2024_RS10	21	334975	5956876	29.51	74	3	0.12	0.75		167.00					pup	
2024	Reservoir	2024_RS11	21	343995	5960286	27.24	72	4	0.04	0.26	55.00	58.00					pup	
2024	Reservoir	2024_RS12	21	340445	5956715	31.78	82	5	0.02	0.15		47.00					pup	
2024	Reservoir	2024_RS13	21	334999	5956805	27.24	73	4	0.03	0.19		51.00					pup	
2024	Reservoir	2024_RS14	21	321617	5953624	27.24	72	5	0.03	0.13		31.00					pup	
2024	Reservoir	2024_RS15	21	302525	5945062	68.1	110	4	0.13	1.93	147.00						nonpup	
2024	Reservoir	2024_RS16	21	301699	5924842	54.48	100	4	0.35	16.0	412.00						nonpup	
2024	Reservoir	2024_RS17	20	699138	5926720	63.56	108	5	0.17	2.91	234.00						nonpup	
2024	Reservoir	2024_RS18	20	699093	5926769	63.56	110	5	0.27	9.54	355.00						nonpup	
2024	Reservoir	2024_RS19	21	316882	5944461	68.1	112	4	0.15	2.85	190.00						nonpup	
2024	Reservoir	2024_RS20	21	310443	5946683	45.4	96	4	0.18	1.77	154.00						nonpup	
2024	Reservoir	2024_RS21	21	316058	5950245	27.24	72	3	0.01	0.08		15.00					pup	
2024	Reservoir	2024_RS22	21	323727	5949789	27.24	74	3	0.02	0.14	24.00	30.00					pup	
2024	Reservoir	2024_RS23	21	327075	5949745	27.24	74	4	0.03	0.29		62.00					pup	
2024	Reservoir	2024_RS24	21	329179	5949642	22.7	70	4	0.03	0.23		61.00					pup	
2024	Reservoir	2024_RS25	21	331376	5949482	27.24	78	4	0.07	0.50	86.00	131.00					pup	
2024	Reservoir	2024_RS26	21	332477	5949639	22.7	72	4	0.06	0.76		87.00					pup	
2024	Reservoir	2024_RS27	21	333746	5953242	27.24	76	4	0.03	0.54	97.00	96.00					pup	
2024	Reservoir	2024_RS28	21	333879	5954947	27.24	80	4	0.01	0.95		300.00					pup	
2024	Reservoir	2024_RS29	21	340591	5956815	27.24	78	4	0.01	0.14		31.00					pup	
2024	Reservoir	2024_RS30	21	350419	5958385	68.1	105	3	0.21	22.4	321.00						nonpup	
2024	Reservoir	2024_RS31	21	343724	5956623	68.1	107	4	0.94	110.00	1,300.00						nonpup	
2024	Reservoir	2024_RS32	21	343724	5956623	22.7	70	2	0.29	1.48	319.00						pup	
2024	Reservoir	2024_RS33	21	334937	5955015	27.24	72	4	0.34	2.00	473.00						pup	
2024	Reservoir	2024_RS34	21	312466	5944678	72.64	120	4	1.22	55.1							nonpup	
2024	Reservoir	2024_RS35	21	301596	5922972	68.1	120	4	0.24	4.98	380.00						nonpup	

NON-PUPS

Sample.Year	Project Phase	Sample ID	Zone	Easting	Northing	Weight (kg)	Length.cm	Blubber (cm)	THg (muscle)	THg (liver)	MeHg Muscle (ng/g)	MeHg Liver (ng/g)	dC13	dN15	Age	Age Estimate	life_stage
2024	Reservoir	2024_RS15	21	302525	5945062	68.1	110	4	0.13	1.93	147.00						nonpup
2024	Reservoir	2024_RS16	21	301699	5924842	54.48	100	4	0.35	16.0	412.00						nonpup
2024	Reservoir	2024_RS17	20	699138	5926720	63.56	108	5	0.17	2.91	234.00						nonpup
2024	Reservoir	2024_RS18	20	699093	5926769	63.56	110	5	0.27	9.54	355.00						nonpup
2024	Reservoir	2024_RS19	21	316882	5944461	68.1	112	4	0.15	2.85	190.00						nonpup
2024	Reservoir	2024_RS20	21	310443	5946683	45.4	96	4	0.18	1.77	154.00						nonpup
2024	Reservoir	2024_RS30	21	350419	5958385	68.1	105	3	0.21	22.4	321.00						nonpup
2024	Reservoir	2024_RS31	21	343724	5956623	68.1	107	4	0.94	110.00	1,300.00						nonpup
2024	Reservoir	2024_RS34	21	312466	5944678	72.64	120	4	1.22	55.1							nonpup
2024	Reservoir	2024_RS35	21	301596	5922972	68.1	120	4	0.24	4.98	380.00						nonpup

NON-PUPS Meat (Muscle) THg

		length vs THg
N	10	0.359334
min	0.13	
max	1.22	
arithmean	0.39	
median	0.23	
#nd	0	
Freq nd	0	

General Statistics on Uncensored Full Data
Date/Time of Computation   ProUCL 5.2 2025-06-02 10:48:23 AM
User Selected Options
From File   WorkSheet.xls
Full Precision   ON

From File: WorkSheet.xls

General Statistics for Uncensored Dataset

Variable	NumObs	# Missing	Minimum	Maximum	Mean	Geo-Mean	SD	SEM	MAD/0.67	Skewness	CV
C0	10	0	0.13	1.22	0.386	0.28269	0.3771	0.11925	0.096368	1.7902326	0.976943

Percentiles for Uncensored Dataset

Variable	NumObs	# Missing	10%ile	20%ile	25%ile(Q1	50%ile(Q2	75%ile(Q3	80%ile	90%ile	95%ile	99%ile
C0	10	0	0.148	0.166	0.1725	0.225	0.33	0.468	0.968	1.094	1.1948

Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects
Date/Time of Computation   ProUCL 5.2 2025-06-02 10:49:27 AM
From File   WorkSheet.xls
Full Precision   ON
Confidence Coefficient   0.95

ALL SEALS - Meat (Muscle) THg

		length vs THg
N	35	0.607116
min	0.01	
max	1.22	
arithmean	0.15	
median	0.05	
#nd	0	
Freq nd	0	

General Statistics on Uncensored Full Data
Date/Time of Computation   ProUCL 5.2 2025-06-02 2:46:44 PM
User Selected Options
From File   WorkSheet.xls
Full Precision   ON

From File: WorkSheet.xls

General Statistics for Uncensored Dataset

Variable	NumObs	# Missing	Minimum	Maximum	Mean	Geo-Mean	SD	SEM	MAD/0.67	Skewness	CV
C0	35	0	0.01	1.22	0.154286	0.068107	0.253705	0.042884	0.044477	3.198711	1.644386

