From: Lockyer, Cathy
To: Carter, Paul A.
Subject: Final Workshop Report - Methylmercury Mitigation & Muskrat Falls (Aug 4, 2016 in Goose Bay) by Wayne Thistle
Date: Monday, October 31, 2016 7:47:57 AM
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Methylmercury Mitigations and Muskrat Falls_RP.pptx
Arb # 957 -Final - Oct 28 - Aug 4 2016 -Final Workshop Report.pdf
August Lake Melville workshop presentation E. Sunderland.pdf
Methylmercury Presentation - MGG.pptx

Hello All please see the below email on behalf of the Martin Goebel, ADM:

This email is a follow-up to the methylmercury scientific workshop held in Happy Valley- Goose Bay on August 4, 2016 entitled "*Methylmercury Mitigation and Muskrat Falls: A Discussion of Practical Solutions.*" The final workshop summary report produced by the workshop's facilitator Mr. Wayne Thistle is attached for your records. The presentations from the workshop are also attached. We anticipate releasing the report to the public soon. Thank you for your participation and advice provided at this workshop.

Regards,

Martin Goebel, ADM of Environment

Regards,

Cathy

_____

Cathy Lockyer | Administrative Assistant

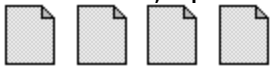
Executive Support

Office of the Assistant Deputy Minister, Environment

Department of Environment & Climate Change

Government of Newfoundland and Labrador

729-2862



Newfoundland Labrador

Water Monitoring
NL Department of Environment and Conservation

Methylmercury Mitigations and Muskrat Falls:
A Discussion of Practical Solutions
Happy Valley-Goose Bay
August 4th, 2016

Water Monitoring

- The NL Department of Environment and Conservation, along with other stakeholders, is monitoring the water along the Churchill River and into Lake Melville:
  - Real-time Water Quantity Monitoring
  - Real-time Water Quality Monitoring
  - Ambient Water Quality Grab Sampling

Real-time Water Monitoring

- There are currently a total of five active Real-time Water Quality/Quantity Monitoring stations along the Churchill River.
- There are additional water quantity only monitoring stations as well.
- The stations currently cover the area upstream of the project (from Grizzle Rapids) down to Lake Melville.

MAP 1: CHURCHILL RIVER MONITORING STATIONS

CIMFP Exhibit P-04286

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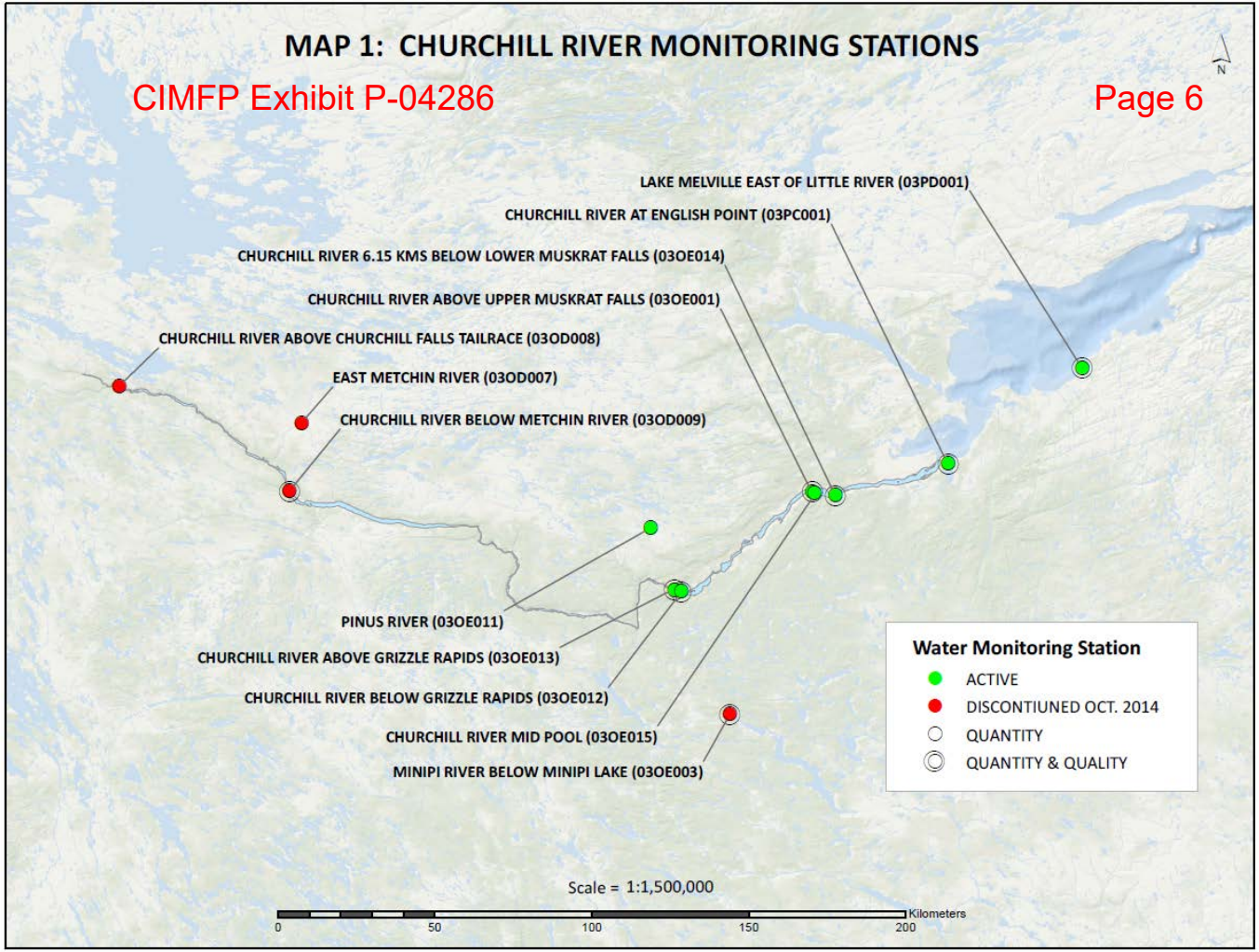


Real-time Water Quality Monitoring

- The Real-time Water Quality Monitoring stations measure key indicator parameters on an hourly basis during the ice-free months (May-Oct).
  - Water temperature
  - pH
  - Specific Conductivity
  - Dissolved Oxygen
  - Turbidity

Real-time Water Quality Monitoring

- Real-time Water Quality Monitoring data provides a continuous record and captures emerging changes in water quality in a proactive manner.
- The data is publicly available and transparent information.
- This type of monitoring has limitations and needs to be complemented with grab sampling.

http://www.env.gov.nl.ca/env/waterres/rti/rtwq/index.html

Ambient Water Quality Grab Sampling

Newfoundland Labrador

- At each of the Real-time Water Quality Monitoring stations there are grab samples collected regularly (approximately 4 per field season during the ice-free months).
- These samples are analyzed for a full suite of parameters (i.e. physical; metals; nutrients; etc.)
- Total mercury is analyzed in each sample collected.
- Samples have been collected regularly since 2009 at the Real-time Water Quality Monitoring stations.

Ambient Water Quality Grab Sampling

- Under the Canada-NL Water Quality Monitoring Agreement there are also select ambient grab sample locations on many of the main tributaries to the Churchill River, for which the historical mercury data can also be obtained upon request.

Water Monitoring

- Real-time Water Quality Monitoring along with the Ambient Water Quality Grab Sampling are used as follows to:
  - provide baseline water quality information prior to reservoir impoundment
  - identify changes/trends in water quality in the water column

Methylmercury Mitigation and Muskrat Falls: A Discussion of Practical Solutions

Scientific Workshop

Happy Valley-Goose Bay

August 4, 2016

Facilitated by:

Wayne Thistle, Q.C., C. Arb., C. Med.

Centre for Innovative Dispute Resolution

Prepared for:

Department of Environment and Climate Change

Hon. Perry Trimper, Minister

Final Report Dated: October 28, 2016

EXECUTIVE SUMMARY

A Scientific Workshop "Methylmercury Mitigation and Muskrat Falls: A Discussion of Practical Solutions" was organized by the Department of Environment and Climate Change (ECC) and held on August 4, 2016 at Hotel North Two in Happy Valley-Goose Bay beginning at 8:30 am.

The Workshop brought together technical experts, Aboriginal groups, government and Nalcor representatives and academic researchers as well as a number of observers. The purpose was to convey perspectives and provide for open dialogue and an opportunity for questions and discussion on the topic of methylmercury measures regarding the Muskrat Falls project. There was a total of 26 participants attending, in person and 5 by teleconference. A total of 20 observers were present.

The attached Report is not intended as a verbatim record of all the discussion but rather encapsulates the main messages and themes and has been categorized under various headings. It was also not intended, in all cases, to identify the individuals (or who they represented) who offered the various commentary.

There was a review of the science involving methylmercury and how it is created and propagated. There were three slide presentations providing significant information relevant to the main theme of the Workshop, namely how to mitigate the adverse consequences when methylmercury is produced as a result of flooding a reservoir? Mitigation measures, both pre-flooding and post-flooding were explored with a variety of opinions and positions being presented. There was also considerable dialogue about the need for monitoring and how consumption advisories should be developed and promulgated.

In this report, partial timber clearing indicates approximately 75% of the trees would be removed; full timber clearing indicates approximately 85% of the trees would be removed. Full clearing indicates full removal of timber, removal of vegetation and removal of the carbon which is concentrated in the upper few centimeters of the soil, The Aboriginal groups expressed, in very strong terms, the need to take all reasonable measures to remove the timber, vegetation and surface soil from the reservoir before flooding, since clearing is expected to reduce the amount of methylmercury produced when flooding of the reservoir occurs. Based on the discussions at the Workshop, it was evident that this degree of clearance has never been attempted in large scale projects and this conclusion was based on small scale experimentation.

The issue of soil removal was explored in a very detailed fashion and it was acknowledged that this is an area where further study is needed. There are many factors to consider if such an undertaking is to be implemented and it is recognized that there are constraints such as terrain and safety involved in such a project. It was recognized that soil has not been removed from reservoirs as no studies were known to exist on this issue. It was noted that a detailed geotechnical and engineering study would be required before removal of soil is commenced.

Dietary studies were explored since, with the increase in methylmercury in Lake Melville it was suggested that the diet and way of life of aboriginal groups and other residents of the area may be significantly impacted if and when consumption advisories warn of dangers to human health associated with the consumption of certain country food.

The Workshop concluded with a thorough discussion of possible follow-up action using both science and indigenous knowledge to develop reasonable and feasible approaches to reduce, to the extent

possible, the negative impacts of the increased environmental concentrations production of methylmercury.

The idea of exploring an Expert Science Table met with overall consensus.

Please note, full copies of the three slide presentations will be forwarded by the Department of Environment and Climate Change along with this final Report of the Workshop.

TABLE OF CONTENTS

1. Background to the Scientific Workshop Held on August 4, 2016

On June 30, 2016, Premier Ball wrote the Innu Nation, the Nunatsiavut Government and the NunatuKavut Community Council referring to the rally he attended in Happy Valley-Goose Bay on June 27, 2016 and acknowledging that the concern of those in attendance was evident. He further stated:

> People's health is of utmost importance and concerns with respect to the potential effects of methylmercury on people's health must be taken seriously while also considering the ecology of the reservoir.
>
> I understand there are varying positions on how to address those concerns. Minister Trimper offered to reconvene the scientific experts from the March 2016 workshop and asked the Nunatsiavut Government to come to the table. I fully support this approach to reassess the issues related to methylmercury, specifically from a mitigation perspective.
>
> Not only will we reconvene the experts from the March workshop, but we will expand the table, inviting the participation of additional provincial and federal government agencies, such as Environment and Climate Change Canada.

2. Goal of the Workshop

In a letter dated July 29, 2016, Martin Goebel, Assistant Deputy Minister (Environment) stated the goal of the Workshop as follows:

As a meeting of technical experts, Aboriginal groups and their observers, the goal of this workshop is to convey perspectives, encourage open dialogue and provide an opportunity for questions and discussion on the topic of methylmercury mitigation measures regarding the Muskrat Falls project. The Department of Environment and Conservation looks forward to this opportunity to hear positions and intends to use the information gained from the workshop to prepare a report on the outcomes and findings by the independent facilitator, Mr. Wayne Thistle (Centre for Innovative Dispute Resolution).

3. The Four Requests of the Nunatsiavut Government

In a letter dated November 9, 2015 from Minister Shiwak to Collen Janes, Deputy Minister of ECC the Minister had requested that the Government of Newfoundland and Labrador direct Nalcor Energy to:

1. Fully clear the future Muskrat Falls reservoir area of wood, brush and vegetation before flooding to reduce Methylmercury inputs downstream into Inuit territory, consistent with recommendation 4.5 of the Joint Review Panel.
2. Negotiate an Impact Management Agreement with the Nunatsiavut Government before Muskrat Falls flooding and subsequent damaging downstream impacts occur, consistent with recommendation 13.9 of the Joint Review Panel.
3. Establish an independent Expert Advisory Committee of recognized academic experts to advise on the design of and audit, a rigourous, credible and predictive monitoring program for downstream impacts of Muskrat Falls on the environment and health, using the best available scientific and Inuit knowledge.

4. Grant Inuit joint decision making authority over downstream environmental monitoring and management of the Lower Churchill project.

4. Presentation by Martin Goebel, Assistant Deputy Minister, Department of Environment and Climate Change ("ECC") – Overview of the Environmental Assessment ("EA") Process for the Muskrat Falls Project ("the Project") and the evidence that informed the Government of Newfoundland and Labrador's ("GNL") June Decision

• **Slide # 2**: **Environmental Assessment Process – Lower Churchill**

o The Project was registered on December 1, 2006.

o Numerous Departments/Agencies were appointed to the Assessment Committee.

o The Joint Review Panel ("JRP")was established on January 8, 2009.

o Public hearings were held from March 3 to April 15, 2011.

o The Final Report was released on August 25, 2011 with 83 recommendations, including:

- Rec. # 4.5 – Full clearing of the Muskrat Falls reservoir. (Note: JRP at p. 74 – This would include soil and vegetation.)
- Rec. # 6.7 – Assessment of downstream effects.
- Rec. #13.9 – Possible requirement for consumption advisories in Goose Bay or Lake Melville.

Slide # 3: Environmental Assessment Process – Lower Churchill

o The Provincial government responded to the JRP report on March 15, 2012.

- Rec. # 4.5 – Agree with principle but with limited opportunities to use the resource, and insignificant MeHg reduction, government supports partial clearing.
- Rec. # 6.7 – Assessment of downstream effects is directed to DFO.
- Rec. #13.9 – Accepted intent; if consumption advisories are required as a result of 6.7, then Nalcor should consult on further mitigation including potential for compensation.

• **Slide # 5 Environmental Assessment Process – Lower Churchill**

o The Project was released on March 15, 2012 subject to the Lower Churchill Hydroelectric Undertaking Order.

o Key conditions in the Order are:
- Environmental Protection Plan (EPP).
- Environmental Effects Monitoring Plans (EEMP).
- Environmental Monitoring and Community Liaison Committee.

o 26 EEMPs; 25 completed to date.

• **Slide # 6**: **How does the Muskrat Falls Project affect methylmercury?**

o The river upstream of the dam will become a reservoir and land will be flooded. The newly flooded soil will release mercury into the water, some of which will be converted to methylmercury, for a number of years after flooding. For a while, therefore, fish may have more methylmercury in their bodies.

o This was a factor examined during the environmental assessment of the project.

o Downstream methylmercury effect is not predicted by Nalcor to extend beyond Goose Bay.

o To ensure mitigation is in place to protect human health, a number of conditions were placed on Nalcor when the project was released that related to methylmercury.

- **Slide # 7**: **What is the Human Health Risk Assessment Plan (HHRAP)?**

o The HHRAP submitted by Nalcor proposes to address conditions of the environmental release order, namely, environmental effects monitoring plans for:

- methylmercury;
- country foods; and
- human health.

Key components:

o Dietary survey, and a human biomonitoring program (hair sampling).

o Objective to determine the potential human health effects of downstream exposure to methylmercury in fish and other country foods (e.g. seal, waterfowl).

- **Slide # 8**: **HHRAP Decision**

o Acceptance of the HHRAP dated April 12, 2016, with the following condition:

> *Should downstream methylmercury monitoring identify the need for consumption advisories as a result of the project, Nalcor shall consult with relevant parties representing Lake Melville resource users. Based on the location of the consumption advisories these users could include Aboriginal Governments and organizations as well as other stakeholder groups. Following consultation, Nalcor shall provide reasonable and appropriate compensation measures to address the impact of the consumption advisory.*

- **Slide # 9**: Analysis and Key Considerations

Scientific Workshop (March 22, 2016)

Participants:

o ENVC, NL-HCS, DFO, HC, Nalcor, Dillon consulting, Reed Harris Environmental, OPE.

o Expertise included environmental health, food safety, ecological aquatic science, toxicology, health risk assessment, hydrology, environmental research, MeHg modelling and fisheries.

Key Findings:

o Schartup *et al*, 2015 and Nalcor's modelling predicted similar increases in methylmercury concentrations in Muskrat Falls reservoir waters but there were differences on how far the effects would be detected downstream.

o Removing all topsoil from the reservoir would have other potentially significant adverse environmental effects, including the elimination of fish habitat.

NG facilitated research:

o High quality work of renowned researchers.

o The Schartup *et al* Study, 2015 is noteworthy in providing insight into potential mechanisms for methyl mercury production and uptake in Lake Melville.

o The recent NG Report confirms that regardless of mitigation, monitoring for methylmercury is still necessary to ensure we protect human health.

- **Slide # 10**: **Analysis and Key Considerations**

Federal and provincial agency comments:

o Health Canada determined the HHRAP was acceptable, and will review monitoring results.

o NL Department of Health and Community Services also determined the HHRAP was acceptable.

Other Key Considerations:

o CCME Aquatic Life standard for methylmercury is 4 ng/L.

o NG research predicts methylmercury levels of up to 0.06 ng/L, less than 66 times less than the CCME guideline.

- **Slide # 11: Full Clearing Analysis (Timber)**

  Full timber clearing:

  o Effectively the same reduction in methylmercury for either full and partial timber clearing, when compared to no clearing.

  o Safety concerns (i.e. working on steep slopes).

- **Slide # 12: Full Clearing Analysis (Soil)**

  Soil clearing:

  o Environmental concerns (i.e. sedimentation, erosion).

  o Loss of fish habitat due to sterile reservoir.

  o Stripping 25 cm of accessible soil from half the flooded area = 5,000,000 m3.

  o Monitoring still necessary.

- **Slide # 13: Conclusion:**

  o EA Process examined MeHg issues extensively.

  o Reservoir clearing was considered.

  o Key future mitigation is the HHRAP.

  o HHRAP includes downstream monitoring.

5. The Human Health Risk Assessment Plan (HHRAP)

- It was noted that Nalcor is doing more work on the HHRA and that regulators would consider that further information.
- Extra work on HHRA will also inform Nalcor's monitoring post-impoundment.
- GNL approved the HHRA Plan, not the HHRA itself.
- Regarding the HHRA Plan, its objective was to ensure there were no human health impacts. The question was asked until

Nalcor's further work is completed, how can Nalcor be allowed to flood?