Percentiles for Uncensored Dataset

Variable	NumObs	# Missing	10%ile	20%ile	25%ile(Q1	50%ile(Q2	75%ile(Q3	80%ile	90%ile	95%ile	99%ile
C0	35	0	0.02	0.028	0.03	0.05	0.175	0.216	0.32	0.527	1.1248

Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects
User Selected Options
Date/Time of Computation   ProUCL 5.2 2025-06-02 2:47:32 PM
From File   WorkSheet.xls
Full Precision   ON
Confidence Coefficient   0.95

C0

Raw Statistics
Number of Valid Observations   35
Number of Distinct Observations   21
Minimum   0.01
Maximum   1.22
Mean of Raw Data   0.154286
Standard Deviation of Raw Data   0.253705
Khat   0.734194
Theta hat   0.210143
Kstar   0.69031
Theta star   0.223502
Mean of Log Transformed Data   -2.68668
Standard Deviation of Log Transformed Data   1.24916

Normal GOF Test Results
Correlation Coefficient R   0.742512
Shapiro Wilk Test Statistic   0.571639
Shapiro Wilk Critical (0.0500000) Value   0.934
Approximate Shapiro Wilk P Value   4.40E-11
Lilliefors Test Statistic   0.284775
Lilliefors Critical (0.0500000) Value   0.1478
Data not Normal at (0.0500000) Significance Level

Gamma GOF Test Results
Correlation Coefficient R   0.944131
A-D Test Statistic   1.473664
A-D Critical (0.0500000) Value   0.789233
K-S Test Statistic   0.16026
K-S Critical(0.0500000) Value   0.154714
Data not Gamma Distributed at (0.0500000) Significance Level

Lognormal GOF Test Results
Correlation Coefficient R   0.979344
Shapiro Wilk Test Statistic   0.947653
Shapiro Wilk Critical (0.0500000) Value   0.934
Approximate Shapiro Wilk P Value   0.124313
Lilliefors Test Statistic   0.144198
Lilliefors Critical (0.0500000) Value   0.1478
Data appear Lognormal at (0.0500000) Significance Level

UCL Statistics for Uncensored Full Data Sets
User Selected Options
Date/Time of Computation   ProUCL 5.2 2025-06-02 2:48:10 PM
From File   WorkSheet.xls
Full Precision   ON

C0

Raw Statistics

Number of Valid Observations	10
Number of Distinct Observations	10
Minimum	0.13
Maximum	1.22
Mean of Raw Data	0.386
Standard Deviation of Raw Data	0.3771
Khat	1.753418
Theta hat	0.220141
Kstar	1.294059
Theta star	0.298286
Mean of Log Transformed Data	-1.2634
Standard Deviation of Log Transformed Data	0.761006

Normal GOF Test Results

Correlation Coefficient R	0.824652
Shapiro Wilk Test Statistic	0.684961
Shapiro Wilk Critical (0.0500000) Value	0.842
Approximate Shapiro Wilk P Value	6.89e-04
Lilliefors Test Statistic	0.338027
Lilliefors Critical (0.0500000) Value	0.2616
Data not Normal at (0.0500000) Significance Level	

Gamma GOF Test Results

Correlation Coefficient R	0.940254
A-D Test Statistic	1.011829
A-D Critical (0.0500000) Value	0.73738
K-S Test Statistic	0.273819
K-S Critical(0.0500000) Value	0.270456
Data not Gamma Distributed at (0.0500000) Significance Level	

Lognormal GOF Test Results

Correlation Coefficient R	0.922516
Shapiro Wilk Test Statistic	0.844928
Shapiro Wilk Critical (0.0500000) Value	0.842
Approximate Shapiro Wilk P Value	0.055755
Lilliefors Test Statistic	0.224063
Lilliefors Critical (0.0500000) Value	0.2616
Data appear Lognormal at (0.0500000) Significance Level	

UCL Statistics for Uncensored Full Data Sets

User Selected Options

Date/Time of Computation	ProUCL 5.2 2025-06-02 10:50:06 AM
From File	WorkSheet.xls
Full Precision	ON
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.13	Mean	0.386
Maximum	1.22	Median	0.225
SD	0.3771	Std. Error of Mean	0.1192495
Coefficient of Variation	0.976943	Skewness	1.7902326

Normal GOF Test

Shapiro Wilk Test Statistic	0.684961	Shapiro Wilk GOF Test	
1% Shapiro Wilk Critical Value	0.781	Data Not Normal at 1% Significance Level	
Lilliefors Test Statistic	0.338027	Lilliefors GOF Test	
1% Lilliefors Critical Value	0.3037	Data Not Normal at 1% Significance Level	
Data Not Normal at 1% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.604598	95% Adjusted-CLT UCL (Chen-1995)	0.6542831
		95% Modified-t UCL (Johnson-1978)	0.6158494

Gamma GOF Test

A-D Test Statistic	1.011829	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.73738	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.273819	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.270456	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	1.753418	k star (bias corrected MLE)	1.2940594
Theta hat (MLE)	0.220141	Theta star (bias corrected MLE)	0.2982861
nu hat (MLE)	35.06836	nu star (bias corrected)	25.881188
MLE Mean (bias corrected)	0.386	MLE Sd (bias corrected)	0.3393206
		Approximate Chi Square Value (0.05)	15.287889
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	13.890699

Assuming Gamma Distribution

C0

General Statistics

Total Number of Observations	35	Number of Distinct Observations	21
		Number of Missing Observations	0
Minimum	0.01	Mean	0.154286
Maximum	1.22	Median	0.05
SD	0.253705	Std. Error of Mean	0.042884
Coefficient of Variation	1.644386	Skewness	3.198711

Normal GOF Test

Shapiro Wilk Test Statistic	0.571639	Shapiro Wilk GOF Test	
1% Shapiro Wilk Critical Value	0.91	Data Not Normal at 1% Significance Level	
Lilliefors Test Statistic	0.284775	Lilliefors GOF Test	
1% Lilliefors Critical Value	0.172	Data Not Normal at 1% Significance Level	
Data Not Normal at 1% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.226799	95% Adjusted-CLT UCL (Chen-1995)	0.249599
		95% Modified-t UCL (Johnson-1978)	0.230664

Gamma GOF Test

A-D Test Statistic	1.473664	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.789233	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.16926	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.154714	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	0.734194	k star (bias corrected MLE)	0.69031
Theta hat (MLE)	0.210143	Theta star (bias corrected MLE)	0.223502
nu hat (MLE)	51.39355	nu star (bias corrected)	48.32172
MLE Mean (bias corrected)	0.154286	MLE Sd (bias corrected)	0.185696
		Approximate Chi Square Value (0.05)	33.36569
Adjusted Level of Significance	0.0425	Adjusted Chi Square Value	32.77552

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.223444	95% Adjusted Gamma UCL	0.227467

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.947653	Shapiro Wilk Lognormal GOF Test	
10% Shapiro Wilk Critical Value	0.944	Data appear Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.144198	Lilliefors Lognormal GOF Test	
10% Lilliefors Critical Value	0.1356	Data Not Lognormal at 10% Significance Level	
Data appear Approximate Lognormal at 10% Significance Level			

Lognormal Statistics

Minimum of Logged Data	-4.60517	Mean of logged Data	-2.68668
Maximum of Logged Data	0.198851	SD of logged Data	1.24916

Assuming Lognormal Distribution

95% H-UCL	0.26956	90% Chebyshev (MVUE) UCL	0.253958
95% Chebyshev (MVUE) UCL	0.304155	97.5% Chebyshev (MVUE) UCL	0.373827
99% Chebyshev (MVUE) UCL	0.510683		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	0.224824	95% BCA Bootstrap UCL	0.257714
95% Standard Bootstrap UCL	0.22219	95% Bootstrap-t UCL	0.312737
95% Hall's Bootstrap UCL	0.577457	95% Percentile Bootstrap UCL	0.228
90% Chebyshev(Mean, Sd) UCL	0.282938	95% Chebyshev(Mean, Sd) UCL	0.341213
97.5% Chebyshev(Mean, Sd) UCL	0.422096	99% Chebyshev(Mean, Sd) UCL	0.580976

Suggested UCL to Use

95% H-UCL	0.26956

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

95% Approximate Gamma UCL	0.653468	95% Adjusted Gamma UCL	0.7191963

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.844928	Shapiro Wilk Lognormal GOF Test	
10% Shapiro Wilk Critical Value	0.869	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.224063	Lilliefors Lognormal GOF Test	
10% Lilliefors Critical Value	0.241	Data appear Lognormal at 10% Significance Level	

Data appear Approximate Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.04022	Mean of logged Data	-1.263404
Maximum of Logged Data	0.198851	SD of logged Data	0.7610056

Assuming Lognormal Distribution

95% H-UCL	0.737546	90% Chebyshev (MVUE) UCL	0.6372103
95% Chebyshev (MVUE) UCL	0.760645	97.5% Chebyshev (MVUE) UCL	0.9319677
99% Chebyshev (MVUE) UCL	1.268498		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	0.582148	95% BCA Bootstrap UCL	0.628
95% Standard Bootstrap UCL	0.569192	95% Bootstrap-t UCL	1.3649566
95% Hall's Bootstrap UCL	1.753951	95% Percentile Bootstrap UCL	0.591
90% Chebyshev(Mean, Sd) UCL	0.743749	95% Chebyshev(Mean, Sd) UCL	0.9057965
97.5% Chebyshev(Mean, Sd) UCL	1.130713	99% Chebyshev(Mean, Sd) UCL	1.5725176

Suggested UCL to Use

95% H-UCL	0.737546

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

NON-PUPS Liver THg

N	10	length vs THg	
min	1.77	0.103538	
max	110.00		
arithmean	22.75		
median	7.26		
#nd	0		
Freq nd	0		

General Statistics on Uncensored Full Data

Date/Time of Computation	ProUCL 5.2 2025-06-02 11:02:49 AM
User Selected Options	
From File	WorkSheet.xls
Full Precision	ON

From File: WorkSheet.xls

General Statistics for Uncensored Dataset

Variable	NumObs	# Missing	Minimum	Maximum	Mean	Geo-Mean	SD	SEM	MAD/0.67!	Skewness	CV
C0	10	0	1.77	110	22.748	8.842923	34.73441	10.98399	8.020756	2.1739693	1.526922

Percentiles for Uncensored Dataset

Variable	NumObs	# Missing	10%ile	20%ile	25%ile(Q1	50%ile(Q2	75%ile(Q3	80%ile	90%ile	95%ile	99%ile
C0	10	0	1.914	2.666	2.865	7.26	20.8	28.94	60.59	85.295	105.059

Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 2025-06-02 11:03:27 AM
From File	WorkSheet.xls
Full Precision	ON
Confidence Coefficient	0.95

C0

Raw Statistics

Number of Valid Observations	10
Number of Distinct Observations	10
Minimum	1.77
Maximum	110
Mean of Raw Data	22.748
Standard Deviation of Raw Data	34.73441
Khat	0.646815
Theta hat	35.16925
Kstar	0.519437
Theta star	43.79356
Mean of Log Transformed Data	2.179618
Standard Deviation of Log Transformed Data	1.440479

Normal GOF Test Results

Correlation Coefficient R	0.812659
Shapiro Wilk Test Statistic	0.67452
Shapiro Wilk Critical (0.0500000) Value	0.842

Approximate Shapiro Wilk P Value 4.51E-04
Lilliefors Test Statistic 0.303997
Lilliefors Critical (0.0500000) Value 0.2616
Data not Normal at (0.0500000) Significance Level

Gamma GOF Test Results

Correlation Coefficient R 0.987093
A-D Test Statistic 0.576925
A-D Critical (0.0500000) Value 0.765233
K-S Test Statistic 0.202789
K-S Critical(0.0500000) Value 0.27799
Data appear Gamma Distributed at (0.0500000) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R 0.968898
Shapiro Wilk Test Statistic 0.921752
Shapiro Wilk Critical (0.0500000) Value 0.842
Approximate Shapiro Wilk P Value 0.480483
Lilliefors Test Statistic 0.179822
Lilliefors Critical (0.0500000) Value 0.2616
Data appear Lognormal at (0.0500000) Significance Level

UCL Statistics for Uncensored Full Data Sets

User Selected Options
Date/Time of Computation ProUCL 5.2 2025-06-02 11:05:34 AM
From File WorkSheet.xls
Full Precision ON
Confidence Coefficient 95%
Number of Bootstrap Operations 2000

C0

General Statistics
Total Number of Observations 10 Number of Distinct Observations 10
  Number of Missing Observations 0
Minimum 1.77 Mean 22.748
Maximum 110 Median 7.26
SD 34.73441 Std. Error of Mean 10.983986
Coefficient of Variation 1.526922 Skewness 2.1739693

Normal GOF Test
Shapiro Wilk Test Statistic 0.67452 Shapiro Wilk GOF Test
1% Shapiro Wilk Critical Value 0.781 Data Not Normal at 1% Significance Level
Lilliefors Test Statistic 0.303997 Lilliefors GOF Test
1% Lilliefors Critical Value 0.3037 Data Not Normal at 1% Significance Level
Data Not Normal at 1% Significance Level

Assuming Normal Distribution
 95% Normal UCL   95% UCLs (Adjusted for Skewness)
 95% Student's-t UCL 42.88289 95% Adjusted-CLT UCL (Chen-1995) 48.883568
  95% Modified-t UCL (Johnson-1978) 44.141413