- The HHRAP may not have directly considered the MeHg pathway to humans but if it did not it was because the pathway had already been considered during the EAD.
- It was pointed out that the project was approved as proposed, so the best thing to do is focus on post-flooding mitigations.
- The point was made that the HHRA will look at all information on balance and this can inform mitigation and the monitoring program. As new information becomes available, it will be incorporated.
- It was further noted that the downstream environment was not considered during the EA and as new information has come to light then GNL needs to reconsider the decisions that have been made.
- The extent to which MeHg would flow downstream was acknowledged in the EA and to the JRP as being uncertain; the DFP permit and the HHRA Plan acknowledges that uncertainty.
- The Schartup *et al* Study, 2015 showed MeHg may go further than thought so Nalcor is making improvements to monitoring, including adding a third monitoring station.

6. What is Methylmercury (MeHg), how is it formed and related issues? (Presentation by Elsie Sunderland from Harvard University by conference call)

- Elemental Hg is what is called quicksilver.
- It is inorganic mercury (Hg(II)) which is converted to methylmercury (MeHg).
- It is mainly microorganisms which convert Hg(II) into MeHg.
- MeHg is not a specified toxic substance under S. 36(3) of the *Fisheries Act* which discusses deleterious substances.

- The primary concern is for MeHg because it is more toxic than inorganic Hg and is the dominant form in fish.
- The different biochemical properties of inorganic Hg and MeHg make MeHg more relevant for human health.
- Inorganic: low absorption (0.01 – 7% average).
- MeHg: high absorption (greater than 90%) primarily in the blood stream; half-life of 50-70 days; chelation is not effective as a treatment.
- The river upstream of the dam will become a reservoir and land will be flooded. The newly flooded soil will release mercury and provide organic carbon as an energy source for methylating bacteria resulting in a relatively short term (1-2 years) pulse of MeHg in the reservoir water. This MeHg enters the food chain leading to increased MeHg concentrations in aquatic animals, particularly predatory fish at the top of the food chain. These fish reach maximum mercury concentrations in 3 – 10 years and may have higher baseline concentrations for up to 40 years.
- MeHg bio-accumulates up the food chain in the flesh of organisms with the final consumers being humans.
- The question was asked as to whether production of MeHg in the estuary would increase due to reservoir creation and how much water column methylation will there be.
- There is uncertainty since Dissolved Organic Carbon (DOC) may increase because of loading from the Muskrat Falls reservoir and because it is hard to quantify water-column methylation it was not included in the Shartup *et al* Study.
- The model predictions of post-impoundment fish mercury concentrations treat the methylation potential of Lake Melville according to the measurement made during the Shartup *et al* Study. The model also allows
- It would be a significant effort to estimate the increase in methylation in Lake Melville waters due to reservoir creation upstream and it was not included in the Schartup *et al* Study. The models also allow for degradation of MeHg downstream

transport from the reservoir to Lake Melville. Recent field data indicate that the degradation is very limited.
- The estuary was treated in the Harvard analysis as if methylation in Lake Melville happens post-flooding exactly as it is happening now.
- If methylation occurs in Lake Melville waters, that would reduce the relative contribution from other sources, including river inputs.
- If Harvard estimates of water column methylation in Lake Melville are accurate, this source would currently be the biggest input of MeHg to Lake Melville.
- There is enough Hg to fuel production; in the water column, methylation is consuming just a fraction of the Hg in the environment.

7. Effect of Methylmercury on Human Health

- The Shartup *et al* Study concluded the elevated methylmercury levels in the Lake Melville food web will adversely impact human health. MeHg is a potent neurotoxin that can cause negative health effects through chronic exposure at very low levels and that Inuit who rely on Lake Melville for their source of essential county food will experience increased risk of methylmercury exposure following flooding of the reservoir.
- Consumed by humans, MeHg can cross the blood-brain barrier, leading to cardiovascular effects in adults (e.g. higher risk of heart attack), and neurological and cognitive impairment among infants and children.
- MeHg crosses the brain/blood/placental interfaces.
- It takes approximately two months for 50% of the MeHg absorbed from the diet to be excreted from the human body.
- There is no known treatment for MeHg, other than limiting its further intake and waiting it out.
- It was noted that when people talk mitigation, they talk risks to the project – they should be talking risks to human health.

- The statement was made that the Workshop must concern itself with human health impacts – how do we mitigate the risks to our health? The project is secondary.

8. The Canadian Council of Ministers of the Environment(CCME) and other Guidelines for Methylmercury

- The CCME standard is 4 ng/L but it was noted this is for aquatic life and is not necessarily reflective of the impacts of biomagnification or protective of higher tropic forms of life.
- The CCME standard is not protective of human health.
- NG research predicts up to 0.06 ng/L, less than 66 times the CCME standard.
- The Health Canada guideline is .2 micrograms of methylmercury per kilogram body weight per day; these numbers are for daily intake whereas the data shows baseline levels, not daily intake.
- Health Canada's .2 is for children and women of child bearing age. For the general population, it is 0.47.
- These numbers are for daily intake whereas the data shows baseline levels, not daily intake.
- Currently, there are 43 individuals with hair concentrations above the Health Canada 2ppm guideline, almost all in Rigolet. These individuals were generally older men.
- It was stated that the exposure values were compared to both the Health Canada guideline and the US Environmental Protection Agency Guideline to provide two different regulatory levels for methylmercury exposure, with the EPA being lower.
- It was questioned why the US EPA guideline is half of the Health Canada guideline.
- Using the EPA guidelines, 150 individuals are already in excess of 1ppm.

- US EPA guidelines are predicated at the level necessary for neurotoxicity; lesser levels can still have health impairments, such as cardiovascular impairments.
- The guidelines also do not consider lower level neurological impairments, such as ADD.

(Note: Presenters used different units of measurement and the facilitator is not confident of the accuracy of how these are denoted, particularly in this section)

9. Country Foods and Methylmercury

- There have been dietary surveys by sampling people from the Lake Melville area to establish baseline levels of consumption standards.
- Approximately 70 % of current MeHg exposure is from locally caught foods.
- Several methods were used to determine the MeHg source for fish, such as carbon and nitrogen isotopic analysis.
- The Schartup, *et al* Study established baseline biomagnification data to determine MeHg change in country foods due to flooding.
- It used measured factors to project biomagnification from baseline data.
- There is a lot of variability in terms of when peak mercury concentrations are reached in fish after reservoir flooding and how long it takes until concentrations return to base levels. There is likely to be a lot of variability in the Lake Melville context but peaks are estimated 3 - 11 years post-flooding.
- The Study assumes freshwater species move throughout the lake system.
- Freshwater species cannot at this time or when the project is completed, move between upstream and downstream of Muskrat Falls.

- Salmon can bioaccumulate mercury as they move out to sea as part of normal seasonal migration.
- Mercury concentrations in fish are about what researchers were expecting when seeking to establish baseline data.
- The Study only sampled portions of fish/animals that people reported eating from locations where they were reported to be harvested.
- It was noted that DFO data shows high levels in trout, low in landlocked salmon – almost the inverse of the Study.
- With respect to uncertainty in the baseline results, the Schartup *et al* Study is as certain as possible. It assessed people's diet in comparison with an assessment of the physical environment and it was felt this is as close as can be achieved via measurements and the Study has produced a lot of baseline data.
- The communities which are impacted are HVGB, Northwest River and Rigolet. Levels in Rigolet are higher than in HVGB or NWR because Rigolet residents eat more country food.
- Dietary survey sampled 1,566 people; Rigolet: 87% response rate, HVGB: 32%, North West River: 44%. These response rates are much higher than Nalcor's (0%, 2%, 10%).
- Mercury hair concentrations are higher in older versus younger age groups; also, higher for men than women.
- Comparisons have not been made with other Inuit populations but it is likely the further north you go, higher are the mercury baseline levels.
- Numerous NG employees worked in communities to talk about diet and collect hair samples.
- Right now mercury exposures are not that high but the base line data was collected to propagate future levels based on the projected MeHg increase.
- The current median is below any regulatory standard.

Slides from the presentation by Dr. Elsie Sunderland

. **Slide:**

o Country foods = 67% of MeHg intake (33% store-bought)
o Considered 90 different food items
o Propagate forward to show changes after flooding

• **Slide: MeHg change due to flooding**

o Distinguished between landlocked and Atlantic salmon

• **Slide: Highly exposed individuals disproportionately impacted**

o Based on the literature, cardiovascular and IQ impacts heightened for those most at risk.

• **Slide: Projected % above 2ppm Health Canada guideline**

o HVGB: 10% (high scenario), 5% (medium), 1% (low)
o NWR: 25%, 7%, 2%
o Rigolet: higher than HVGB or NWR

• **Slide: Using 1ppm (US EPA) guideline**

o HVGB: 25% (high scenario)
o NWR: 50% (high)
o Rigolet: 64% (high)

• **Slide: Total # of people above the guidelines:**

o Health Canada Standard: 26 (low scenario); 104 (medium); 618 (high)
o EPA Standard: 40; 252; 1,027

• **Slide: Acute Toxicity Possible**

o

Intake/day /	Low Scenario /	Medium /	High
1-3ppm	14	19	249
3-5	0	0	17
5+	0	0	16

- **Slide: Given what they eat now, a lot of people are at risk**

- **Slide: Comparison of HHRAs**

o Harvard: > 1,000 participants, all Inuit or family member
o Nalcor: 293 participants, 196 of whom were Aboriginal
o Harvard: conducted over 3 seasons
o Nalcor: Winter only
o Harvard: concludes total reservoir clearing (including 20 cm of topsoil) will reduce Inuit exposure by 2/3rds
o Nalcor: no conclusions can be made about Inuit-specific future exposure or those most vulnerable.

- Nalcor's study did not capture the diversity of the diet of respondents that was captured by the Harvard study so unless Nalcor projects forward, it will not see potentially dangerous exposures.
- It was noted that Nalcor is doing more work on the HHRA and that regulators would consider that further information.
- Extra work on HHRA will also inform Nalcor's monitoring post-impoundment.
- GNL approved the HHRA Plan, not the HHRA itself.

10. Further information from the Schartup *et al* Study, 2015:

- There was general consensus that the Study is based on sound research and sound methodologies.
- There is general acceptance that there will be increases in MeHg as a result of reservoir flooding.
- There are data and predictions involved in reaching that conclusion.
- Updated estimates of methylmercury loaded to Muskrat Falls waters from flooded soils have been made since the Schartup *et al* Study.

- The projected increases in water MeHg concentrations in the reservoir are:
    - Low: 3x to 0.067 ng/L
    - Medium: 10x to 0.2 ng/L
    - High: 15x to 0.3 ng/L
- It was noted the absolute increases in MeHg concentrations in the Muskrat Falls waters predicted by the Schartup *et al* Study were not unlike the levels predicted by Nalcor in 2010. However, the enrichment is higher because of the lower baseline concentrations that were used.
- The increase in MeHg in water exported from the Muskrat Falls reservoir was predicted to increase concentration in Lake Melville from 13% (low scenario) to 380% of baseline concentrations (high scenario). These estimates are based on an analysis that assumes conditions are similar throughout Lake Melville.
- Stratification means that the freshwater signal carries further into Lake Melville (in surface waters) than would be the case if Lake Melville waters were vertically mixed.
- Lake Melville is highly stratified, with high salinity on the bottom and a freshwater layer on top with very little mixing.
- The model shows inputs of Hg and DOC to the Lake Melville estuary contributing to methylation at the salt/freshwater interface.
- Data from Lake Melville for the first time show (high) methylation rates in oxinated surface water
- The entire freshwater layer of the Churchill River estuary will be impacted, maybe higher near HVGB, lower near Rigolet.
- The projections of water MeHg concentrations are for the surface layer annual average especially because there is so little vertical mixing in the estuary.
- Fish are not likely to stay just near HVGB so it is probably fair to say there may be differences in their exposure throughout the Lake system.

- The time frame in which the increases are likely to be seen would probably be within a few weeks of flooding with the peak being in the first 1-3 years. The pulse in fish will last 10-30 years. Elevated (above baseline) mercury concentrations in fish are expected to be observed for 10 – 30 years after reaching maximum concentrations 3 – 10 years after the reservoir impoundment.
- It was noted these estimates are consistent with DFO evidence.
- Creating extra trophic levels leads to higher rates of MeHg biomagnification: this was apparently happening within the "marine snow" layer where several trophic levels of plankton organism aggregate .
- Plankton are opportunistic feeders.

11.Water Monitoring Presentation by Renee Paterson, Senior Environmental Scientist, ECC:

- Monitoring for total Hg has been included since 2009/10 but biota is not sampled.
- Testing is done for Hg and water quality.
- There are 3 methods of monitoring on the Churchill River and in Lake Melville: Real Time Water Quality Monitoring; Real Time Water Quantity Monitoring (hydrograph); and, Ambient (grab sampling).
- There are 5 monitoring stations along the Churchill River (from Grizzle Rapids down to and Lake Melville).
- Hourly data is taken during ice-free months, on water temperature, pH, specific conductivity, dissolved oxygen, and turbidity, providing a fingerprint of water quality.
- Data is available on ENVC's website within 2 hours.
- There are some limitations, including that only certain parameters are monitored; hence, monitoring is supplemented with grab samples.

- 4-5 grab samples are collected at each station during the annual ice-free months and assessed for total Hg; these samples are analyzed for nutrients, ions and also for total Hg.
- Grab samples have been done annually since 2009-10, when stations were installed.
- Under NL-federal agreement, selected grab samples are also done at sites on various tributaries to the Churchill River.
- This data also allows ENVC to establish baseline info so as to monitor post-impoundment changes and impacts.

12. Pre-flooding Mitigation Measures:

(a) Full clearing versus partial clearing of timber:

- Concerns were expressed around the ability to fully clear timber, reiterating that "full clearing of timber" would amount to clearing 85% of the timber, given that 15% is inaccessible due to the steep slope of the reservoir banks, equipment and engineering issues and safety issues.
- There is equipment available that could do the full clearing of timber but it was argued that while not all organics could be removed, Nalcor must do better than 75%.
- Full vs. partial clearing of timber would result in only a 10% difference in the amount of timber cleared. Effectively, there is only a small 10% reduction in projected MeHg generation for full clearing of timber compared to partial clearing and the benefits of both clearing options compared to no clearing are also small.
- Either partial or full clearing of timber is not effective in reducing the post-impoundment increase in mercury methylation because ultimately only timber (a source of recalcitrant carbon that is not readily available to methylating bacteria and not the ground

vegetation and topsoil (a source of labile carbon and bacteria can readily use for their energy needs) is being removed.

- It was noted that the process of clearing the timber and the associated disturbance of the soil in the area of the future reservoir can lead to run-off of water with high MeHg concentrations into the river and/or into the reservoir during the early stages of flooding.
- A geotechnical assessment would be required before it could be determined whether the equipment could operate safely given the slope instability in some areas.
- There is a considerable amount of uncertainty and risks associated with full clearing.
- Including a mitigation measure such as full clearing is unprecedented and would require a massive undertaking and research; there is no literature on full clearing
- This would be one of the largest civil engineering jobs in the country if it included soil clearing.
- Effectively, there is a similar reduction in MeHg for either full clearing or partial clearing of above ground vegetation as presented by Nalcor when compared to no clearing.
- Even if full clearing is attempted down to the mineral soil horizon (i.e. the top 20 cm of soil) in the area to be flooded by the reservoir, some organic material will remain in the soil and in areas with full clearing is not possible due to safety and/or logistical concerns.
- This means that even with full clearing there likely will be an increase in mercury methylation soon after reservoir formation but this increase will be much lower and will not last as long as under scenarios that only clear timber.

- When a new reservoir is created there is a pulse of MeHg entering the water. The MeHg has been generating some time prior to flooding and is being flushed from the soil porewater during flooding and leached from leaves and other decomposing plant material. This source of MeHg is in addition to the MeHg that is newly generated in increased quantities after reservoir flooding.
- Eventually, years to decades, a new sediment surface would form in the fully cleared zone if soil was removed and it might have characteristics similar to upstream sediments.

(b) Issues particular to the clearing of organic material other than timber:

- It was noted that full clearing would be “the removal of timber and organic rich surface soil”.
- There are environmental concerns such as sedimentation and erosion impacts to the river with respect to the proposed removal of soil from the area of the proposed reservoir.
- A potential loss of some fish habitat was also noted, given the reservoir would lose a substantial portion of organic material (the term used was “the reservoir would be effectively sterilized”).
- The question was asked is there any peer-reviewed science which studied the impact of such sterility and it was suggested it seems speculative to say a reservoir denuded of soil would destroy habitat and create sterility; the most likely result would be a short-term reduction in benthic production.
- Further it was suggested that “sterility” may be the wrong word since there is an understanding that the habitat would be re-established, though it would take

some time for the river to re-establish an organic sediment layer.

- It was estimated that it would take between 1 - 3years for the reservoir to have a “normal” organic sediment layer.
- Full clearing will affect fish that otherwise would feed on the plankton, so there would be dead and distressed fish. It was noted this would need further consideration under the *Fisheries Act*.
- Humus soils (peatlands) represent the largest reservoir of organic carbon to stimulate Hg methylation.
- It was estimated that the amount of soil required to be removed would be 5M cubic metres. This amounts to a pile one kilometre in diameter and 20 metres high.
- On this issue, it was further noted, that much more than 5M cubic metres of soil would have to be removed to increase bowl stability.
- Blading off 20 centimetres of soil would be very difficult.
- Full clearing of topsoil has never been attempted for a full scale so there is a significant level of uncertainty regarding the various environmental effects.
- This amount of material creates environmental problems on land such as where to temporarily (during clearing) and permanently (outside of the reservoir watershed) store that soil.
- During clearing operations, soil can only be transported approximately three km from the extraction location before it becomes logistically unfeasible.
- Scientists would need to tell the engineers how far the soil had to be transported.
- Piles of soil could create fire risk.

- Questions were asked regarding the potential for production and run-off of MeHg from the soil pile(s) and generation of greenhouse gases.
- No reservoir has ever been scraped of soil, so there must remain a significant level of speculation.
- Organic carbon is concentrated in the upper approximately 20 centimetres of a normal forest soil.
- Based on the data compiled by Elsie Sunderland from experimental reservoirs at the ELA, there is a clear indication for a strong linear relationship between the amount of carbon available ((t/ha) and the amount of MeHg produced (Mg/ha/yr).
- Using data respecting the volume of carbon in flooded soils, Schartup *et al* indicated that there is a strong linear relationship between the amount of carbon available and the amount of MeHg produced.
- Would the use of heavy equipment to remove soil contribute to increased MeHg production and run-off?
- It was suggested that if you stripped vegetation and organics in soils you could prevent much of the increase in MeHg production. If the organic material is removed, it would remove the potential for MeHg generation. However, it is probably not feasible to remove even half the soil so it is likely there would be some soil left in the reservoir to contribute to MeHg production.
- The NG estimated full clearing of timber as 1 % of total project cost. Stripping 15 cm of soil would cost $178 million. Stripping 20 cm would cost $230 million.
- Nalcor noted that the costs to explore the issue of where to dispose of the soil were likely not included in the NG's estimate.
- An undertaking of soil clearing would almost certainly require a new EA.

- There is no literature or case study on full clearing that includes soil removal.
- There seems to be uncertainty around the feasibility of full clearing and perhaps a study is required.
- There was a suggestion that perhaps 3 - 5 people could look at full clearing, including soil removal vs. partial or full clearing of timber.

(c) A Mesocosm Study

- The Schartup *et al* Study removed the top 1-2 cm litter layer and all vegetation of sediment core samples in its experiments to estimate the magnitude of the MeHg pulse (flux) from flooded soils in the Muskrat Falls reservoir.
- Further experiments could be done comparing core samples with and without topsoil.
- The problem is that core samples are not always realistic – it may be a good idea to use a mesocosm although issues of realism are also applicable to mesocosms.
- A well-designed experiment to look at the effects of clearing would take a significant amount of time to design and execute. It could not be done in weeks, for example.
- A mesocosm study could use enclosures over different types of flooded soils.
- A mesocosm can be suboptimal because of organic growth (which may sequester MeHg) on the walls of the enclosures.

13. Why did the Government of NL conclude that monitoring was necessary and what would be involved in monitoring?

- The answer given was that monitoring is the only way to prove or disprove predictions.
- To protect human health, monitoring is the only way to inform mitigation.
- The objective of monitoring is to determine the potential human health effects of downstream exposure to MeHg in fish and other country foods.
- The NG's scientific report and study concluded there is no safe threshold for MeHg and that monitoring was always required.
- The HHRAP submitted by Nalcor proposes to address conditions of the *Lower Churchill Hydroelectric Generation Project Undertaking Order* (NL Regulation 19/12) which order releases Nalcor Energy from environmental assessment, namely, environmental effects monitoring plans for:
  - MeHg in water
  - Fish and other country foods (e.g. seal, waterfowl)
  - Human health
- Key components in monitoring include a dietary survey and a human biomonitoring program (hair sampling).

14. Main Messages from Aboriginal Groups

- Three Aboriginal groups participated:

o Nunatsiavut Government
o Innu Nation
o NunatKavut Government

- There seems to be a conclusion that mitigation measures will reduce the risk of mercury exposure to human health. An advisory may lessen impacts on health but it does not lessen impacts on indigenous rights;

- The JRP recommended that federal and provincial governments require a comprehensive assessment of downstream effects, including identifying all possible pathways for MeHg in the food web. This has not occurred.
- There was an expression of appreciation for the scientific and research community for working on this issue of such importance to the aboriginal communities.

o The Nunatsiavut Government:

- Inuit health and our way of life and food security for our children and grandchildren are all very important.
- Protecting that is the responsibility of the NG.
- How can you put a cost on culture, health? The NG is urging the GNL to adopt the precautionary principle in the assessment of the health risks to Inuit from the Project and that would require the full (soil) clearing of the reservoir.
- Full clearing of topsoil is a priority for the Nunatsiavut Government
- The NG's proposed mitigations are all pre-flood mitigation.
- Safety is important; the rest (financial cost) is secondary.
- Human health trumps all.
- Aboriginal groups want more than consultation; they want to negotiate an Impact Management Agreement.

o The Innu Nation:

- The Innu position is that they want to discuss these issues further and consider the science to ensure impacts are minimized and there is effective mitigation and monitoring.

- It is clear that Nalcor and the federal and provincial governments cannot do this alone. There must be a full and thorough review conducted with the participation of independent scientists, indigenous experts and representatives from the Innu, Inuit and local residents. Every option must be examined while there are still options.

15. Consumption Advisories

- How will consumption advisories be created?
- In the past, consumption advisories were just posted. This was not effective and the NG worked with the GNL and agreed that information would be provided to the communities before posting the signs. This has been a more effective approach.
- The view was expressed that consumption advisories are a last resort and not to be desired.
- The consumption advisory process is something for which the province does not have the resources; it is the responsibility of HC.

16. Pausing the Project

- The NG suggested the project should be paused until satisfactory answers can be found to outstanding issues. No water should flow into the reservoir until this is done.
- Certain decisions must be made before flooding the reservoir.
- The NG's proposed mitigations are all pre-flood mitigations.

17. Post Flooding Mitigation Measures

(a) General Comments

- The whole approach to post-mitigation measures needs to be designed in consultation with the communities and needs to include a strong education component.
- The concept of post–mitigation measures at this time is somewhat precedent-setting, as in most places, the action is to just issue a consumption advisory.
- The view was expressed that any post-flooding mitigation measure is suboptimal. The primary mitigation is full clearing. Everything else is secondary.

(b) What other potential mitigation options exist post-impoundment?

Nitrates and Oxygenation

- An example was given for successful suppression of Hg methylation rates in an upper N Y state lake.
- Consideration should be given to nitrate additions or oxygenation to suppress MeHg production.
- When you add nitrate to water, the nitrate shifts the activity of bacteria so methylating bacteria is less active.
- Nitrate addition works best in solution and in anaerobic contexts.
- Nitrate addition would not be a one-time addition and may require addition once a year for several years.
- This approach only works if you add nitrates on a regular basis and a pilot would have to be conducted.
- Since net Hg methylation rates are highest in the summer months, you may not need to add nitrates year round.
- It is necessary to determine how feasible it would be to do this on a recurring basis.

- Considering the short residence time in the Muskrat Falls reservoir (approximately 10 days), the amount of nitrates to be added would be massive.
- Care should be taken when considering the impacts of adding nitrates since the risks of algal production could be counterproductive.
- If the system is nitrogen-limited, adding nitrates could lead to algal blooms.
- This approach is not guaranteed to work but may work best where water loses oxygen.
- This approach would have to be tested pre-flooding if it planned to rely on it post-flooding.
- The effects of nitrate additions in the reservoir would have to be considered along with the effects on methylmercury production, methylmercury concentrations and trophic conditions downstream.
- If nitrates are added to the reservoir and it would actually reduce methylation, this would result in less MeHg going from the reservoir to Lake Melville but one cannot be sure what would be the impact on methylation in Lake Melville.
- Oxygenation may also work given methylating bacteria thrive in anaerobic conditions; however, the results from the Schartup *et al* Study show that here can be Hg methylation under aerobic conditions.
- Oxygenation could help but only if the water column is deoxygenated.
- There will be no anoxia in the water column of the reservoir as it is part of the river and there is consistent mixing of water.
- Iron and manganese oxidants can also act as a cap for MeHg.
- Although Nalcor has concluded that the reservoir is not predicted to be stratified or deoxygenated, both methods would be worth considering further.

(c) Dietary Studies

- Health Canada has two programs – the First Nations Food Nutrition and Environment Study and the First Nations Environmental Contaminants Program. These programs can provide funding and technical support to study diet, impacts on MeHg and changes in country foods to help fully understand the impacts of changes in Me Hg exposure of local residents.
- Land Claim organizations should be able to build a case for why they want to access the programs.
- These are annual programs and there is no reason the NG could not access them.
- If there are any concerns about Nalcor led work, this could be an option to secure independent research.
- You can shift diets but that is harder to do where food insecurity already exists.
- Nalcor is envisioning education and engagement campaigns which would also include discussion of cooking practices which could help reduce MeHg intake, as could changing dietary practices, such as pairing specific drinks with specific foods.
- There are 12-15 papers on the potential of changing cooking practices, focusing on the changing of proteins in the cooking processes; given MeHg attaches to protein in the tissue, altering the protein provided an opportunity to reduce MeHg ingestion.
- There may be a need or opportunity to involve nutrition experts in these discussions.
- Selenium could also be considered as an option to reduce MeHg absorption of food.

18. Possible follow-up action

(a) Expert Science Table

- The NG has proposed an Independent Expert Advisory Committee since politicians have said they do not understand the science well enough.
- From the Workshop discussion, there seemed to be a consensus that perhaps this idea should be proposed as an added component to the federal government Environmental Assessment (EA) modernization process. EAs are highly complex; it is always a challenge for decision-makers to understand the science and explain it to the public.
- As part of Environment and Climate Change Canada's (ECCC) role, it can convene and chair an expert science table which brings together representatives from across government to discuss issues. Such a table guided ECCC action in respect of the Manolis L.

(b) A Mesocosm Study

- It was suggested that possible action from the Workshop could be a consideration of a mesocosm study on the effect of different soil/vegetation types on net Hg methylation rates and MeHg fluxes after flooding. It was further suggested that ECCC should take the lead on such a study. This could be part of an amendment to the environmental monitoring plan.

(c) Nitrates and Oxygenation

It was suggested there should be consideration given to the use of nitrates and oxygenation as post-impoundment mitigation measure to reduce MeHg production in the reservoir.

(d) Dietary Studies, as previously described should be undertaken.

(e) Full Clearing

There appeared to be some consensus that it may be necessary to get a further assessment of benefits from full clearing. There has to be a recognition that the terrain and safety issues may be a limiting factor in so far as removal of all vegetation and organic material is concerned. It was suggested a feasibility study could be undertaken to determine how much organic material can be removed. The experimental aspect of such a study could be completed using core samples which are flooded with most of the organics on the top of the soil core being removed. Full clearing would amount to the top 20 centimetres of the soil being removed.

REFERENCES

1. Schartup, A.T., P.H. Soerensen, A.L. Gosnell, etc., K.J. Calder, R.S.D. Mason, R.P. and E.M Sunderland. Freshwater discharges drive high level of methylmercury in Artic marine biota. Proceedings of the National Academy of Sciences of the USA (PNAS), 112:11, 789-794 ("Schartup et al, 2015")
2. DFO. 2016 Review of Mercury Bioaccumulation in the Biota of Lake Melville, DFO Can. Sci. Advis. Sec. Sci. Resp. 2016/015. ("DFO Review")
3. Nalcor (Nalcor Energy). 2015 Human Health Risk Assessment Plan (Revision B4). February 25, 2015. Doc. No. LCP-PT-MD-0000-EV-PL-0026-01. ("Nalcor HHRAP, 2015")
4. Government of NL and Government of Canada response to the Report of the Join Review Panel for Nalcor Energy's Lower Churchill Hydroelectric Generation Project – March 2012
5. Scientific Workshop: Methylmercury and Muskrat Falls: Sharing and Understanding Our Varied Perspectives – March 22, 2016
6. Durkalec, A., Sheldon, T., Bell, T. (Eds.) 2016. Lake Melville: Avativut Kanuittailinnivut (Our Environment, Our Health) Scientific Report. Nain, NL. Nunatsiavut Government.

Appendix "A" - Scope of Work

The Facilitator (Consultant) was engaged effective July 19, 2016 to complete the following services:

1. The Consultant shall be responsible for facilitating a one day scientific workshop to be held in Happy Valley-Goose Bay, Labrador on Thursday, August 4, 2016 starting at 8:30am and ending at 5:30pm. The workshop, entitled, Methylmercury Mitigations and Muskrat Falls: A Discussion of Practical Solutions, will be a forum to provide an opportunity for attending provincial and federal government representatives and representatives of the Nunatsiavut Government, Innu Nation and the NunatuKavut Community Council to discuss and dialogue issues related to methylmercury production pertaining to the Muskrat Falls project in an effort to identify practical solutions.

2. Following the workshop, the Consultant shall provide to the Client a "Contract Document" which provides a summary of the discussion which took place at the workshop. The document shall be in sufficient detail so as to outline the key topics raised, a summary of the discussion of the various topics as per the workshop agenda and any recommendation or advice provided by the participants.

3. The Consultant shall act in a position of neutrality both in his role as facilitator and author of the Contract Document.

Appendix "B" – Workshop Agenda

8:30 am Opening Welcome
Facilitator
- Workshops origins, objectives and themes

8:45 am Review of Workshop Process and Agenda
Facilitator
- Review workshop process and agenda and facilitator/recorded role

9:00 am Participant Introductions
All participants
- Each person will introduce themselves and note the organization they are representing.

9:15 am Opening Comments
Martin Goebel
- The Department of Environment and Conservation will present an overview of the EA process for the Muskrat Falls project and the evidence that informed Government's June announcement.

9:45 am Pre-inundation Mitigations: Evidence and Options
All participants
- Beginning with the Nunatsiavut Government's expert representative(s), who will present their research, each organization's expert(s) will have approximately 10 minutes to introduce their perspective and evidence on mitigation options for methylmercury reduction; this will be followed by a discussion amongst participants.

11:00 am Coffee Break

11:15 am (continued) Pre-inundation Mitigations: Evidence and Options
All participants

1:30 pm Lunch Break (Provided)

2:00 pm Post-inundation Mitigation/Monitoring and other tools

All participants

- Beginning with the Nunatsiavut Government's expert representative(s), who will present their perspectives and proposed solutions regarding the implications for Inuit Health, each organization's expert(s) will have approximately 5 -10 minutes to outline their perspective regarding this issue, inclusive of the monitoring program in place; this will be followed by a discussion amongst participants

5:00 pm Closing Comments

Facilitator

- The Facilitator will explain how the outcome summary document will be completed and distributed to participants. Thank all participants for attending the workshop.

5:15 pm Close of workshop

Appendix "C" – Workshop Attendees

Table:
Wayne Thistle – Facilitator
Brian Harvey – Note Keeper
Paul Carter – NL Department of Environment and Conservation (ENVC)
Martin Goebel – ENVC
Geoff Mercer – Environment and Climate Change Canada (ECCC)
Dr. Wolfgang Jansen – Innu Nation
George Russell, NunatuKavut Community Council, Inc.
Jim McCarthy – Nalcor
Jackie Wells – Nalcor
Rob Willis – Nalcor
Peter Madden – Nalcor
Jane Kirk – ECCC
Greg Kaminski – Health Canada
Colin Carroll – NL Forestry & Agrifoods Agency
Bruce Pauli – ECCC
Dr. Margo Wilson – Labrador-Grenfell Regional Health Authority (LGH)
Diane Oliver-Scales – LGH
Dr. David Allison – NL Department of Health and Community Services
Rodd Laing – Nunatsiavut Government (NG)
Carl McLean – NG
Dr. Trevor Bell – Memorial University of Newfoundland

Telephone:
Dr. Elsie Sunderland – Harvard University
Robin Anderson – Fisheries and Oceans Canada (DFO)
Renee Pat
erson – ENVC
David Haley – Nalcor

Reed Harris – Nalcor

Seated:
Johannes Lampe – President, NG
Darryl Shiwak – Minister, NG
Greg Flower – Minister, NG
Isabella Pain – NG
Michelle Kinney – NG
Loretta Michelin – NG
Bert Pomeroy – NG
Anastasia Qupee – Grand Chief, Innu Nation
Richard Nuna – Innu Nation
Donna Paddon – Innu Nation
Paula Reid – Innu Nation
Cathy Guirguis – Innu Nation
Todd Russell – President, NCC
Roberta Benefiel – Grand Riverkeepers
Lisa Dempster – MHA, Deputy Speaker
Randy Edmunds – MHA
Minister Perry Trimper – ENVC
Emily Timmins – ENVC
Bonnie Learning – ENVC
Michelle Watkins – NL Labrador and Aboriginal Affairs Office

Appendix "D" – Workshop Participants

Facilitator	
Centre for Innovation Dispute Resolution	Wayne Thistle
Labrador & Aboriginal Affairs (note keeper)	Brian Harvey
Federal Departments	
Fisheries and Oceans Canada	Robin Anderson (By teleconference)
Environment and Climate Change Canada	Bruce Pauli Jane Kirk Geoff Mercer
Health Canada	Gregory Kaminski
Provincial Departments	
Health and Community Services	Dr. David Allison
Labrador-Grenfell Regional Health Authority	Dr. Margo Wilson Diane Oliver-Scales
Forestry and Agrifoods Agency	Colin Carroll
Environment and Conservation	Martin Goebel, Renee Paterson (By teleconference) Paul Carter

Nalcor Energy	Peter Madden Jackie Wells Dave Haley (by teleconference) Reed Harris (by teleconference) Jim McCarthy Rob Willis
Aboriginal Groups Nunatsiavut Government	Carl McLean Rodd Laing
Innu Nation	Dr. Wolfgang Jansen
NunatuKavut Community Council	George Russell Jr.
Academic Researchers	Dr. Elsie Sunderland (by teleconference) Dr. Trevor Bell

Appendix "E" – Workshop Participants' Bios

NL Department of Environment and Conservation
Martin Goebel
Assistant Deputy Minister (Environment)

Martin Goebel, P.Eng, started his career with the Department of Environment and Conservation in October 1983. As ADM since 2009, Martin has worked on many projects including the environmental assessment of the Lower Churchill Power Development, environmental clean-up projects at Buchans and Hopedale and continues to lead water resources projects such as drinking water safety, waste water management and real-time water quality monitoring. Work in this area includes developing policy, budgeting, preparing cabinet papers, formulating legislation and representing the Department in public forums.

Martin represents the province on Federal/Provincial/Territorial committees including the Canadian Council of Ministers of Environment Environmental Planning and Protection Committee and the National Administrators Table of the F/P/T Hydrometric Surveys Program.

Renee Paterson
Senior Environmental Scientist

Renee has been working in the Water Resources Management Division for 15 years and is the coordinator for the Real-time Water Quality Monitoring Program. Renee has been involved with the Lower Churchill Project throughout

the environmental assessment process and continues to work towards addressing water quality/quantity issues relating to the project. Renee holds a B.SC. (Biology) and M.Sc. (Environmental Science) from Memorial University.

Paul Carter
Environmental Scientist

Paul Carter joined the Department of Environment and Conservation in 1990 and worked eight years working in the Water Resources Management Division in various positions with the Surface Water, Water Quality and Water Investigations before moving to his current position of Environmental Scientist with the Environmental Assessment Division. In 2008, Paul was appointed to Chair the Assessment Committee for the Lower Churchill Hydroelectric Generation Project. For this role he has worked on the Terms of Reference for the Joint Review Panel, Guidelines for the Environmental Impact Statement, and Provincial Government response to the Report of the Joint Review Panel.

Paul holds a B.Sc. in Physical Geography, B.Sc. (Honours) specializing in Hydrology, and M.A.Sc. Environmental Engineering and Applied Science from Memorial University of Newfoundland.

NL Department of Health and Community Services
David Allison
Chief Medical Officer of Health

Dr. David Allison MD, FRCPC, is Chief Medical Officer of Health for the province. David has served in public health

roles New Brunswick, Alberta and Saskatchewan since 1982. He is also a member of the Emergency Response Unit (ERU) roster of the Canadian Red Cross and has completed short deployments in Haiti (2010), Sierra Leone (2012) and Nepal (2015).

David is a past co-chair of Immunize Canada and has been involved in environmental health research as an investigator assessing concerns about environmental lead in St. John's, NL. As a clinical associate professor in the Division of Community Health and Humanities of the Faculty of Medicine at Memorial University, he has been involved with teaching of medical students and supervision of MPH students undertaking practicums.

Margo Wilson
Labrador-Grenfell Health

Dr. Margo Wilson is a family physician in Happy Valley-Goose Bay. She completed her residency with additional training in emergency medicine in St. John's, then became a staff physician at the Labrador Health Centre, where she has been working since 2011. In addition to her role with Labrador-Grenfell Health, Dr. Wilson is a clinical associate professor with the Discipline of Family Medicine in the Faculty of Medicine at Memorial University.

Diane Oliver-Scales
Labrador Grenfell Health

Diane is a clinical nurse manager of public health at Labrador-Grenfell Health in Happy Valley-Goose Bay.

Fisheries and Oceans Canada
Robin Anderson
Research Scientist

Dr. Robin Anderson is a Research Scientist in the Ecological Sciences Section and has developed and carried out research projects in quantitative aquatic ecology for over 35 years. Robin came to Newfoundland in 1991 after holding faculty positions at the University of Quebec at Montreal and at the University of Maryland.
Robin's research program examines and models the effects of human activity on aquatic habitats, including substantial research in mercury impacts on fish following reservoir creation, evaluating risks to ecosystems, and integrating spatial patterns and processes in food web and environmental studies. She has provided expert testimony and scientific advice on the potential and observed environmental impacts of human activity on fish and fish habitat including major environmental assessments of mines, hydroelectric projects and offshore oil development, environmental effects monitoring (EEM) programs and site decommissioning proposals.