Gamma GOF Test
A-D Test Statistic 0.576925 Anderson-Darling Gamma GOF Test
5% A-D Critical Value 0.765233 Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic 0.202789 Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value 0.27799 Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics
k hat (MLE) 0.646815 k star (bias corrected MLE) 0.5194371
Theta hat (MLE) 35.16925 Theta star (bias corrected MLE) 43.793556
nu hat (MLE) 12.9363 nu star (bias corrected) 10.388743
MLE Mean (bias corrected) 22.748 MLE Sd (bias corrected) 31.562887
  Approximate Chi Square Value (0.05) 4.1861698
Adjusted Level of Significance 0.0267 Adjusted Chi Square Value 3.5284449

Assuming Gamma Distribution
 95% Approximate Gamma UCL 56.45331 95% Adjusted Gamma UCL 66.976567

Lognormal GOF Test
Shapiro Wilk Test Statistic 0.921752 Shapiro Wilk Lognormal GOF Test
10% Shapiro Wilk Critical Value 0.869 Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic 0.179822 Lilliefors Lognormal GOF Test
10% Lilliefors Critical Value 0.241 Data appear Lognormal at 10% Significance Level
Data appear Lognormal at 10% Significance Level

Lognormal Statistics
Minimum of Logged Data 0.57098 Mean of logged Data 2.1796175
Maximum of Logged Data 4.70048 SD of logged Data 1.4404789

Assuming Lognormal Distribution
 95% H-UCL 176.0578 90% Chebyshev (MVUE) UCL 51.428706
 95% Chebyshev (MVUE) UCL 65.19425 97.5% Chebyshev (MVUE) UCL 84.300287
 99% Chebyshev (MVUE) UCL 121.8304

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	40.81505	95% BCA Bootstrap UCL		48.963
95% Standard Bootstrap UCL	39.96185	95% Bootstrap-t UCL		91.937886
95% Hall's Bootstrap UCL	123.1063	95% Percentile Bootstrap UCL		41.797
90% Chebyshev(Mean, Sd) UCL	55.69996	95% Chebyshev(Mean, Sd) UCL		70.626085
97.5% Chebyshev(Mean, Sd) UCL	91.34297	99% Chebyshev(Mean, Sd) UCL		132.03728

Suggested UCL to Use

95% Adjusted Gamma UCL   66.97657

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

PUPS

Sample.Year	Project Phase	Sample ID	Zone	Easting	Northing	Weight (kg)	Length.cm	Blubber (cm)	THg (muscle)	THg (liver)	MeHg Muscle (ng/g)	MeHg Liver (ng/g)	dC13	dN15	Age	Age Estimate	life_stage
2024	Reservoir	2024_RS01	21	323881	5953650	27.24	72	4	0.03	0.10	36.00	23.00					pup
2024	Reservoir	2024_RS02	21	326132	5953569	29.51	76	4	0.04	0.20		43.00					pup
2024	Reservoir	2024_RS03	21	327113	5949788	29.51	74	4	0.08	0.63		76.00					pup
2024	Reservoir	2024_RS04	21	330285	5949676	31.78	80	3	0.08	0.87	128.00	130.00					pup
2024	Reservoir	2024_RS05	21	330355	5949755	38.59	84	4	0.02	0.20		26.00					pup
2024	Reservoir	2024_RS06	21	330283	5949752	29.51	79	4	0.05	0.36	51.00	57.00					pup
2024	Reservoir	2024_RS07	21	330283	5949752	29.51	76	5	0.05	0.49		9.00					pup
2024	Reservoir	2024_RS08	21	329338	5951404	31.78	75	5	0.03	0.33		53.00					pup
2024	Reservoir	2024_RS09	21	334971	5955148	27.24	73	4	0.02	0.16	21.00	27.00					pup
2024	Reservoir	2024_RS10	21	334975	5956876	29.51	74	3	0.12	0.75		167.00					pup
2024	Reservoir	2024_RS11	21	343995	5960286	27.24	72	4	0.04	0.26	55.00	58.00					pup
2024	Reservoir	2024_RS12	21	340445	5956715	31.78	82	5	0.02	0.15		47.00					pup
2024	Reservoir	2024_RS13	21	334999	5956805	27.24	73	4	0.03	0.19		51.00					pup
2024	Reservoir	2024_RS14	21	321617	5953624	27.24	72	5	0.03	0.13		31.00					pup
2024	Reservoir	2024_RS21	21	316058	5950245	27.24	72	3	0.01	0.08		15.00					pup
2024	Reservoir	2024_RS22	21	323727	5949789	27.24	74	3	0.02	0.14	24.00	30.00					pup
2024	Reservoir	2024_RS23	21	327075	5949745	27.24	74	4	0.03	0.29		62.00					pup
2024	Reservoir	2024_RS24	21	329179	5949642	22.7	70	4	0.03	0.23		61.00					pup
2024	Reservoir	2024_RS25	21	331376	5949482	27.24	78	4	0.07	0.50	86.00	131.00					pup
2024	Reservoir	2024_RS26	21	332477	5949639	22.7	72	4	0.06	0.76		87.00					pup
2024	Reservoir	2024_RS27	21	333746	5953242	27.24	76	4	0.03	0.54	97.00	96.00					pup
2024	Reservoir	2024_RS28	21	333879	5954947	27.24	80	4	0.01	0.95		300.00					pup
2024	Reservoir	2024_RS29	21	340591	5956815	27.24	78	4	0.01	0.14		31.00					pup
2024	Reservoir	2024_RS32	21	343724	5956623	22.7	70	2	0.29	1.48	319.00						pup
2024	Reservoir	2024_RS33	21	334937	5955015	27.24	72	4	0.34	2.00	473.00						pup

PUPS Meat (Muscle) THg

N	25	length vs THg	
min	0.01	-0.32315	
max	0.34		
arithmean	0.06		
median	0.03		
#nd	0		
Freq nd	0		

General Statistics on Uncensored Full Data

Date/Time of Computation	ProUCL 5.2 2025-06-02 1:16:30 PM
User Selected Options	
From File	WorkSheet.xls
Full Precision	ON

From File: WorkSheet.xls

General Statistics for Uncensored Dataset

Variable	NumObs	# Missing	Minimum	Maximum	Mean	Geo-Mean	SD	SEM	MAD/0.675	Skewness	CV
C0	25	0	0.01	0.34	0.0616	0.038543	0.080864	0.016173	0.014826	2.8059882	1.312729

Percentiles for Uncensored Dataset

Variable	NumObs	# Missing	10%ile	20%ile	25%ile(Q1	50%ile(Q2	75%ile(Q3	80%ile	90%ile	95%ile	99%ile
C0	25	0	0.014	0.02	0.02	0.03	0.06	0.072	0.104	0.256	0.328

Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 2025-06-02 1:17:12 PM
From File	WorkSheet.xls
Full Precision	ON
Confidence Coefficient	0.95

C0

Raw Statistics
Number of Valid Observations	25
Number of Distinct Observations	11
Minimum	0.01