Robin holds a B.Sc. in Biology from Université Laval, an M.Sc. in Biology from Université Laval, and a Ph.D. in Biology from McGill University.

Health Canada
Gregory Kaminski
Senior Environmental Health Assessment Specialist

Gregory Kaminski works as a Senior Environmental Health Assessment Specialist in the Healthy Environments and Consumer Safety Branch. He has over 25 years of experience in the areas of environmental and human health risk assessment. He worked for Inuit-owned Makivik corporation as a wildlife biologist, assessed effects of pulp and paper mill effluents on fish and biota when working as a consultant on cycle 1 Environmental Effects Monitoring required by the federal regulation, and developed computer models for Hydro Quebec in the areas of utility pole treatment, storage sites and accidental spills into terrestrial and aquatic environments.

Gregory joined the federal government in 2001. At the Pest Management Regulatory Agency he helped to assess human and ecological risks linked to the application and registration of pesticides. As the head of the office of Environmental Effects Monitoring for Pulp and Paper with Environment Canada, he helped to re-design the regulation for that sector and developed regulations for the mining sector. In 2010 Greg moved to Health Canada where he works on assessing effects of proposed development projects on human health. Gregory holds a B.Sc. and an M.Sc. from McGill University.

Environment and Climate Change Canada
Geoff Mercer
Regional Director General, Atlantic and Quebec Regions

Geoff Mercer was appointed Regional Director General on June 23, 2016 and represents the interests of the Atlantic and Quebec Regions within Environment and Climate Change Canada. As well, he contributes to the delivery of national programs and manages major horizontal issues. He is tasked

with ensuring ongoing relations with private and public partners and key stakeholders in the regions.

Geoff came to Environment and Climate Change Canada in January 2009 as the Atlantic Regional Director, Environmental Protection Operations Directorate. In July 2013, he was appointed as the Associate Regional Director General, Atlantic and Quebec Regions. From 1988 until 2008, Geoff was a member of National Defence where he held various positions in the Canadian Forces, and also in the department's environmental management program.

He is originally from Montreal, Quebec, and obtained a Bachelor's degree and a Master's degree in Science (Biology) from Memorial University of Newfoundland.

Jane Kirk
Research Scientist, Water Science & Technology, Science & Technology Branch

Dr. Jane Kirk’s research focuses on the impacts of human alterations to aquatic ecosystems, including the transport, fate, and bioaccumulation of contaminants such as mercury, metals, and polycyclic aromatic hydrocarbons, the role of anthropogenic stressors, such as eutrophication, in altering contaminant cycling, and the impacts of climate change on carbon cycling and biological communities in freshwater lakes. Dr. Kirk completed her PhD at the University of Alberta in the Department of Biological Sciences on sources of toxic methylmercury to Arctic marine ecosystems, including the atmosphere, production of methylmercury within the marine water column, and inputs from rivers that have been altered for hydroelectric power production. Dr. Kirk is currently a Research Scientist in the Aquatic

Contaminants Research Division of Environment and Climate Change Canada and an Adjunct Assistant Professor in the Department of Geography at University of Toronto Mississauga. She is based out of the Canada Centre for Inland Waters in Burlington, Ontario.

Bruce Pauli
Chief, Ecosystem Health Research, Wildlife & Landscape Science, Science & Technology Branch

Bruce Pauli's research and monitoring activities on the levels and biological effects of environmental pollution are aimed at establishing techniques that can be used to evaluate and assess environmental change. His research focuses on techniques to use wildlife species as sentinel organisms to assess levels of contaminants and adverse effects of multiple stressors on wildlife in human-changed ecosystems. This research has included efforts to standardize toxicity tests with native amphibian species, to examine determinants of disease in amphibians, and to develop an understanding of cumulative effects and the response of wildlife to multiple stressors. The goal is to establish relevant and robust measures useful for assessments of ecosystem health and change. Bruce Pauli is currently a Research Manager and Chief, Ecosystem Health Research Section in the Ecotoxicology and Wildlife Health Division, Science and Technology Branch, Environment and Climate Change Canada. He is based at the National Wildlife Research Centre at Carleton University in Ottawa, Ontario.

Forestry and Agrifoods Agency
Colin Carroll
Regional Ecosystem Director, Labrador

Colin Carroll is the Regional Ecosystem Director with the Forest Service's Branch for the Labrador Region in Happy Valley – Goose Bay and Western Region in Corner Brook. He is currently one of two Provincial Government Appointed members of the Torngat Wildlife and Plants co-Management Board and is Chair of the Model Forest NL and the Canadian Institute of Forestry NL Section.

Colin graduated from the University of British Columbia's Forestry Program in 1996 and is a Registered Professional Forester. He has worked in both the Forest Industry in Northern BC and forestry related wildlife research. Worked as an instructor in the Natural Resources Programs (forestry and fish and wildlife technician) at the College of the North Atlantic in Corner Brook and Bonavista campuses. District Ecosystem Manager with the Provinces Forestry Services Branch in Cartwright and Northwest River in Labrador. He was part of the Environmental Assessment group for the Lower Churchill Project who's role was to focus on the reservoir and transmission line clearing activities and provide comments as part of the forestry team that also presented at the panel hearings.

Innu Nation
Wolfgang Jansen
Aquatic Scientist

Dr. Wolfgang Jansen is an aquatic scientist with North/South Consultants Inc. in Winnipeg, which he joined in 2001. He has worked in consulting and a casual research scientist with DFO (Winnipeg) from 1999 to 2009. He also has project experience with Manitoba Hydro in environmental impact assessment and monitoring, fish passage and movement, as well as mercury in fish.

Wolfgang has authored or co-authored over 50 scientific publications on subjects such as fish and aquatic invertebrate migrations, fish trophic ecology, bioenergetics and habitat use, pollution impacts on fish physiology and ecology, methodology of bog restoration, population dynamics and impacts of invasive aquatic species and the life history of aquatic invertebrates.

Wolfgang holds a B.Sc. in Agricultural Engineering from University of Bonn in Germany, an M.Sc. Department of Zoology, University of Manitoba, and a Ph.D. from Department of Zoology, University of Hohenheim in Germany.

NunatuKavut Community Council
George Russell Jr.
Environment and Resource Manager

Nunatsiavut Government
Carl McLean
Deputy Minister of Lands and Natural Resources

Rodd Laing
Director of Environment

Academic Researchers

Elsie Sunderland
Associate Professor, Harvard University

Dr. Elsie Sunderland is the Thomas D. Cabot Associate Professor of Environmental Science and Engineering in the Harvard John A. Paulson School of Engineering and Applied Science. She holds a secondary appointment in the Department of Environmental Health in the Harvard T.H. Chan School of Public Health. She is a faculty associate in the Harvard University Center for the Environment and the Harvard Center for Risk Analysis. Prior to joining the faculty at Harvard, she held several positions at the headquarters for the U.S. Environmental Protection Agency, where she worked on regulatory impact assessments and the development and application of models to inform regulatory decisions. Dr. Sunderland's research group (http://bgc.seas.harvard.edu) studies how global contaminants are distributed in the environment, magnify in food webs and pose risks to human health. Much of Dr. Sunderland's present research is focused on understanding how global contaminants are affecting the health of northern communities and how climate change and industrial development will affect future health risks.

Trevor Bell
Professor, Memorial University

Dr. Trevor Bell is a Professor of Geography at Memorial University. For over three decades he has studied landscape history from a variety of perspectives, including climate

change impacts and human-environment interactions. He has played an important role in the ArcticNet NCE, both as project leader and coordinator of the eastern Arctic integrated regional impact assessment. One of these ArcticNet projects, Nunatsiavut Nuluak, co-led with Tom Sheldon, Director of Environment for the Nunatsiavut Government, focused on Labrador fiords including Lake Melville. Dr. Bell shared the 2013 Arctic Inspiration Prize with the Nunatsiavut Government for their knowledge-to-action program on healthy homes in sustainable subarctic communities. He has led the recent development of the SmartICE initiative, which supports safer travel for sea-ice users and shipping in northern coastal regions.

Nalcor Energy
Jackie Wells
EA Commitments / Environmental Effects Monitoring Programs Lead

Jackie Wells is an Environmental Effects Monitoring Lead for the Lower Churchill Project, responsible for environmental effects monitoring programs for the Labrador – Island Transmission Link and the Lower Churchill Hydroelectric Generation Facility. These programs ensure our environmental commitments are being met and environmental protection measures are mitigating the effects of the project on various environmental components. Some of the key programs include: Labrador caribou, Newfoundland caribou, furbearers, methylmercury, human health risk assessment, Newfoundland marten, avifauna, and listed plants. She has 15 years' experience in the environmental sector including environmental research, education and environmental assessment.

Jackie holds a B.Sc. (Biology), a B.Ed. and an M.Sc. (Biology) degrees from Memorial University of Newfoundland.

Peter Madden
Regulatory Compliance Lead

Peter Madden is the Regulatory Compliance Lead for the Lower Churchill Project. His primary responsibilities with include implementation of the LCP EMS, regulatory stakeholder management, project environmental effects monitoring and mitigation programs. He has 10 years experience in environmental research, environmental assessment, and environmental and regulatory compliance.

Peter holds a B.Sc. (Hons) in Behavioural Neuroscience, an M.A.Sc. in Environmental Engineering, an M.B.A, and Masters Certificate in Project Management.

David Haley
Environmental Regulatory Compliance Manager

David Haley has more than thirty one (31) years of applied Environmental Engineering and Project Management experience. David has worked and managed numerous projects in Atlantic and Arctic Canada, including the 5 Wing Goose Remediation Project. David has worked on the Lower Churchill Project since 2012 in the role of Environmental Engineering Manager.

David is recognized as a Site Professional under the Newfoundland and Labrador Contaminated Site Management Programs, was named a Fellow of Engineers Canada (FEC), and in 2010 was granted the certification of Environmental

Professional (EP) by ECO-Canada. David is a registered Professional Engineer in the Province of Newfoundland and Labrador.

Education: 1981 – 1983 Diploma Engineering, Dalhousie University, Halifax, Nova Scotia; and, 1983 – 1985 B.Eng. Civil, Technical University of Nova Scotia, Halifax, Nova Scotia.

Rob Willis
Senior Toxicologist & Risk Assessor Dillon Consulting

Rob Willis is the Senior Toxicologist and Risk Assessor for Dillon Consulting Limited and extensive experience and expertise in human health and ecological (terrestrial and aquatic) risk assessment (HHERA), toxicity-based benchmarks development, the development of HHERA guidance and approaches, chemicals management and priority setting, and various aspects of applied toxicology and environmental chemistry. Rob has evaluated mercury and methylmercury exposure and risk in a number of previous human health risk assessment (HHRA) studies in various regions of Canada. He is currently retained by Nalcor Energy as their HHRA subject matter expert for the Lower Churchill Hydroelectric Generation Project.

Rob frequently serves as an expert reviewer of risk assessment and toxicological documents prepared by others, is routinely invited to participate in federal risk assessment program guidance development, and serves (or has served) as an invited member on a number of provincial and regional technical committees that pertain to HHERA.

Rob holds an M.E.S. from Dalhousie University and a B.Sc. with an emphasis in environmental toxicology, from the University of Guelph. He is a Canadian Certified Environmental Practitioner (EP) in the areas of air quality protection, and human and environmental health and safety (since 2004), and a qualified person for risk assessment under Ontario Reg. 153/04.

James McCarthy
Senior Aquatic Lead, Lower Churchill Project

James McCarthy is an associate biologist and Certified Fisheries Professional with over twenty years of experience. Jim has been involved in a wide range of projects in Newfoundland and Labrador, Alaska, British Columbia and Nova Scotia for private organizations and government agencies. Projects have generally entailed the design and implementation of environmental assessments, aquatic offset plans, baseline studies, and environmental effects monitoring programs related to various human activities such as oil and gas, hydroelectric developments, mining/construction, and forest harvesting. His efforts in aquatic research and offset planning have focused on the identification of habitats sensitive to human disturbance for aquatic species.

Jim is a Ph.D. candidate at University of New Brunswick's Canadian Rivers Institute where a portion of his research will focus on potential ecosystem niche changes within and downstream of the Muskrat Falls reservoir and how they may affect mercury bioaccumulation and transport.

Reed Harris
President, Reed Harris Environmental Ltd

Reed Harris, BSc. (Civ Eng), M. Eng., P. Eng., has over 30 years of experience in the environmental engineering field. Since 1988, Reed has specialized in the behaviour of mercury in aquatic and terrestrial ecosystems. He has developed and applied models of mercury cycling and bioaccumulation in freshwater, marine and terrestrial systems, and made predictions of fish mercury concentrations in connection with the Lower Churchill River Hydroelectric project.

Facilitator
Wayne Thistle
Centre for Innovative Dispute Resolution

Wayne Thistle has been an active Arbitrator, Mediator, Facilitator and Dispute Resolution expert and for the past forty years assisting parties throughout Canada in resolving disputes primarily in labour, insurance, industrial and commercial areas. He has worked with all levels of governments and Crown agencies, and with many employers and unions in diverse sectors including natural resources, particularly oil and gas, mining, forestry and fishery sectors, the airline industry, the health sector, the education sector, transportation and communications sector, the insurance industry, the construction industry and the banking and financial sector.

Mr. Thistle was admitted to the Chartered Arbitrator designation by the Arbitration and Mediation Institute of Canada in 1988 and to the Chartered Mediator designation in 2011. He has completed the Advanced Program in Alternative Dispute Resolution presented by the University of Windsor, Faculty of Law, and Stitt Feld Handy Houston law firm of Toronto. He also has undergone training offered in the Harvard Law School Program on Negotiation

specializing in Conflict Resolution and Human Resource Effectiveness. He has been recognized by his peers in the *Best Lawyers in Canada* publication in the field of Dispute Resolution in each edition from 2008 – 2017.

Mr. Thistle has served in various administrative capacities over a thirty-five year career at Memorial University of Newfoundland and prior to his retirement in 2003 held, for twenty-one years, the position of Vice-President (Administration and Finance) and Legal Counsel. He has taught Commercial Law in the Faculty of Business Administration and Education Law in the Faculty of Education. He holds a Bachelor of Science (Honours Math and Physics) degree, a Bachelor of Education Degree and a Master of Arts Degree from Memorial University and a Bachelor of Laws degree from Dalhousie University.

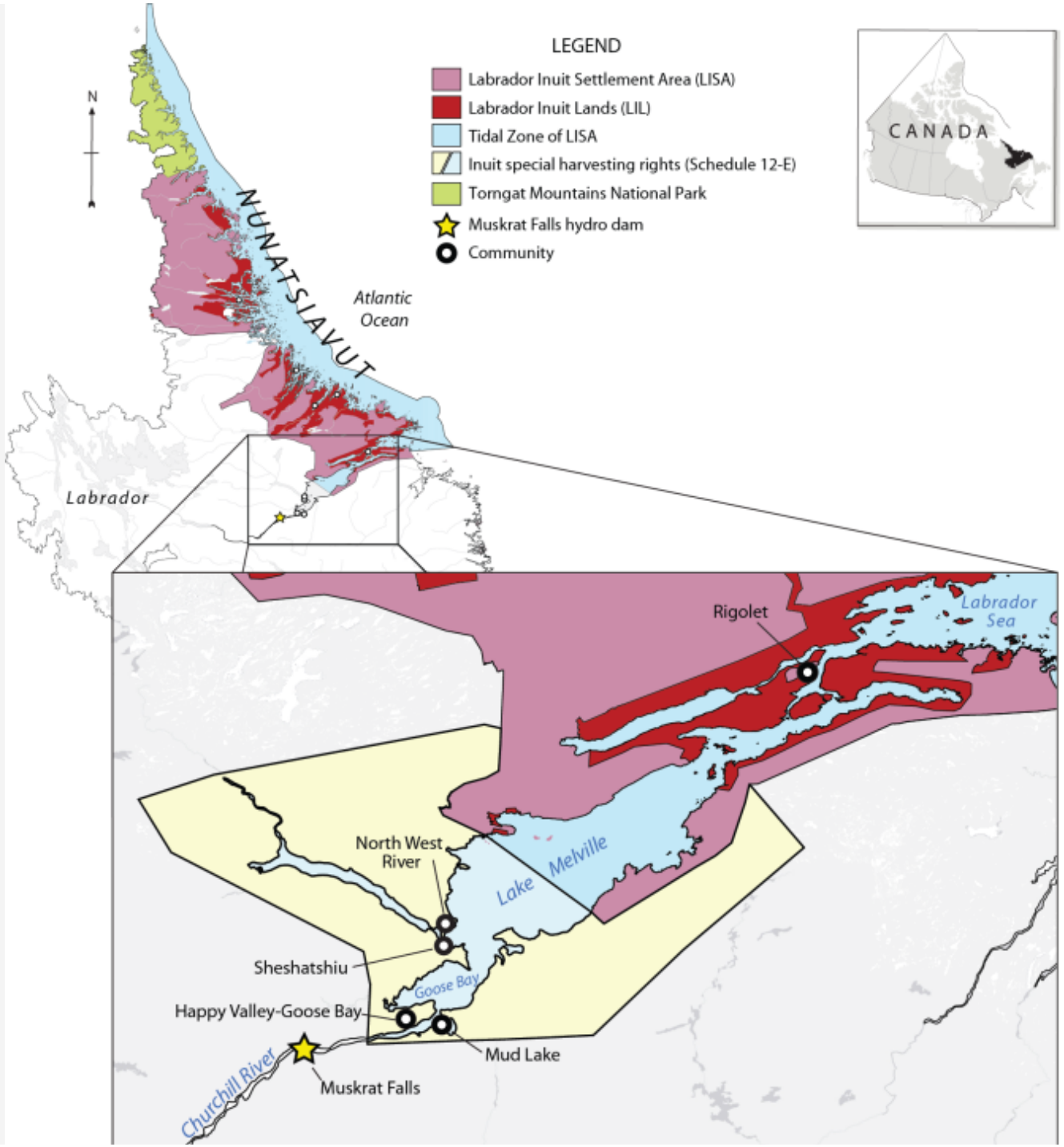
Brian Harvey
Director, Aboriginal Affairs
Assistant recorder / note keeper

Brian holds a B.Sc. (Biology) From Memorial University and an LL.B. from Dalhousie. Following a short time in private practice, Brian joined Government in 2005, with the Department of Natural Resources. Since then, Brian has worked throughout Government, including as a Cabinet Officer with Cabinet Secretariat, and including two secondments to Nalcor Energy to work on the Hebron Project negotiations and on the acquisition of the former Abitibi Bowater properties in Grand Falls-Windsor.

Brian has been Director of Aboriginal Affairs since 2010, and in 2015, received a Public Service Award of Excellence.

LAKE MELVILLE: AVATIVUT, KANUITTAILINNIVUT (OUR ENVIRONMENT, OUR HEALTH)





LEGEND
Labrador Inuit Settlement Area (LISA)
Labrador Inuit Lands (LIL)
Tidal Zone of LISA
Inuit special harvesting rights (Schedule 12-E)
Torngat Mountains National Park
Muskrat Falls hydro dam
Community
N
CANADA
NUNATSIAVUT
Atlantic Ocean
Labrador
Rigolet
Labrador Sea
North West River
Lake Melville
Sheshatshiu
Goose Bay
Happy Valley-Goose Bay
Mud Lake
Churchill River
Muskrat Falls

Muskrat Falls hydro dam


Lake Melville research program
What did the project tell us?

Funding

Lake Melville: Avativut, Kanuittailinnivut Research Program

University of Manitoba

Memorial University

Tides Canada

ArcticNet

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NSF

Nunatsiavut: Senani jârini kajusimanik pivallianimmut

Nunatsiavut: 10 Years of Continued Progress

Biogeochemistry of Global Contaminants Harvard

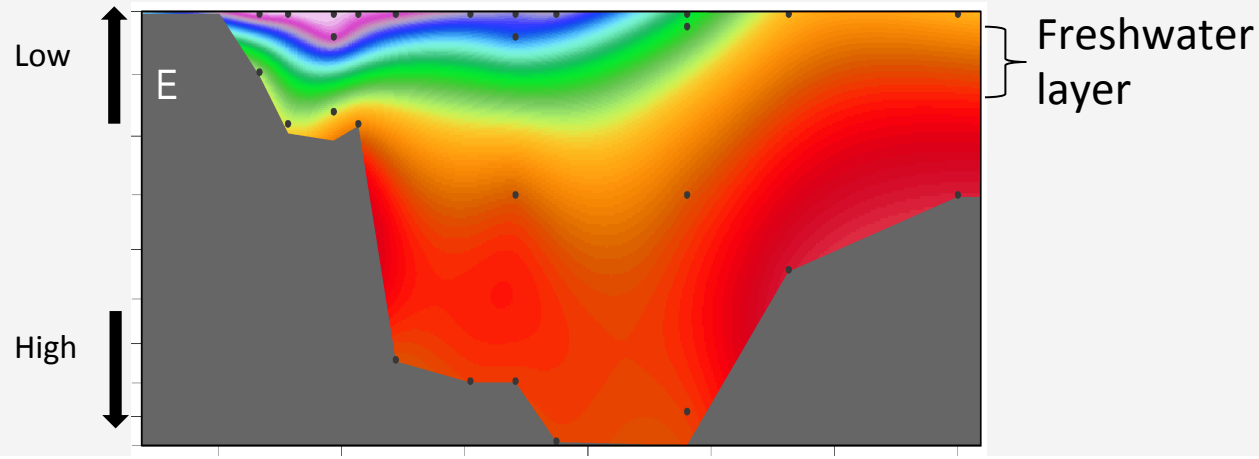
NIEHS National Institute of Environmental Health Sciences


Lake Melville Research Program
Physical lake processes – Memorial University
Climate – Memorial University
Sea ice – Memorial University
Sediments and organic carbon – University of Manitoba
Mercury and methylmercury – Harvard University

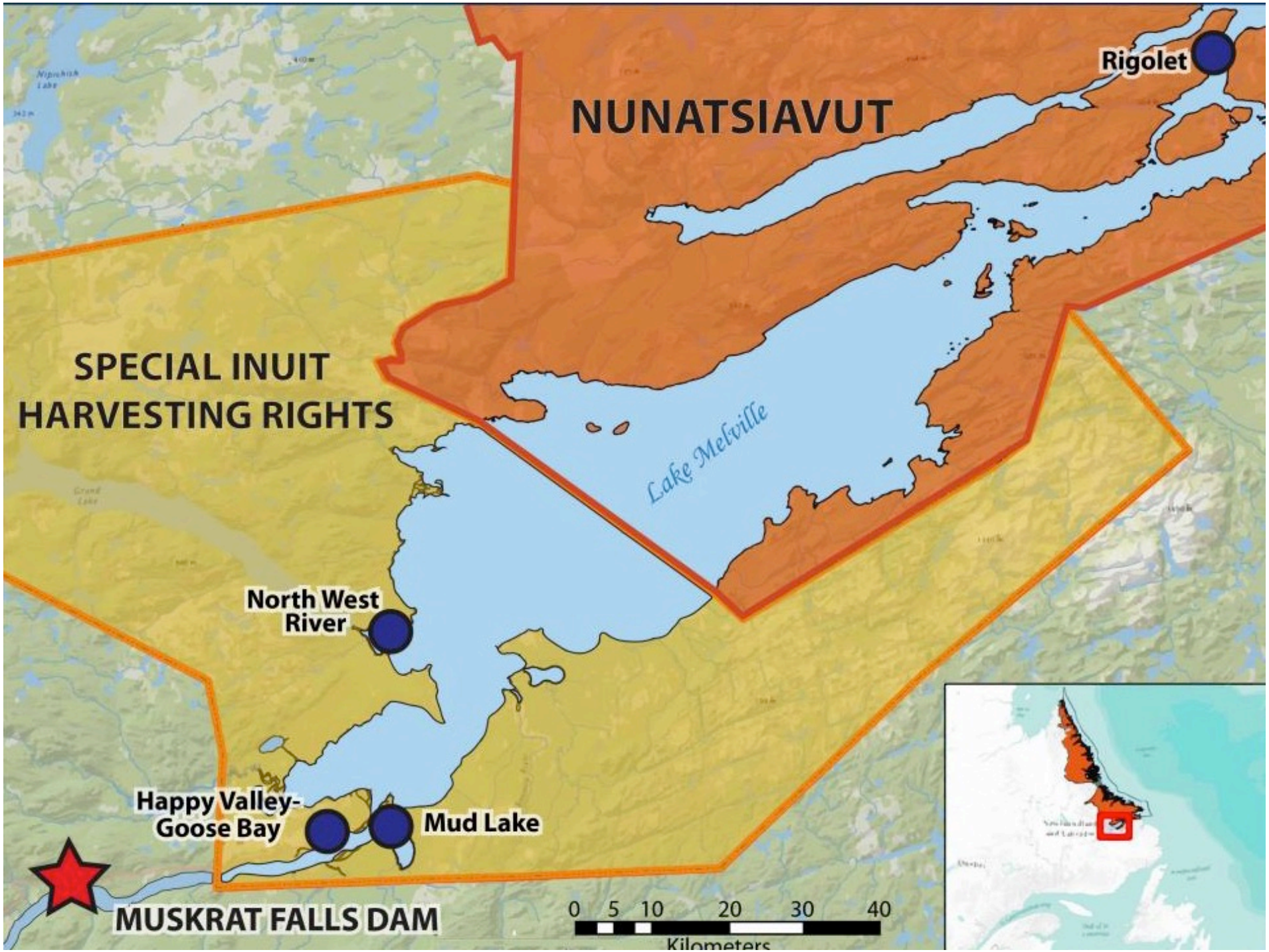
First observations of Lake Melville - 2012

- Lake Melville dynamics driven by large freshwater input from rivers.
  - Freshwater discharged at the mouth of the Churchill river moves across the entirety of Lake Melville

SALINITY:



Sediments and organic carbon

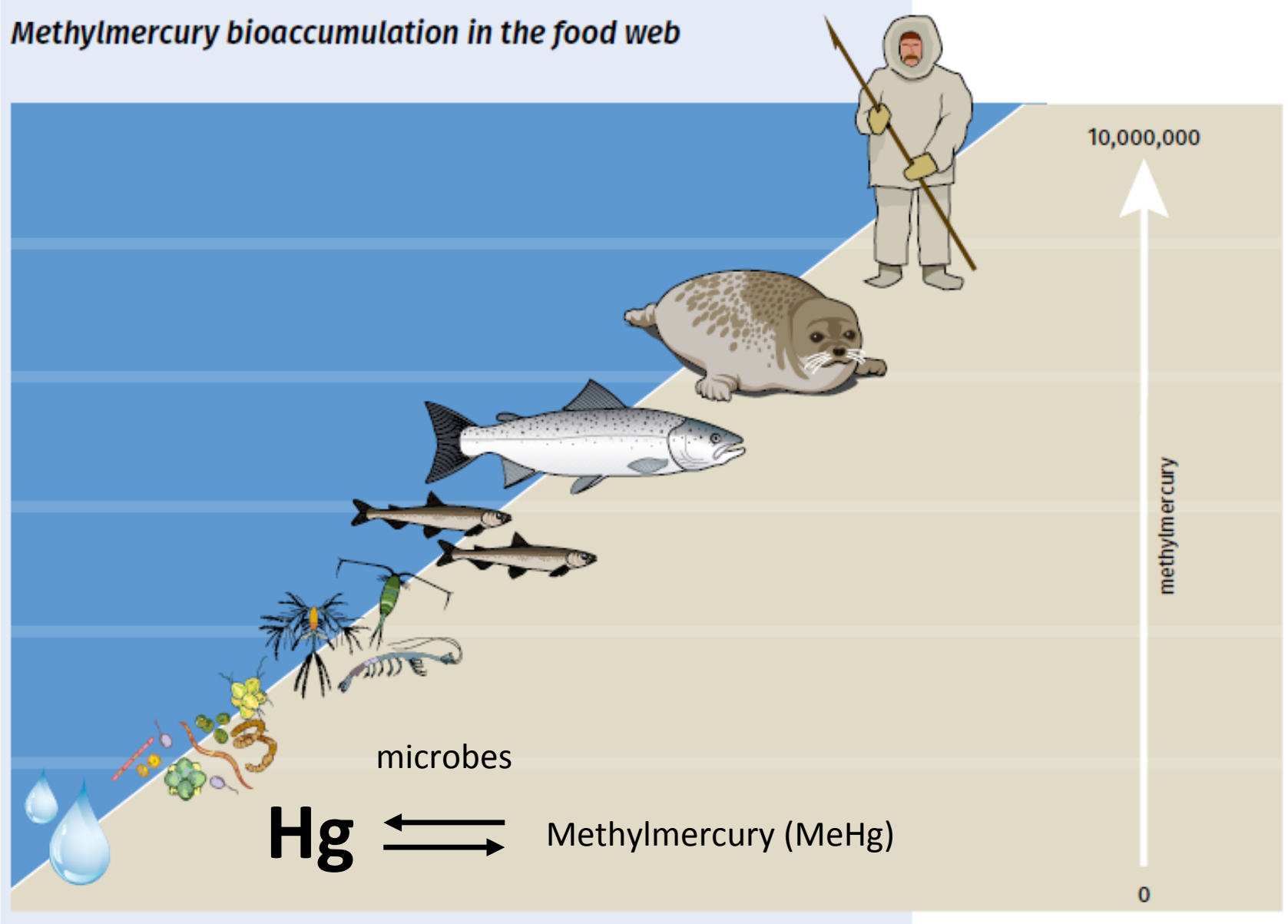

Rigolet
NUNATSIAVUT
SPECIAL INUIT
HARVESTING RIGHTS
Lake Melville
North West
River
Happy Valley-
Goose Bay
Mud Lake
MUSKRAT FALLS DAM
0 5 10 20 30 40
Kilometers

The form of mercury determines its health impact

- Inorganic mercury
  (i.e., quicksilver and Hg^{II})
  - Low absorption (0.01 – 7% avg)

- Methylmercury
  - High absorption (>90%)
  - Primarily a central nervous system toxin
  - Half-life of 50-70 days
  - Chelation not effective

Key Inuit concern - Methylmercury

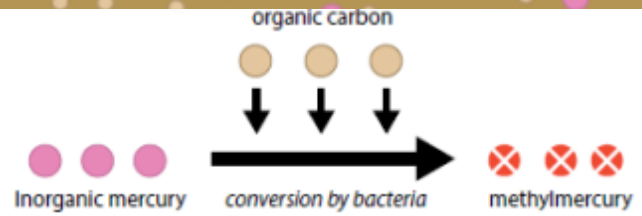


Hydro dams and mercury

Before flooding

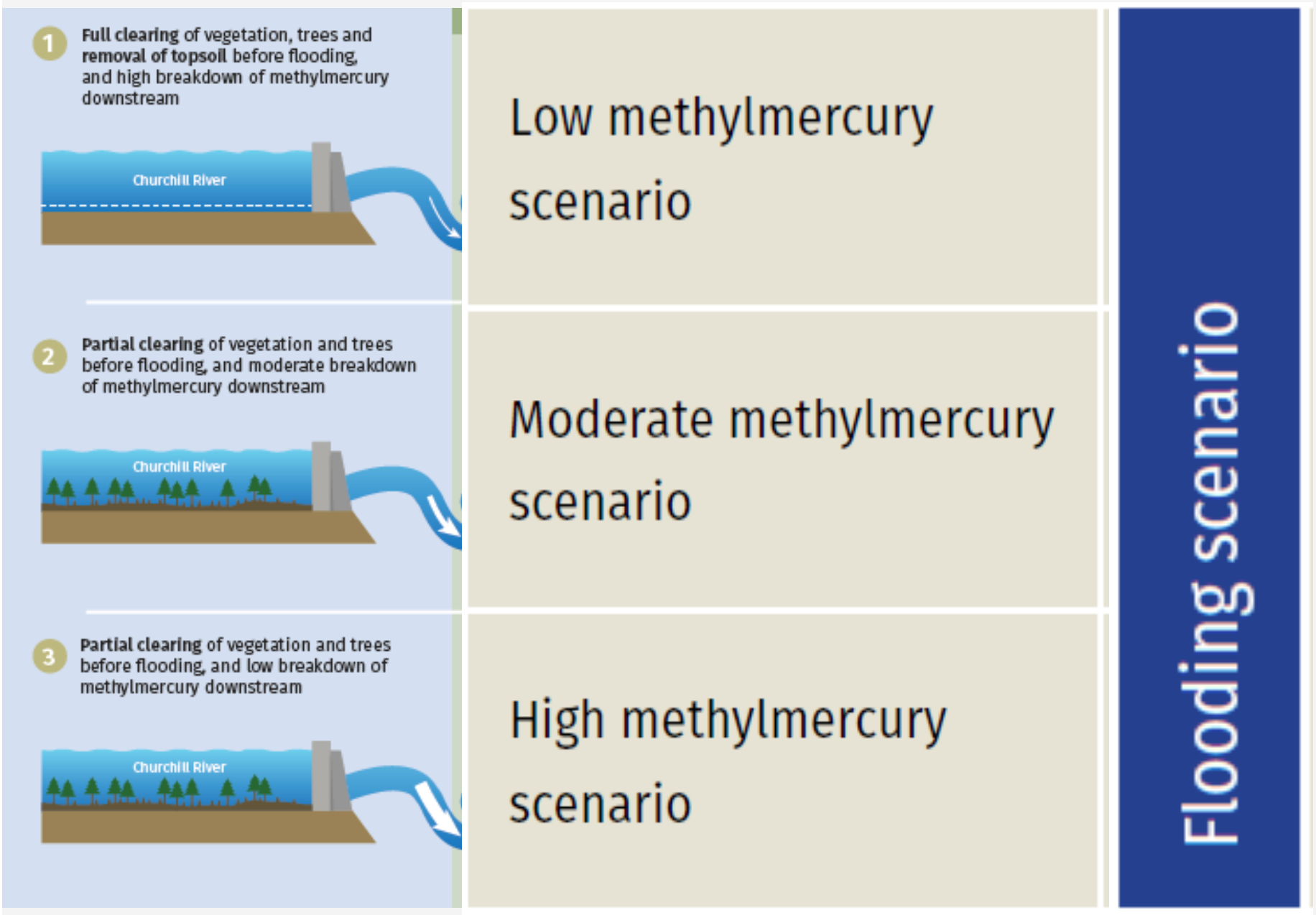
After flooding

Inorganic Mercury
Organic Carbon
Methylmercury



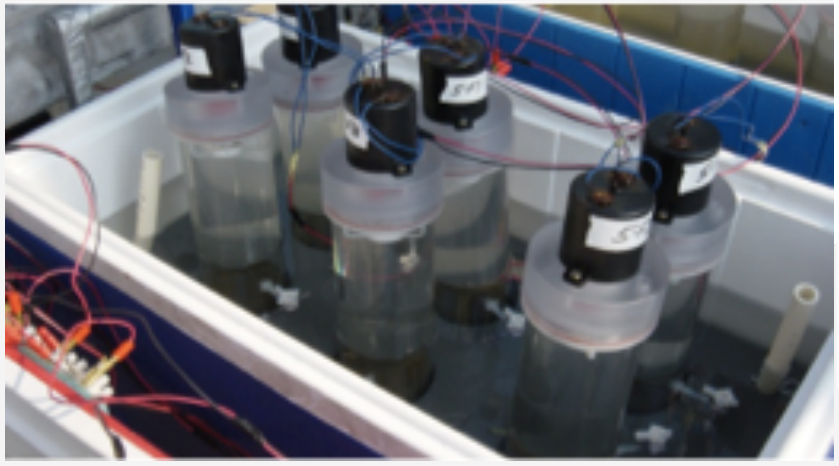
Components of impacts analysis

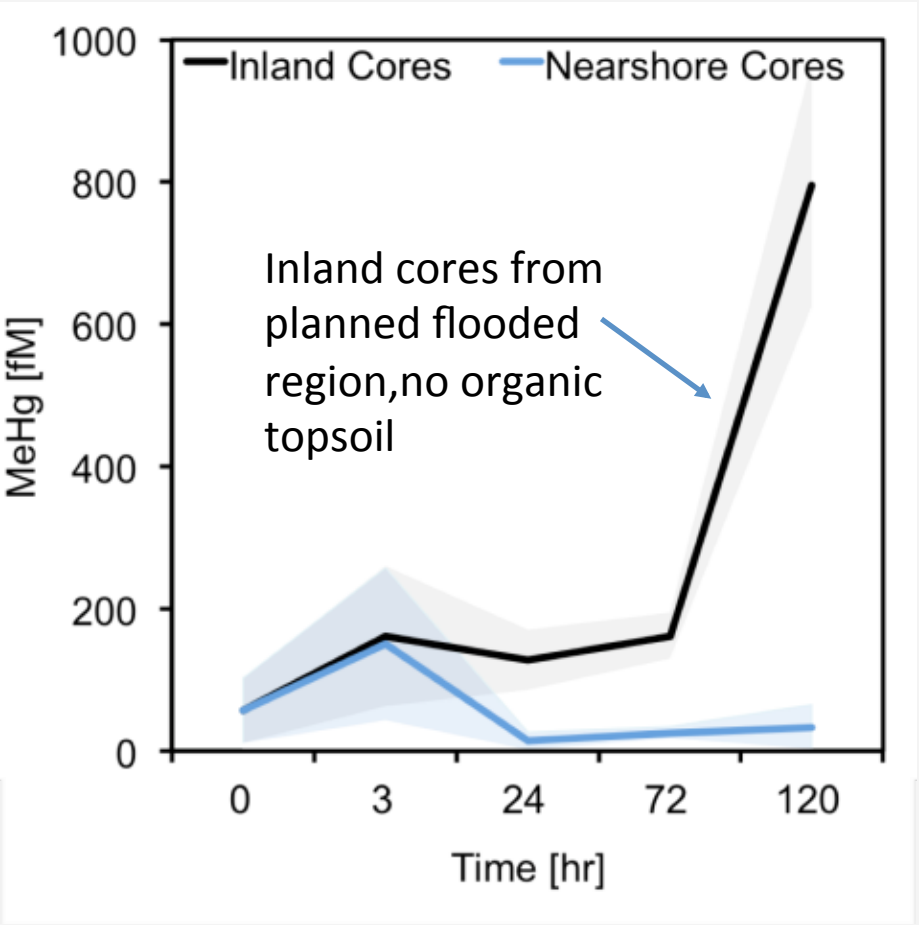
1. Pulse of methylmercury in the flooded reservoir
2. Transport and accumulation in the downstream environment (Lake Melville)
3. Enrichment of methylmercury in country foods (birds, fish, and seal)
4. Changes in Inuit exposures