Maximum	0.34		
Mean of Raw Data	0.0616		
Standard Deviation of Raw Data	0.080864		
Khat	1.205704		
Theta hat	0.051091		
Kstar	1.087686		
Theta star	0.056634		
Mean of Log Transformed Data	-3.25599		
Standard Deviation of Log Transformed Data	0.900958		

Normal GOF Test Results

Correlation Coefficient R	0.753757
Shapiro Wilk Test Statistic	0.581743
Shapiro Wilk Critical (0.0500000) Value	0.918
Approximate Shapiro Wilk P Value	3.24E-08
Lilliefors Test Statistic	0.290001
Lilliefors Critical (0.0500000) Value	0.1726
Data not Normal at (0.0500000) Significance Level	

Gamma GOF Test Results

Correlation Coefficient R	0.916551
A-D Test Statistic	1.503036
A-D Critical (0.0500000) Value	0.768318
K-S Test Statistic	0.209904
K-S Critical(0.0500000) Value	0.178797
Data not Gamma Distributed at (0.0500000) Significance Level	

Lognormal GOF Test Results

Correlation Coefficient R	0.962859
Shapiro Wilk Test Statistic	0.924242
Shapiro Wilk Critical (0.0500000) Value	0.918
Approximate Shapiro Wilk P Value	0.067106
Lilliefors Test Statistic	0.169536
Lilliefors Critical (0.0500000) Value	0.1726
Data appear Lognormal at (0.0500000) Significance Level	

UCL Statistics for Uncensored Full Data Sets

User Selected Options

Date/Time of Computation	ProUCL 5.2 2025-06-02 1:18:38 PM
From File	WorkSheet.xls
Full Precision	ON
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	25	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	0.01	Mean	0.0616
Maximum	0.34	Median	0.03
SD	0.080864	Std. Error of Mean	0.0161728
Coefficient of Variation	1.312729	Skewness	2.8059882

Normal GOF Test

Shapiro Wilk Test Statistic	0.581743	Shapiro Wilk GOF Test
1% Shapiro Wilk Critical Value	0.886	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.290001	Lilliefors GOF Test
1% Lilliefors Critical Value	0.201	Data Not Normal at 1% Significance Level
Data Not Normal at 1% Significance Level		

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.08927	95% Adjusted-CLT UCL (Chen-1995)	0.0978999
		95% Modified-t UCL (Johnson-1978)	0.0907825

Gamma GOF Test

A-D Test Statistic	1.503036	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.768318	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.209904	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.178797	Data Not Gamma Distributed at 5% Significance Level
Data Not Gamma Distributed at 5% Significance Level		

Gamma Statistics

k hat (MLE)	1.205704	k star (bias corrected MLE)	1.0876857
Theta hat (MLE)	0.051091	Theta star (bias corrected MLE)	0.056634
nu hat (MLE)	60.28517	nu star (bias corrected)	54.384286
MLE Mean (bias corrected)	0.0616	MLE Sd (bias corrected)	0.0590648
		Approximate Chi Square Value (0.05)	38.43958
Adjusted Level of Significance	0.0395	Adjusted Chi Square Value	37.525289

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.087152	95% Adjusted Gamma UCL	0.089275

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.924242	Shapiro Wilk Lognormal GOF Test
10% Shapiro Wilk Critical Value	0.931	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.169536	Lilliefors Lognormal GOF Test
10% Lilliefors Critical Value	0.1589	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics
Minimum of Logged Data   -4.60517   Mean of logged Data   -3.255992
Maximum of Logged Data   -1.07881   SD of logged Data   0.9009578

Assuming Lognormal Distribution
   95% H-UCL   0.089468   90% Chebyshev (MVUE) UCL   0.0907149
   95% Chebyshev (MVUE) UCL   0.106174   97.5% Chebyshev (MVUE) UCL   0.1276311
   99% Chebyshev (MVUE) UCL   0.169779

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution

Note that the red annotation appears to the right.

arithmean of UCL estimates for
non-parametric data distribution
at alpha of 0.05

Nonparametric Distribution Free UCLs
   95% CLT UCL   0.088202   95% BCA Bootstrap UCL   0.0972   0.121522
   95% Standard Bootstrap UCL   0.087054   95% Bootstrap-t UCL   0.1384482
   95% Hall's Bootstrap UCL   0.218057   95% Percentile Bootstrap UCL   0.0896
   90% Chebyshev(Mean, Sd) UCL   0.110119   95% Chebyshev(Mean, Sd) UCL   0.1320957
   97.5% Chebyshev(Mean, Sd) UCL 0.162599   99% Chebyshev(Mean, Sd) UCL   0.2225175

Suggested UCL to Use
95% Student's-t UCL   0.08927   rejected as data distribution is non-parametric

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

PUPS Liver THg

N   25   length vs THg
min   0.08   -0.14348
max   2.00
arithmean   0.48
median   0.29
#nd   0
Freq nd   0

                                    General Statistics on Uncensored Full Data
Date/Time of Computation   ProUCL 5.2 2025-06-02 1:57:35 PM
User Selected Options
From File   WorkSheet.xls
Full Precision   ON

From File: WorkSheet.xls

General Statistics for Uncensored Dataset

Variable	NumObs	# Missing	Minimum	Maximum	Mean	Geo-Mean	SD	SEM	MAD/0.675	Skewness	CV
C0	25	0	0.08	2	0.4772	0.329596	0.46347	0.092694	0.237213	1.9779537	0.971228

Percentiles for Uncensored Dataset

Variable	NumObs	# Missing	10%ile	20%ile	25%ile(Q1	50%ile(Q2	75%ile(Q3	80%ile	90%ile	95%ile	99%ile
C0	25	0	0.134	0.148	0.16	0.29	0.63	0.752	0.918	1.374	1.8752

                                    Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects
User Selected Options
Date/Time of Computation   ProUCL 5.2 2025-06-02 1:58:08 PM
From File   WorkSheet.xls
Full Precision   ON
Confidence Coefficient   0.95

C0

Raw Statistics
Number of Valid Observations   25
Number of Distinct Observations   23
Minimum   0.08
Maximum   2
Mean of Raw Data   0.4772
Standard Deviation of Raw Data   0.46347
Khat   1.495933
Theta hat   0.318998
Kstar   1.343088
Theta star   0.355301
Mean of Log Transformed Data   -1.10989
Standard Deviation of Log Transformed Data 0.862437

Normal GOF Test Results

Correlation Coefficient R   0.873976
Shapiro Wilk Test Statistic   0.771628

Shapiro Wilk Critical (0.0500000) Value	0.918
Approximate Shapiro Wilk P Value	3.81E-05
Lilliefors Test Statistic	0.199818
Lilliefors Critical (0.0500000) Value	0.1726
Data not Normal at (0.0500000) Significance Level	