1
Full clearing of vegetation, trees and removal of topsoil before flooding, and high breakdown of methylmercury downstream
Churchill River
Low methylmercury scenario
2
Partial clearing of vegetation and trees before flooding, and moderate breakdown of methylmercury downstream
Churchill River
Moderate methylmercury scenario
3
Partial clearing of vegetation and trees before flooding, and low breakdown of methylmercury downstream
Churchill River
High methylmercury scenario
Flooding scenario

MeHg in Flooded Reservoir Increases Rapidly

Rapid increase in methylmercury in river water above saturated soils 3-days after flooding

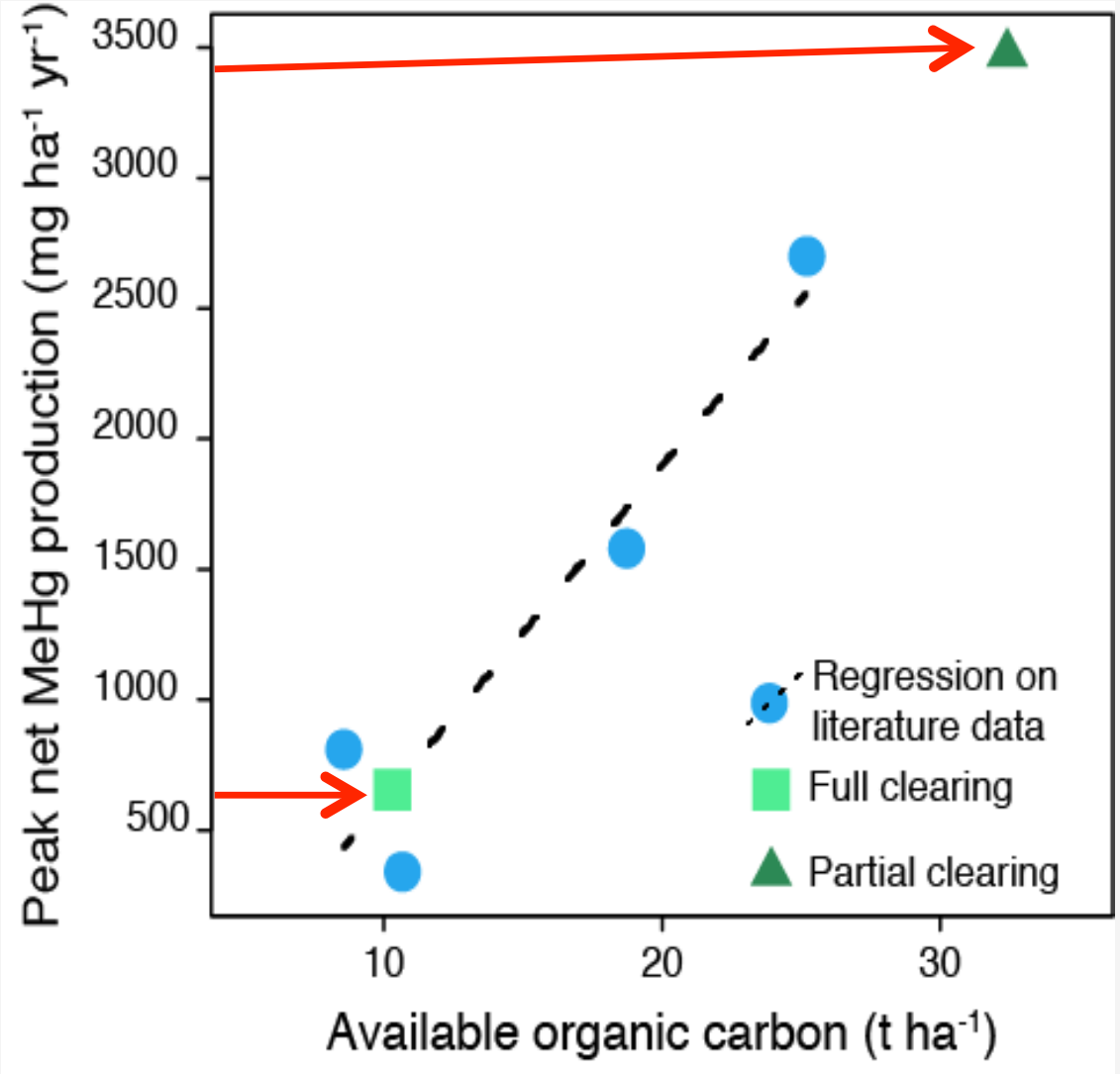




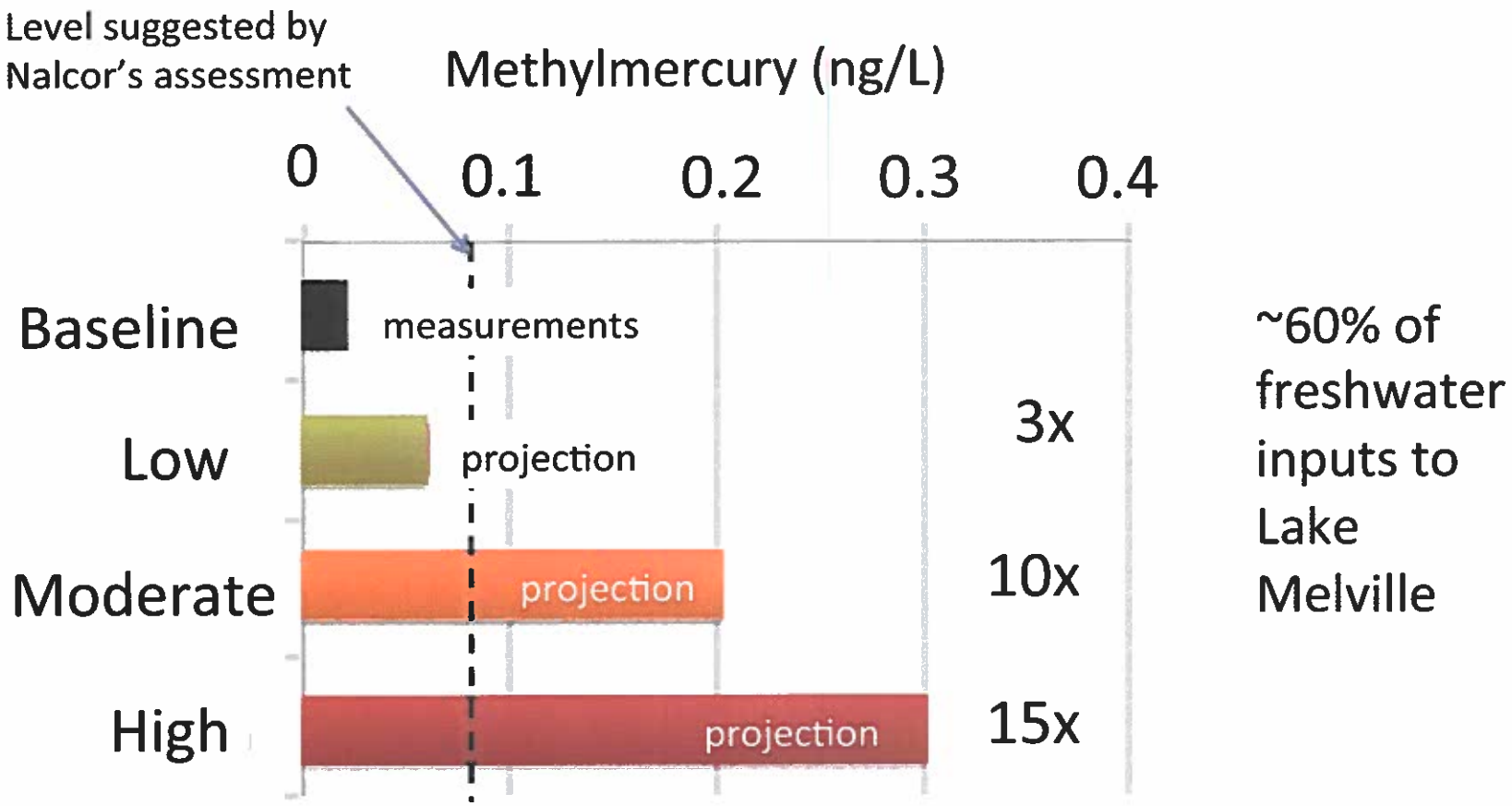
Schartup et al., 2015

Magnitude of Reservoir Methylmercury Pulse

Difference between full clearance (including topsoil) and partial clearance (underway)



Projected increases in reservoir methylmercury



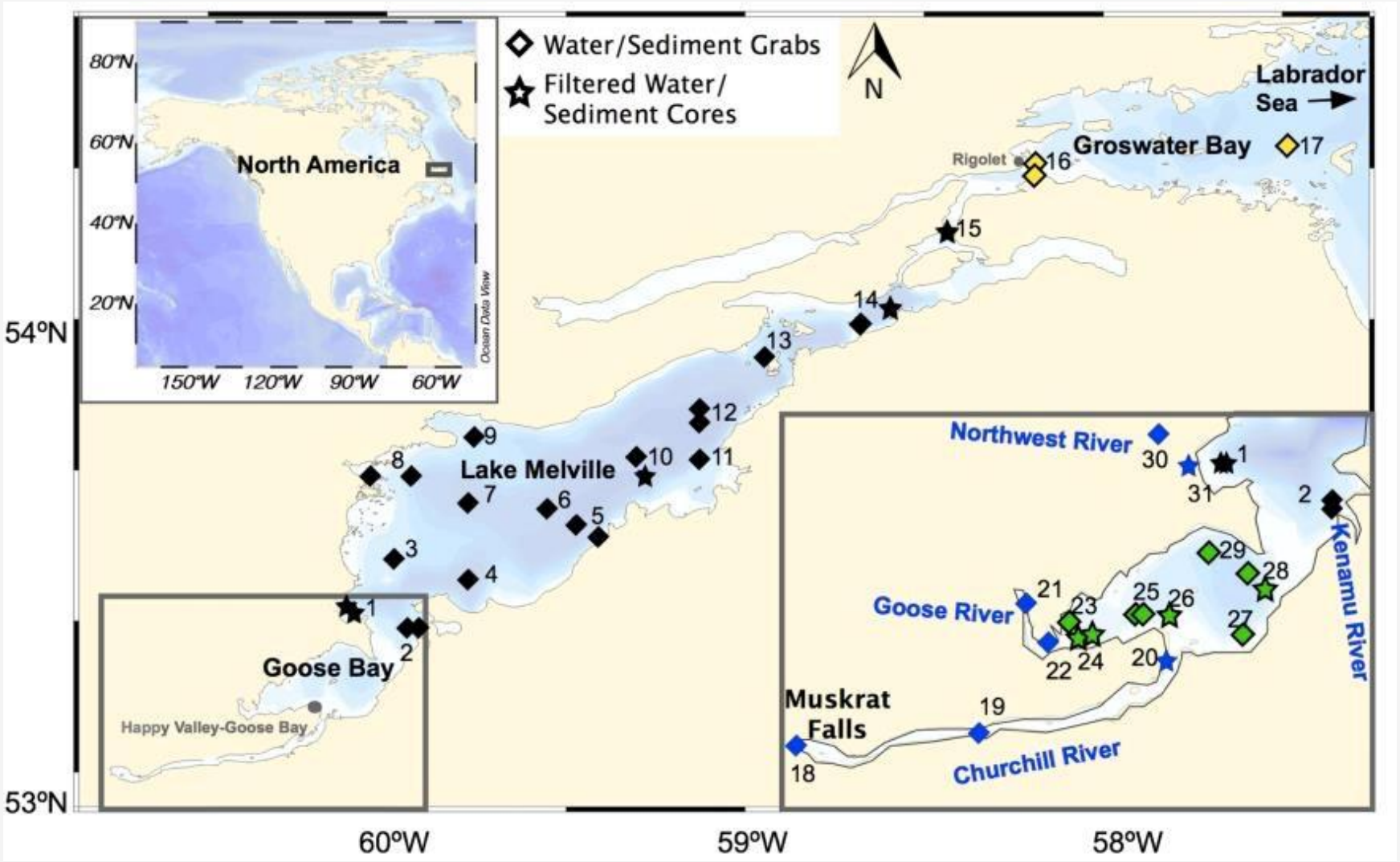
~60% of freshwater inputs to Lake Melville

Baseline data from Schartup et al. (2015); River measurements are ongoing

Components of impacts analysis

1. Pulse of methylmercury in the flooded reservoir
2. Transport and accumulation in the downstream environment (Lake Melville)
3. Enrichment of methylmercury in country foods (birds, fish, and seal)
4. Changes in Inuit exposures

Field sampling in Lake Melville (2012-2014)

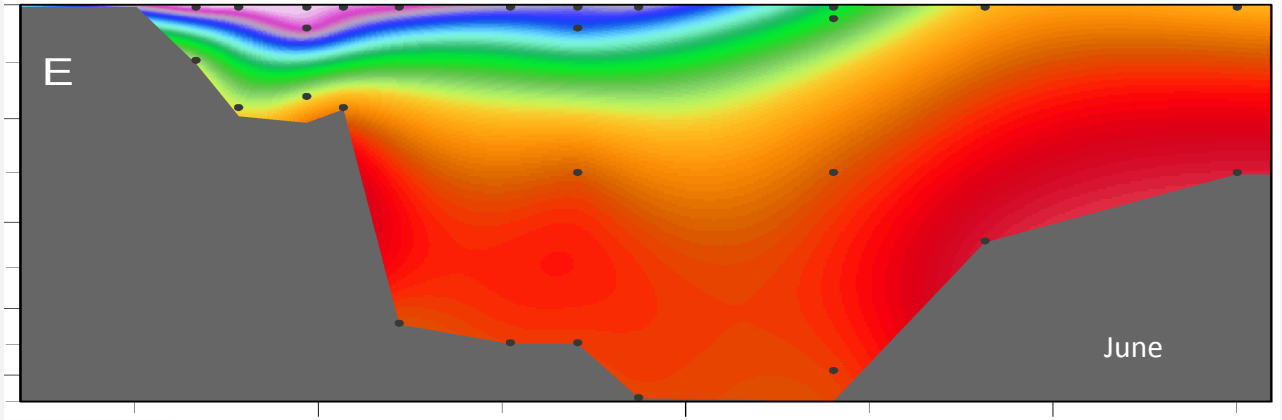


Mercury concentrated in surface layer

SALINITY:

Low

High

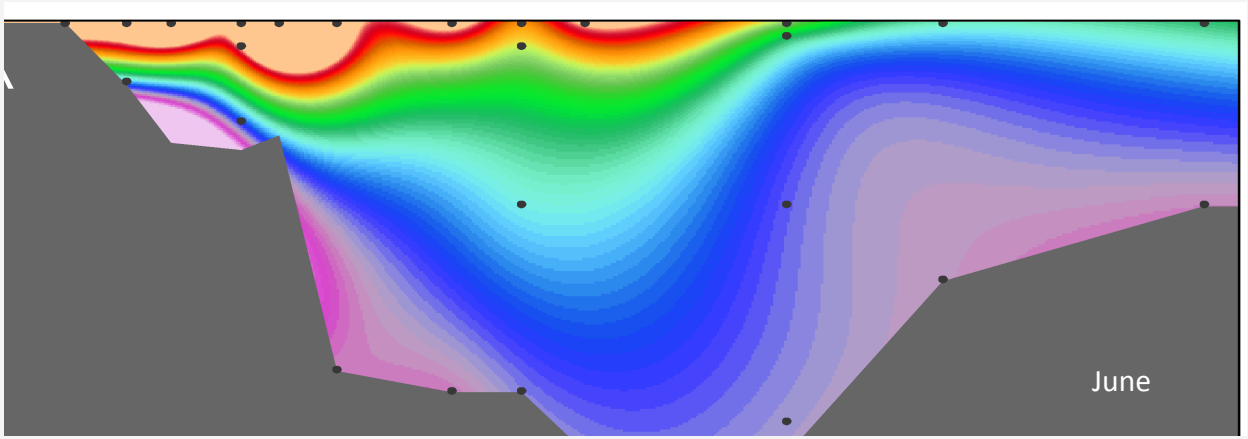


Freshwater layer

MERCURY:

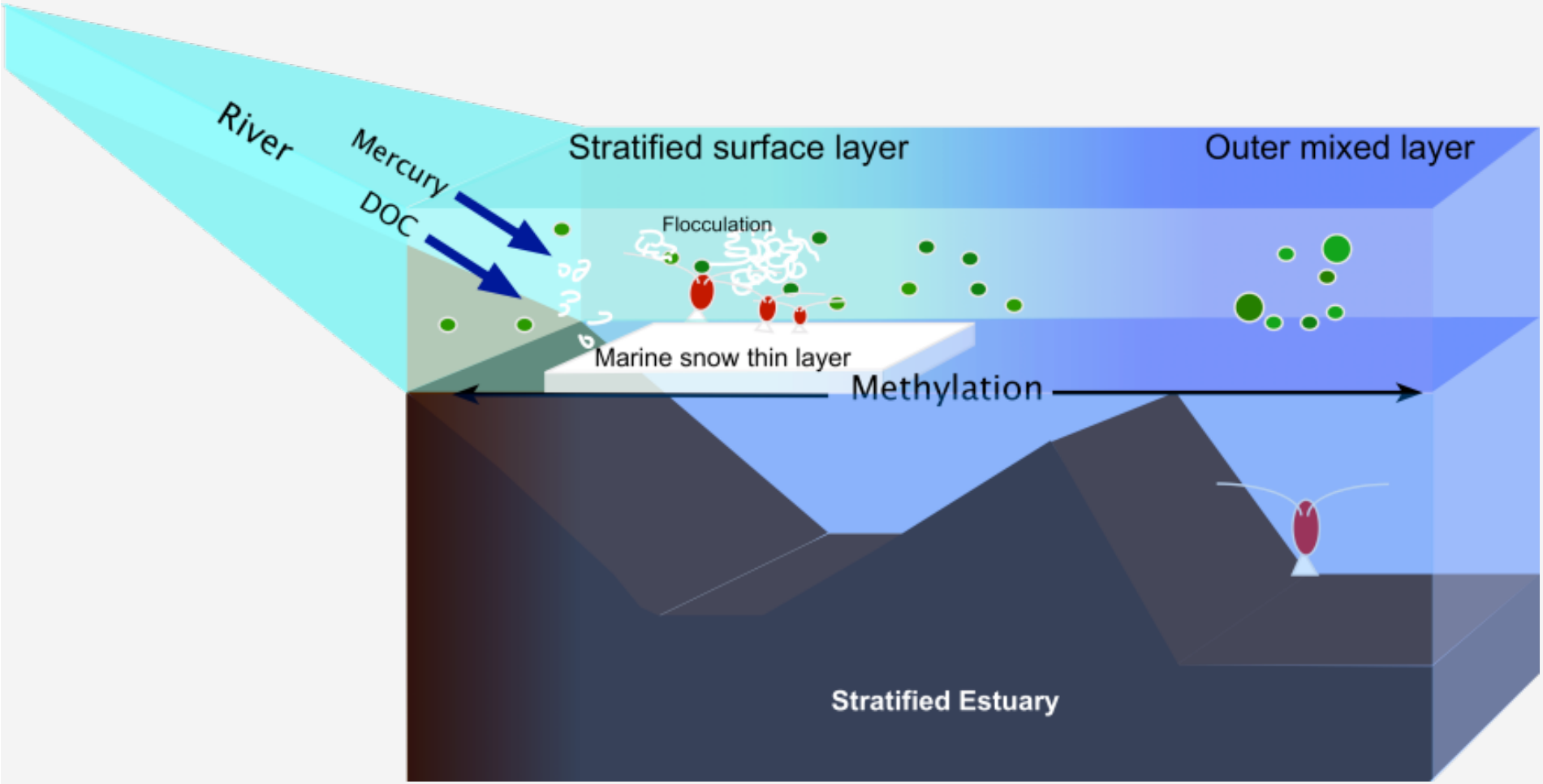
High

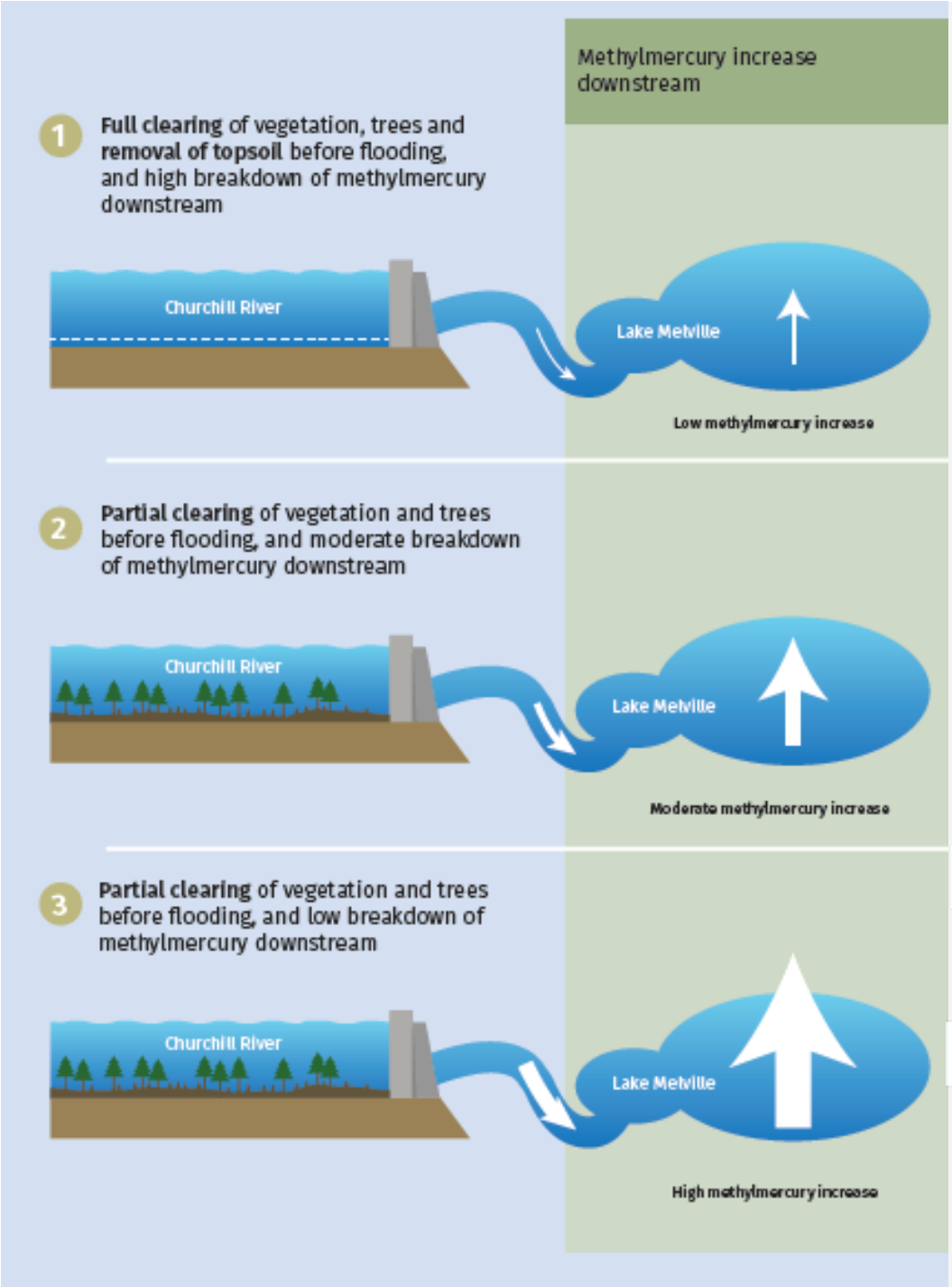
Low



Mercury enriched layer

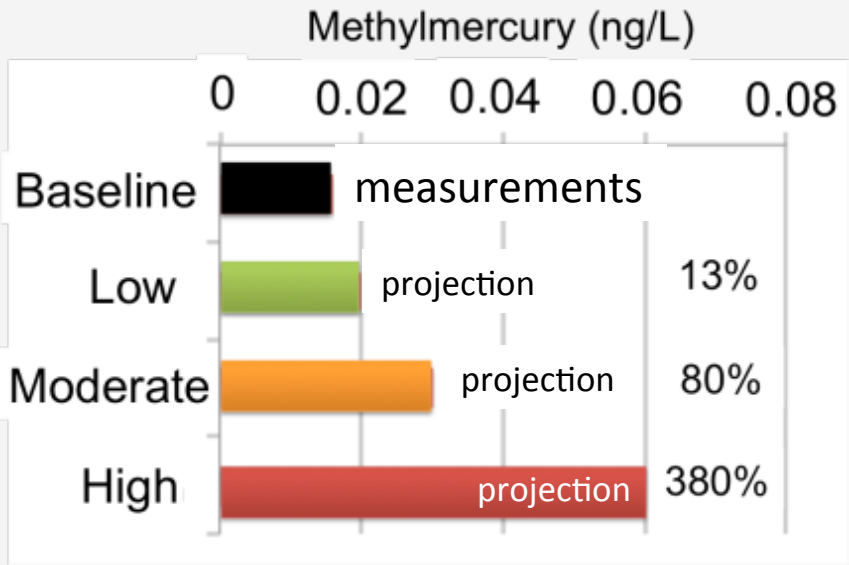
What is happening in the freshwater layer?





"*Lake Melville is not included within the Assessment Area as there will be no change in flow or salinity, water temperature, ice or other physical disturbance beyond the mouth of the Churchill River from this Project.*" (Nalcor Energy 2009)

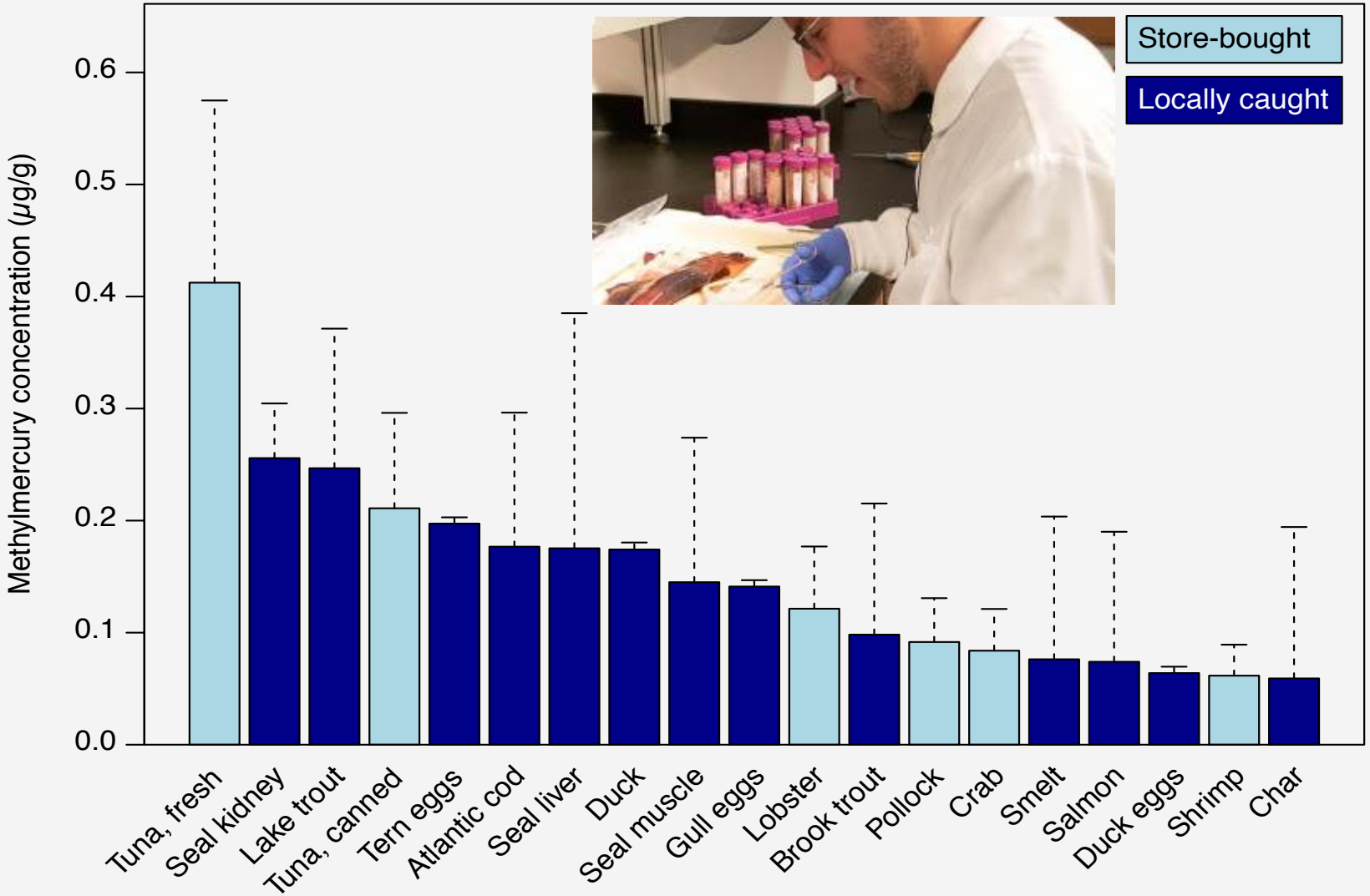
Increase in Lake Melville surface water methylmercury



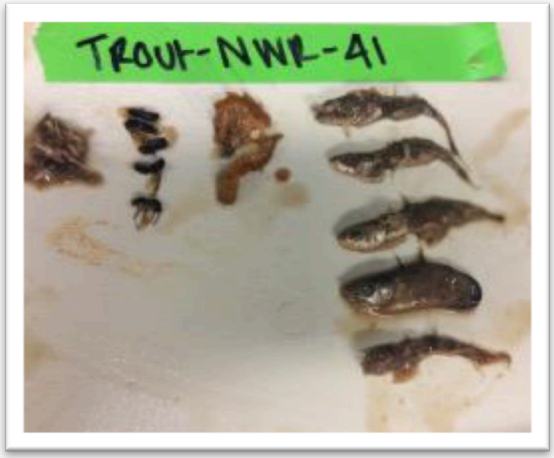
Components of impacts analysis

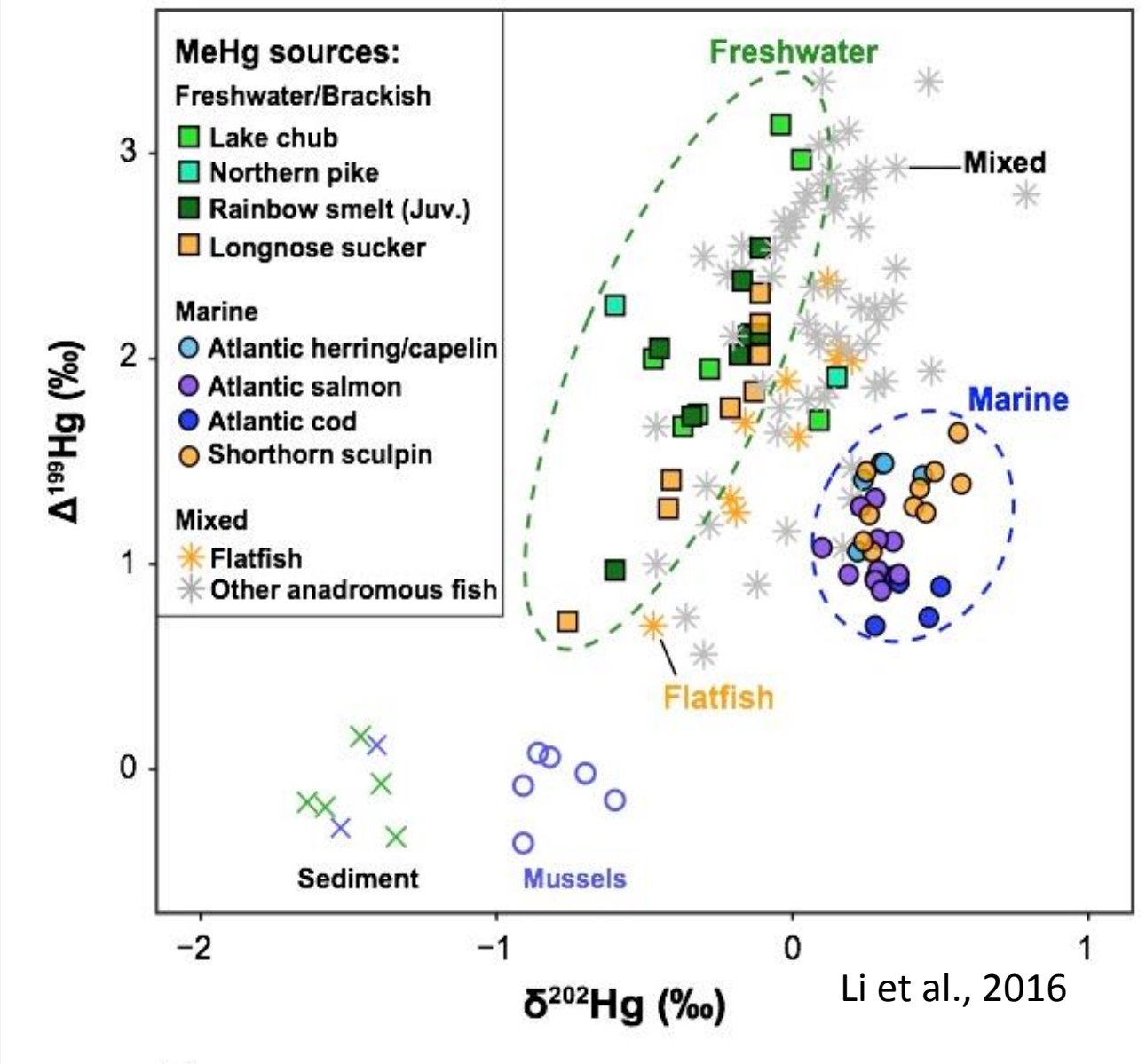
1. Pulse of methylmercury in the flooded reservoir
2. Transport and accumulation in the downstream environment (Lake Melville)
3. Enrichment of methylmercury in country foods (birds, fish, and seal)
4. Changes in Inuit exposures

Methylmercury in frequently consumed foods



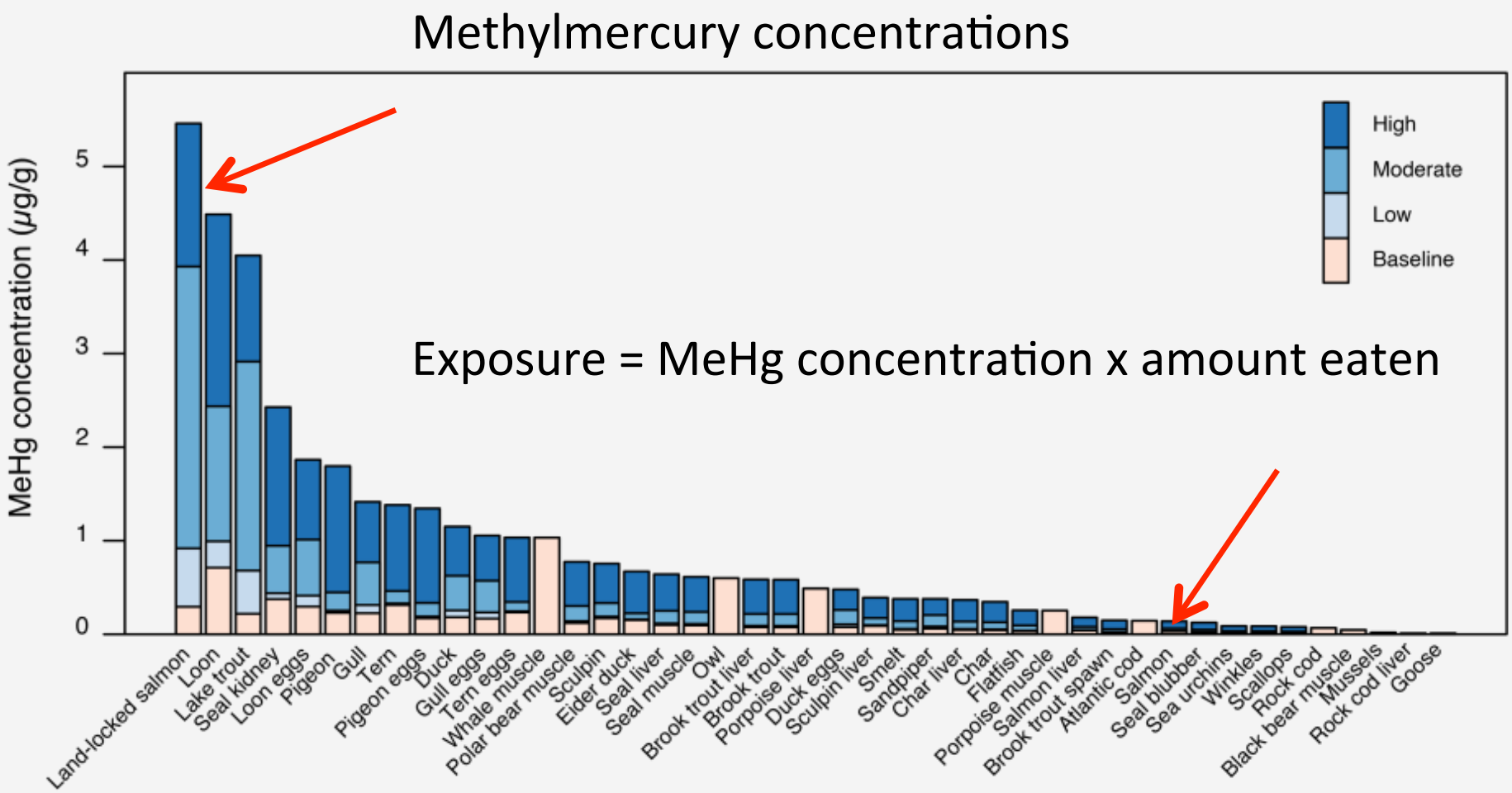
Extensive data on MeHg sources for fish





Li et al., 2016

MeHg change in country foods due to flooding



Components of impacts analysis

1. Pulse of methylmercury in the flooded reservoir
2. Transport and accumulation in the downstream environment (Lake Melville)
3. Enrichment of methylmercury in country foods (birds, fish, and seal)
4. Changes in Inuit exposures