Gamma GOF Test Results

Correlation Coefficient R	0.983414
A-D Test Statistic	0.622702
A-D Critical (0.0500000) Value	0.761614
K-S Test Statistic	0.138751
K-S Critical(0.0500000) Value	0.177705
Data appear Gamma Distributed at (0.0500000) Significance Level	

Lognormal GOF Test Results

Correlation Coefficient R	0.986988
Shapiro Wilk Test Statistic	0.965474
Shapiro Wilk Critical (0.0500000) Value	0.918
Approximate Shapiro Wilk P Value	0.554564
Lilliefors Test Statistic	0.118783
Lilliefors Critical (0.0500000) Value	0.1726
Data appear Lognormal at (0.0500000) Significance Level	

UCL Statistics for Uncensored Full Data Sets

User Selected Options

Date/Time of Computation	ProUCL 5.2 2025-06-02 1:58:45 PM
From File	WorkSheet.xls
Full Precision	ON
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	25	Number of Distinct Observations	23
		Number of Missing Observations	0
Minimum	0.08	Mean	0.4772
Maximum	2	Median	0.29
SD	0.46347	Std. Error of Mean	0.092694
Coefficient of Variation	0.971228	Skewness	1.9779537

Normal GOF Test

Shapiro Wilk Test Statistic	0.771628	Shapiro Wilk GOF Test
1% Shapiro Wilk Critical Value	0.886	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.199818	Lilliefors GOF Test
1% Lilliefors Critical Value	0.201	Data appear Normal at 1% Significance Level
Data appear Approximate Normal at 1% Significance Level		

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.635789	95% Adjusted-CLT UCL (Chen-1995)	0.6688493
		95% Modified-t UCL (Johnson-1978)	0.6418999

Gamma GOF Test

A-D Test Statistic	0.622702	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.761614	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.138751	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.177705	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics

k hat (MLE)	1.495933	k star (bias corrected MLE)	1.3430877
Theta hat (MLE)	0.318998	Theta star (bias corrected MLE)	0.3553007
nu hat (MLE)	74.79665	nu star (bias corrected)	67.154386
MLE Mean (bias corrected)	0.4772	MLE Sd (bias corrected)	0.4117639
		Approximate Chi Square Value (0.05)	49.294685
Adjusted Level of Significance	0.0395	Adjusted Chi Square Value	48.251252

Assuming Gamma Distribution

| 95% Approximate Gamma UCL | 0.650092 | 95% Adjusted Gamma UCL | 0.6641501 |

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.965474	Shapiro Wilk Lognormal GOF Test
10% Shapiro Wilk Critical Value	0.931	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.118783	Lilliefors Lognormal GOF Test
10% Lilliefors Critical Value	0.1589	Data appear Lognormal at 10% Significance Level
Data appear Lognormal at 10% Significance Level		

Lognormal Statistics

| Minimum of Logged Data | -2.52573 | Mean of logged Data | -1.109888 |
| Maximum of Logged Data | 0.693147 | SD of logged Data | 0.8624372 |

Assuming Lognormal Distribution

95% H-UCL	0.720087	90% Chebyshev (MVUE) UCL	0.7375137
95% Chebyshev (MVUE) UCL	0.859238	97.5% Chebyshev (MVUE) UCL	1.028187
99% Chebyshev (MVUE) UCL	1.360054		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	0.629668	95% BCA Bootstrap UCL	0.666
95% Standard Bootstrap UCL	0.62407	95% Bootstrap-t UCL	0.7040535
95% Hall's Bootstrap UCL	0.753103	95% Percentile Bootstrap UCL	0.63
90% Chebyshev(Mean, Sd) UCL	0.755282	95% Chebyshev(Mean, Sd) UCL	0.8812437
97.5% Chebyshev(Mean, Sd) UCL	1.056074	99% Chebyshev(Mean, Sd) UCL	1.3994934

Suggested UCL to Use

95% Student's-t UCL   0.635789   rejected as data distribution is gamma more so than normal (based on GOF test outcomes)

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ALL SEALS - Liver THg

N	35	**length vs THg**	
min	0.08	0.492817	
max	110.00		
arithmean	6.84		
median	0.54		
#nd	0		
Freq nd	0		

General Statistics on Uncensored Full Data

Date/Time of Computation	ProUCL 5.2 2025-06-02 2:58:49 PM
User Selected Options	
From File	WorkSheet.xls
Full Precision	ON

From File: WorkSheet.xls

General Statistics for Uncensored Dataset

Variable	NumObs	# Missing	Minimum	Maximum	Mean	Geo-Mean	SD	SEM	MAD/0.67!	Skewness	CV
C0	35	0	0.08	110	6.840286	0.84364	20.58429	3.479381	0.593032	4.319987	3.009274

Percentiles for Uncensored Dataset

Variable	NumObs	# Missing	10%ile	20%ile	25%ile(Q1	50%ile(Q2	75%ile(Q3	80%ile	90%ile	95%ile	99%ile
C0	35	0	0.14	0.184	0.2	0.54	1.965	2.862	13.416	32.21	91.334

Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 2025-06-02 2:59:29 PM
From File	WorkSheet.xls
Full Precision	ON
Confidence Coefficient	0.95

C0

Raw Statistics

Number of Valid Observations	35
Number of Distinct Observations	33
Minimum	0.08
Maximum	110
Mean of Raw Data	6.840286
Standard Deviation of Raw Data	20.58429
Khat	0.325179
Theta hat	21.03548
Kstar	0.316354
Theta star	21.62228
Mean of Log Transformed Data	-0.17003
Standard Deviation of Log Transformed Data	1.82964

Normal GOF Test Results

Correlation Coefficient R	0.585775
Shapiro Wilk Test Statistic	0.37421
Shapiro Wilk Critical (0.0500000) Value	0.934
Approximate Shapiro Wilk P Value	1.62E-14
Lilliefors Test Statistic	0.404284
Lilliefors Critical (0.0500000) Value	0.1478
Data not Normal at (0.0500000) Significance Level	

Gamma GOF Test Results

Correlation Coefficient R	0.922238
A-D Test Statistic	3.830046
A-D Critical (0.0500000) Value	0.850884
K-S Test Statistic	0.262812
K-S Critical(0.0500000) Value	0.160794
Data not Gamma Distributed at (0.0500000) Significance Level	

Lognormal GOF Test Results

Correlation Coefficient R	0.953976
Shapiro Wilk Test Statistic	0.902971
Shapiro Wilk Critical (0.0500000) Value	0.934
Approximate Shapiro Wilk P Value	0.004774
Lilliefors Test Statistic	0.131271
Lilliefors Critical (0.0500000) Value	0.1478
Data appear Approximate_Lognormal at (0.0500000) Significance Level	

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 2025-06-02 3:00:20 PM
From File	WorkSheet.xls
Full Precision	ON

Confidence Coefficient 95%
Number of Bootstrap Operations 2000

C0

General Statistics

Total Number of Observations	35	Number of Distinct Observations	33
		Number of Missing Observations	0
Minimum	0.08	Mean	6.840286
Maximum	110	Median	0.54
SD	20.58429	Std. Error of Mean	3.479381
Coefficient of Variation	3.009274	Skewness	4.319987

Normal GOF Test

Shapiro Wilk Test Statistic	0.37421	Shapiro Wilk GOF Test
1% Shapiro Wilk Critical Value	0.91	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.404284	Lilliefors GOF Test
1% Lilliefors Critical Value	0.172	Data Not Normal at 1% Significance Level
Data Not Normal at 1% Significance Level		

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	12.72366	95% Adjusted-CLT UCL (Chen-1995)	15.27811
		95% Modified-t UCL (Johnson-1978)	13.1471

Gamma GOF Test

A-D Test Statistic	3.830046	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.850884	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.262812	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.160794	Data Not Gamma Distributed at 5% Significance Level
Data Not Gamma Distributed at 5% Significance Level		

Gamma Statistics

k hat (MLE)	0.325179	k star (bias corrected MLE)	0.316354
Theta hat (MLE)	21.03548	Theta star (bias corrected MLE)	21.62228
nu hat (MLE)	22.76249	nu star (bias corrected)	22.14475
MLE Mean (bias corrected)	6.840286	MLE Sd (bias corrected)	12.16152
		Approximate Chi Square Value (0.05)	12.44686
Adjusted Level of Significance	0.0425	Adjusted Chi Square Value	12.10136

Assuming Gamma Distribution

95% Approximate Gamma UCL	12.16985	95% Adjusted Gamma UCL	12.51731

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.902971	Shapiro Wilk Lognormal GOF Test
10% Shapiro Wilk Critical Value	0.944	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.131271	Lilliefors Lognormal GOF Test
10% Lilliefors Critical Value	0.1356	Data appear Lognormal at 10% Significance Level
Data appear Approximate Lognormal at 10% Significance Level		

Lognormal Statistics

Minimum of Logged Data	-2.52573	Mean of logged Data	-0.17003
Maximum of Logged Data	4.70048	SD of logged Data	1.82964

Assuming Lognormal Distribution

95% H-UCL	14.0262	90% Chebyshev (MVUE) UCL	9.052642
95% Chebyshev (MVUE) UCL	11.33499	97.5% Chebyshev (MVUE) UCL	14.5028
99% Chebyshev (MVUE) UCL	20.72535		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	12.56336	95% BCA Bootstrap UCL	16.526
95% Standard Bootstrap UCL	12.39956	95% Bootstrap-t UCL	32.3238
95% Hall's Bootstrap UCL	33.81312	95% Percentile Bootstrap UCL	12.93686
90% Chebyshev(Mean, Sd) UCL	17.27843	95% Chebyshev(Mean, Sd) UCL	22.00655
97.5% Chebyshev(Mean, Sd) UCL	28.56901	99% Chebyshev(Mean, Sd) UCL	41.45969

Suggested UCL to Use

95% H-UCL	14.0262

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

A-2: Excerpted Information From May 8th, 2025 Interim Summary of Seal Liver MeHg Data

Seal Liver MeHg

2016 Baseline Seal Liver MeHg % of THg

All seals (2016)		Pups (2016)		NonPups (2016)	
N	30	N	25	N	5
min	1.116773	min	15.43689	min	1.116773
max	51.29032	max	51.29032	max	6.286982
arithmean	29.12173	arithmean	34.38246	arithmean	2.818062
# <RDL	0	# <RDL	0	# <RDL	0
% <RDL	0	% <RDL	0	% <RDL	0
median	31.54848	median	31.92	median	2.636943

2017 (partial flooding) Seal Liver MeHg% of THg

All seals (2017)		Pups (2017)		NonPups (2017)	
N	10	N	4	N	6
min	2	min	28.4	min	2
max	43.58974	max	43.58974	max	9.81651376
arithmean	17.82683	arithmean	37.69982	arithmean	4.57817746
# <RDL	0	# <RDL	0	# <RDL	0
% <RDL	0	% <RDL	0	% <RDL	0
median	7.821643	median	39.40476	median	3.76886792

2018 (partial flooding) Seal Liver MeHg% of THg

All seals (2018)		Pups (2018)		NonPups (2018)	
N	10	N	4	N	6
min	1.286932	min	18.63889	min	1.28693182
max	41.42857	max	41.42857	max	5.78313253
arithmean	14.38656	arithmean	29.97378	arithmean	3.99508505
# <RDL	0	# <RDL	0	# <RDL	0
% <RDL	0	% <RDL	0	% <RDL	0
median	5.756597	median	29.91382	median	4.66185897

As both 2017 and 2018 were partial reservoir flooding years, with similar conditions, combining these years together yields the following summary statistics for seal MeHg% of THg.

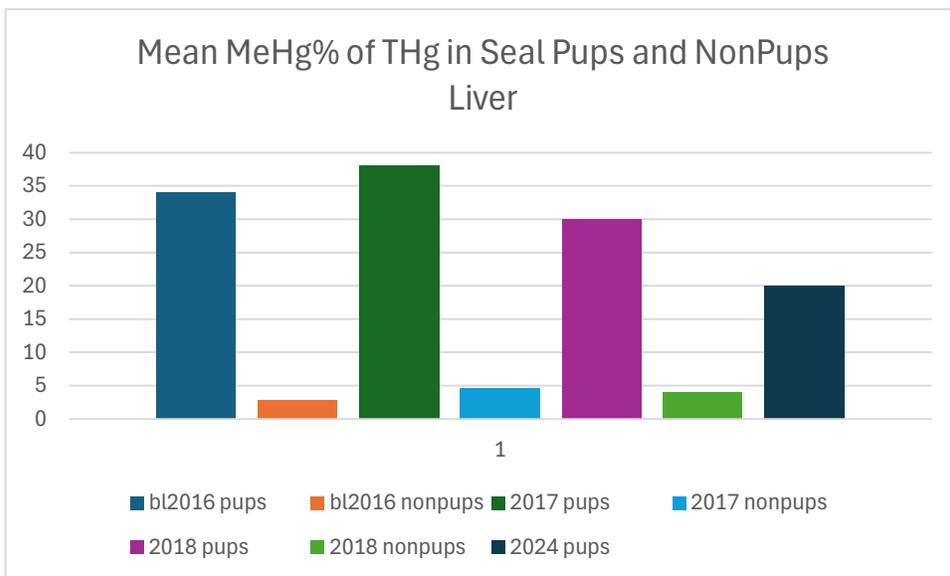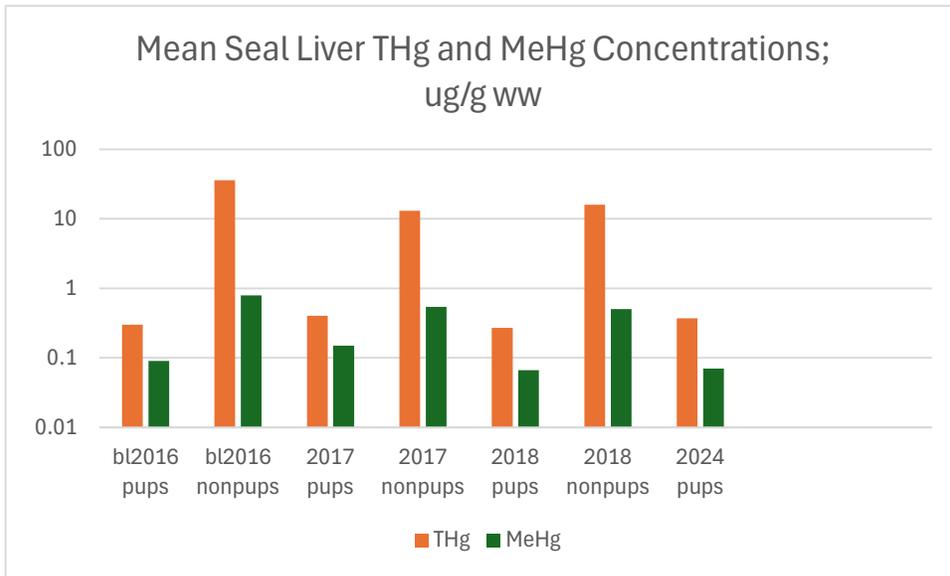**2017+2018 Combined (partial flooding) Seal Liver MeHg% of THg**

All seals (2017-2018)		Pups (2017-2018)		NonPups (2017-2018)	
N	20	N	8	N	12
min	1.286932	min	18.63889	min	1.28693182
max	43.58974	max	43.59	max	9.81651376
arithmean	16.1067	arithmean	33.8368	arithmean	4.28663125
# <RDL	0	# <RDL	0	# <RDL	0
% <RDL	0	% <RDL	0	% <RDL	0
median	5.804952	median	38.34762	median	4.64426101

In 2024, just pups had livers submitted for MeHg analysis. In 2025, efforts will be made to submit both pup and nonpup seal liver samples for MeHg analysis. The 2024 pup liver MeHg% data are summarized below.

2024 Seal Liver MeHg% of THg

Pups (2024)	
N	23
min	1.84
max	31.6
arithmean	19.95
# <RDL	0
% <RDL	0
median	21.4

It is evident that pups have a much higher MeHg% of THg in their livers than non-pups do. This is expected and is observed in the literature as well. The reason why is likely because pups are <1 year old and are weaned after about 2 months on average, so they have incurred MeHg exposure from fish consumption for perhaps several to 10 months at most, depending on how many months old the pups are when harvested. The pups would be unlikely to have had sufficient time to metabolize ingested and absorbed MeHg to a significant extent, or to the same extent that older seals would (even if only a couple years old). Also, pups have not yet developed the same degree or activity of MeHg demethylation capacity in their livers that older seals have. This suggests that seal pup livers are likely less efficient than adult seal livers at demethylating MeHg. This is common to all mammals wherein juvenile life stages are often less efficient at contaminant detoxification/metabolism than adults simply because they are still developing the internal capacity of their tissues and organs to respond to an absorbed contaminant dose, via various metabolic pathways, some of which enable the detoxification of contaminants. This is true for virtually all contaminants, not just MeHg. For MeHg, a key reaction in MeHg metabolism in the liver of all mammals is demethylation, and the conversion of MeHg to inorganic Hg. Inorganic Hg is more readily eliminated than MeHg, less toxic than MeHg, and less likely/less able to partition to and/or persist in tissues and organs that may be consumed by people.

The following graphs provide a more visual illustration of the seal liver THg and MeHg data and the proportion (%) of THg that is comprised of MeHg.

Mean Seal Liver THg and MeHg Concentrations; ug/g ww

Legend: ■ THg ■ MeHg

X-axis categories: bl2016 pups, bl2016 nonpups, 2017 pups, 2017 nonpups, 2018 pups, 2018 nonpups, 2024 pups

Mean MeHg% of THg in Seal Pups and NonPups Liver

Legend: ■ bl2016 pups ■ bl2016 nonpups ■ 2017 pups ■ 2017 nonpups ■ 2018 pups ■ 2018 nonpups ■ 2024 pups

Attachment B: Graphs of THg Exposure Point Concentrations (EPCs) – Baseline to 2024 (Brook Trout, Rainbow Smelt, Burbot, Ringed Seal)

With respect to the EPC graphs presented below, the following definitions apply:

- "bl" = baseline year.
- "pf" = partial flooding year.
- "op" = operational year.
- "EPC (original)" = calculated EPCs that include <RDL values, wherein the <RDL values were substituted with the achieved RDL value for a given sample (this is standard common HHRA practice and has been conducted throughout the entire duration of the Muskrat Falls HHRA Program).
- "EPC (size exclusion)" applies only to the EPC graphs for brook trout and burbot as these are the only fish species considered within the HHRA program where consumption is likely limited by the size of the fish. While no formal angling surveys in study area communities have been conducted to inform on the specific sizes of trout or burbot most likely to be consumed, a <6 inch (152 mm) size exclusion was arbitrarily applied (based on previous experience and professional judgement) for brook trout and burbot to enable comparison of both original and "size-exclusion" THg EPC calculations. Rainbow smelt were excluded from any size consideration as it appears to date that there is no preferential consumption patterns related to smelt size (length).

A change from prior annual HHRA reports in relation to the EPC graphs is that the baseline years data has now been separated or disaggregated into THg data for each separate year (for all considered species), rather than reporting the pooled or aggregated baseline THg data across all baseline years. While the use of pooled or aggregated baseline data across multiple years is common and appropriate in HHRA and EEM programs, there was interest in determining if the examination of individual baseline years THg data for the species of interest may reveal trends during the baseline years that are not discernable with the pooled or aggregated data.

Brook Trout THg EPCs (mg/kg ww) - All Years

Burbot THg EPCs (mg/kg ww) - All Years

Rainbow Smelt THg EPCs (mg/kg ww) - All Years

All Seals (Pups and Non-Pups) THg EPCs in Muscle Tissue (mg/kg ww) - All Years

Legend: ■ EPC (orginal)

All Seals (Pups and Non-Pups) THg EPCs in Liver Tissue (mg/kg ww) - All Years

Legend: ■ EPC (original)

Non-Pup Seals THg EPCs in Muscle Tissue (mg/kg ww) - All Years

Non-Pup Seals THg EPCs in Liver Tissue (mg/kg ww) - All Years

Pup Seals THg EPCs in Muscle Tissue (mg/kg ww) - All Years

Legend: ■ EPC (original)

Pup Seals THg EPCs in Liver Tissue (mg/kg ww) - All Years

Legend: ■ EPC (original)