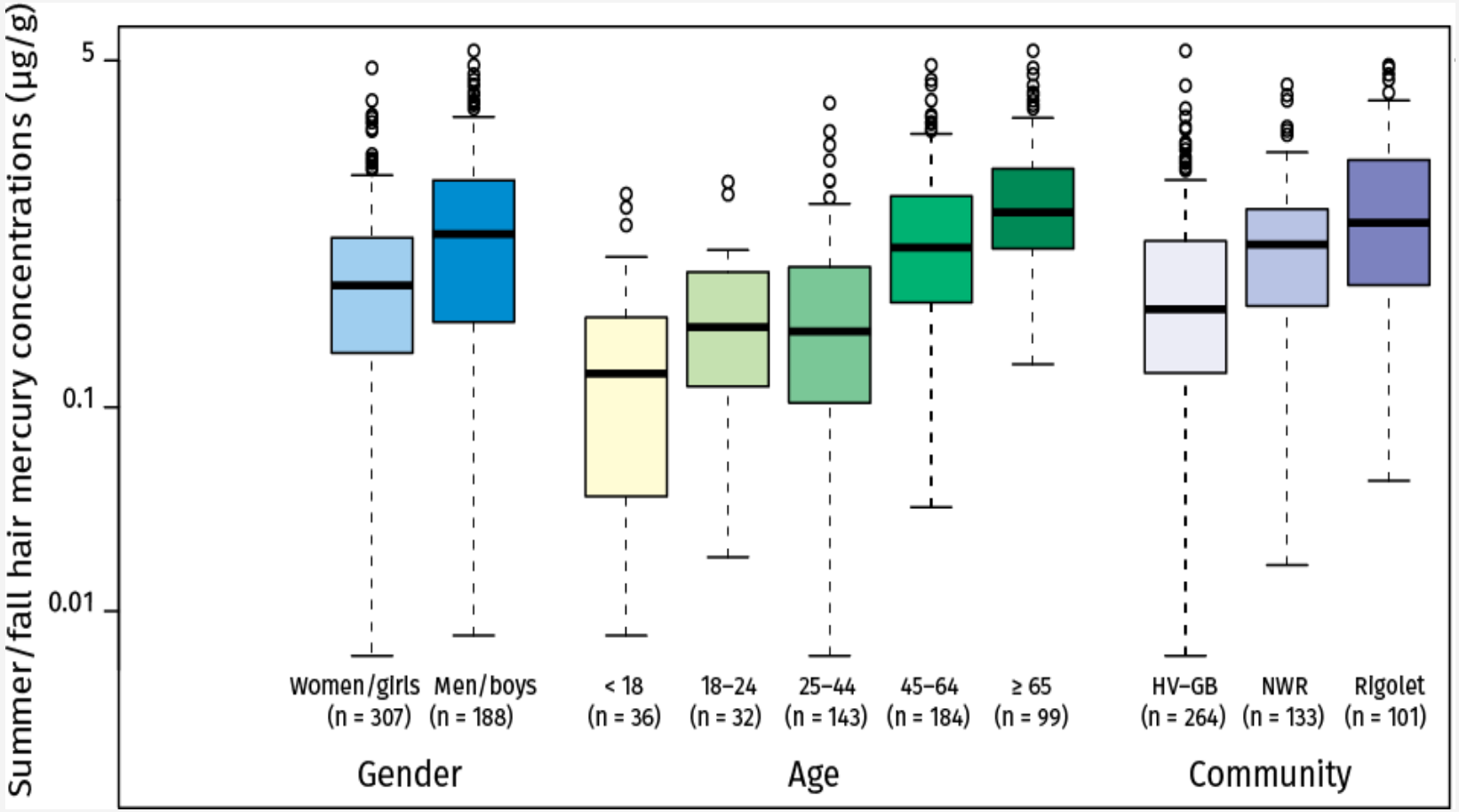
Variability in Inuit diet drives ranges in MeHg exposure

Community participation (n=1566):

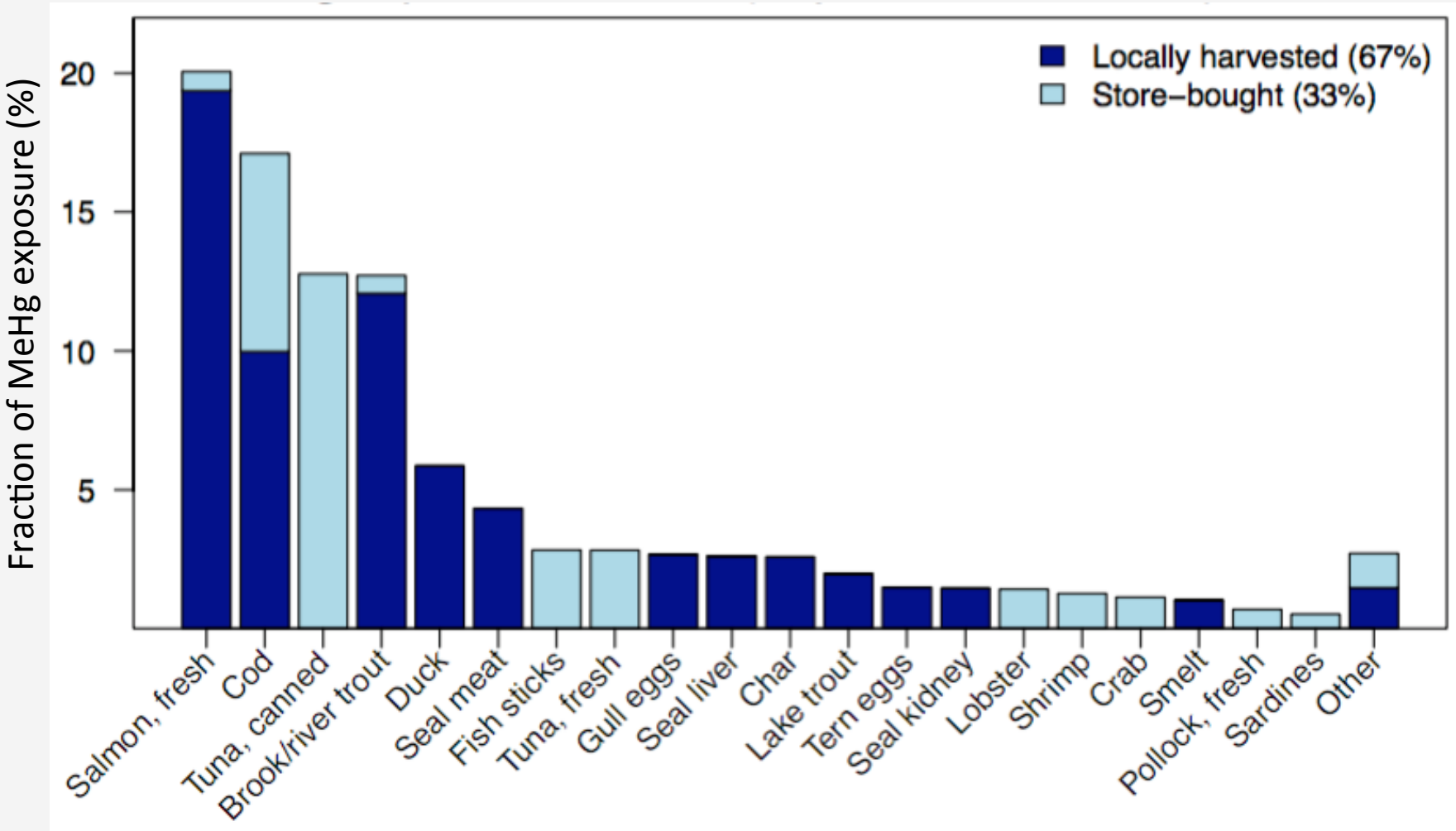
Rigolet = 87% (Nalcor survey = zero)

HV-GB = 32% (Nalcor survey = 38 Inuit + 83 non-Inuit, total = 2%)

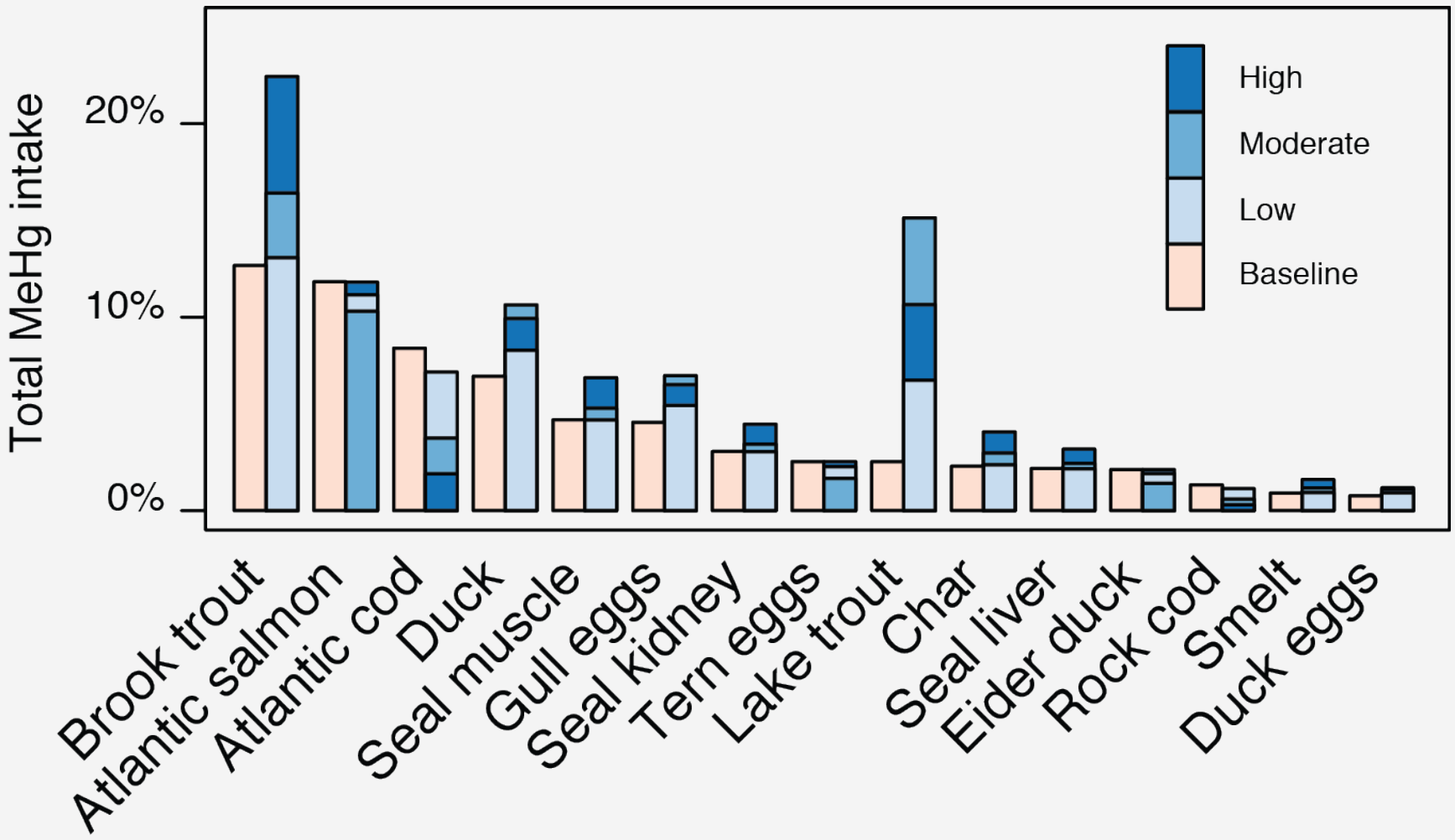
NWR = 44% (Nalcor survey = 30 Inuit + 23 non-Inuit, total = 10%)



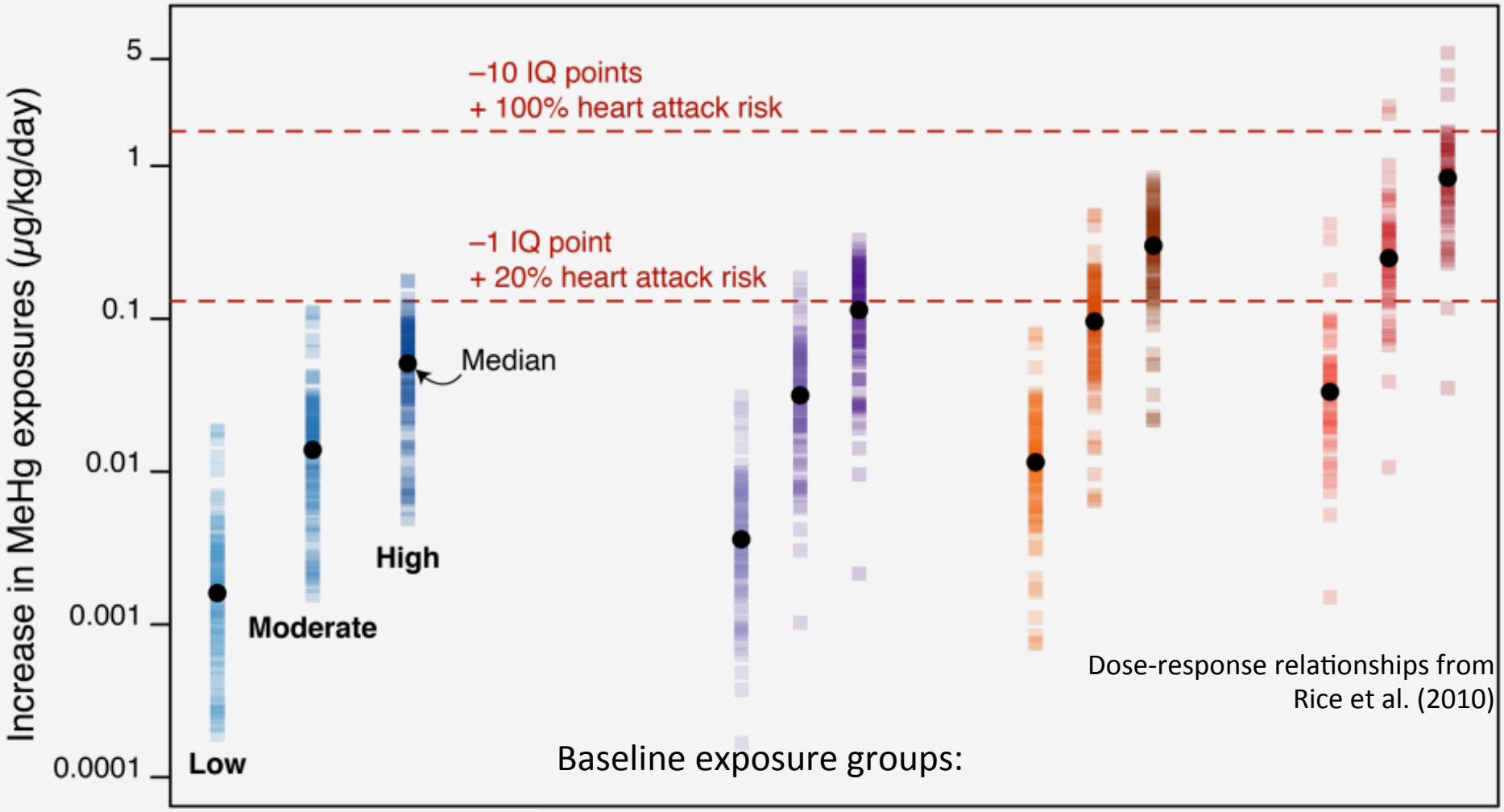
Country foods = 67% total methylmercury intake



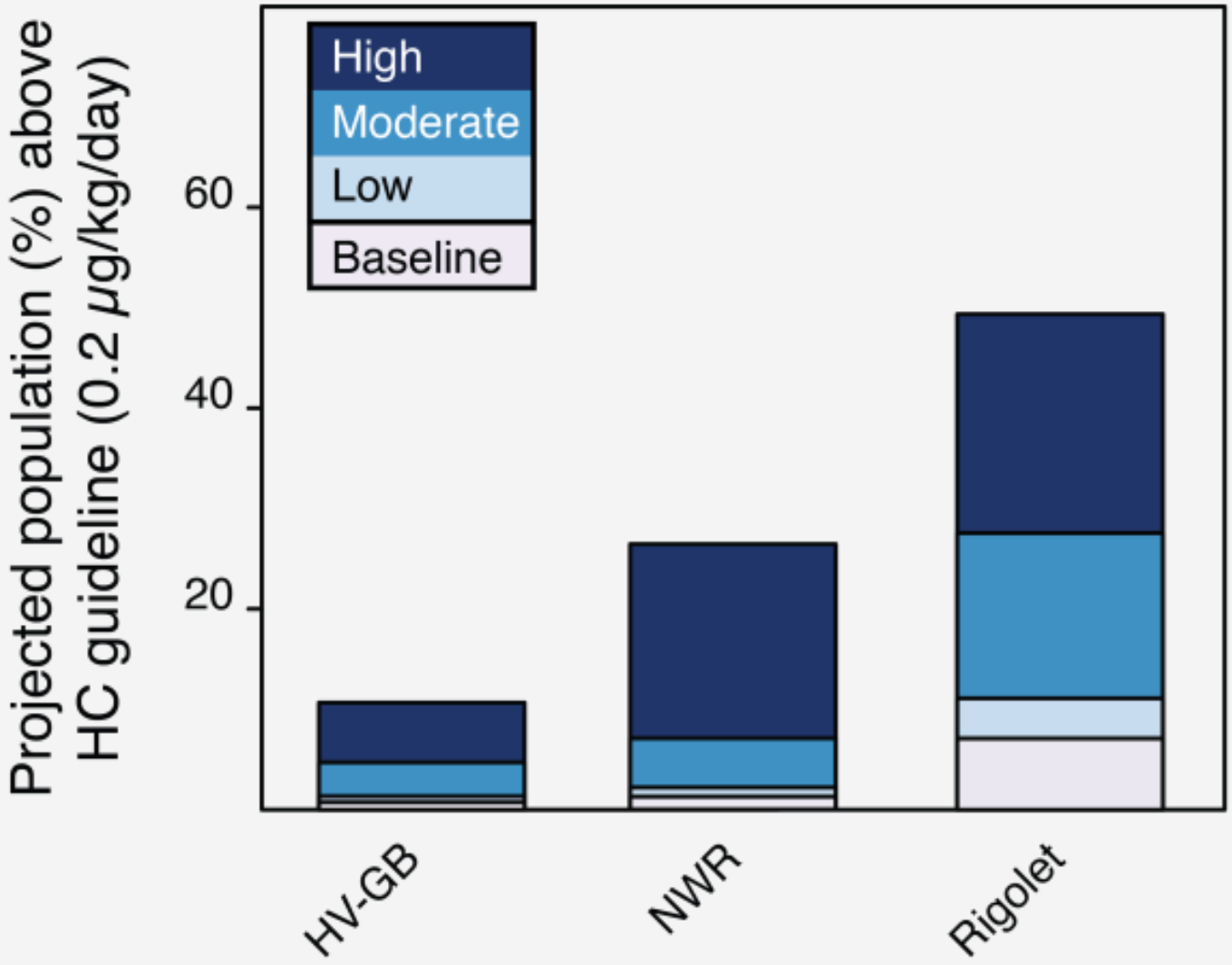
MeHg exposure change in Inuit due to flooding



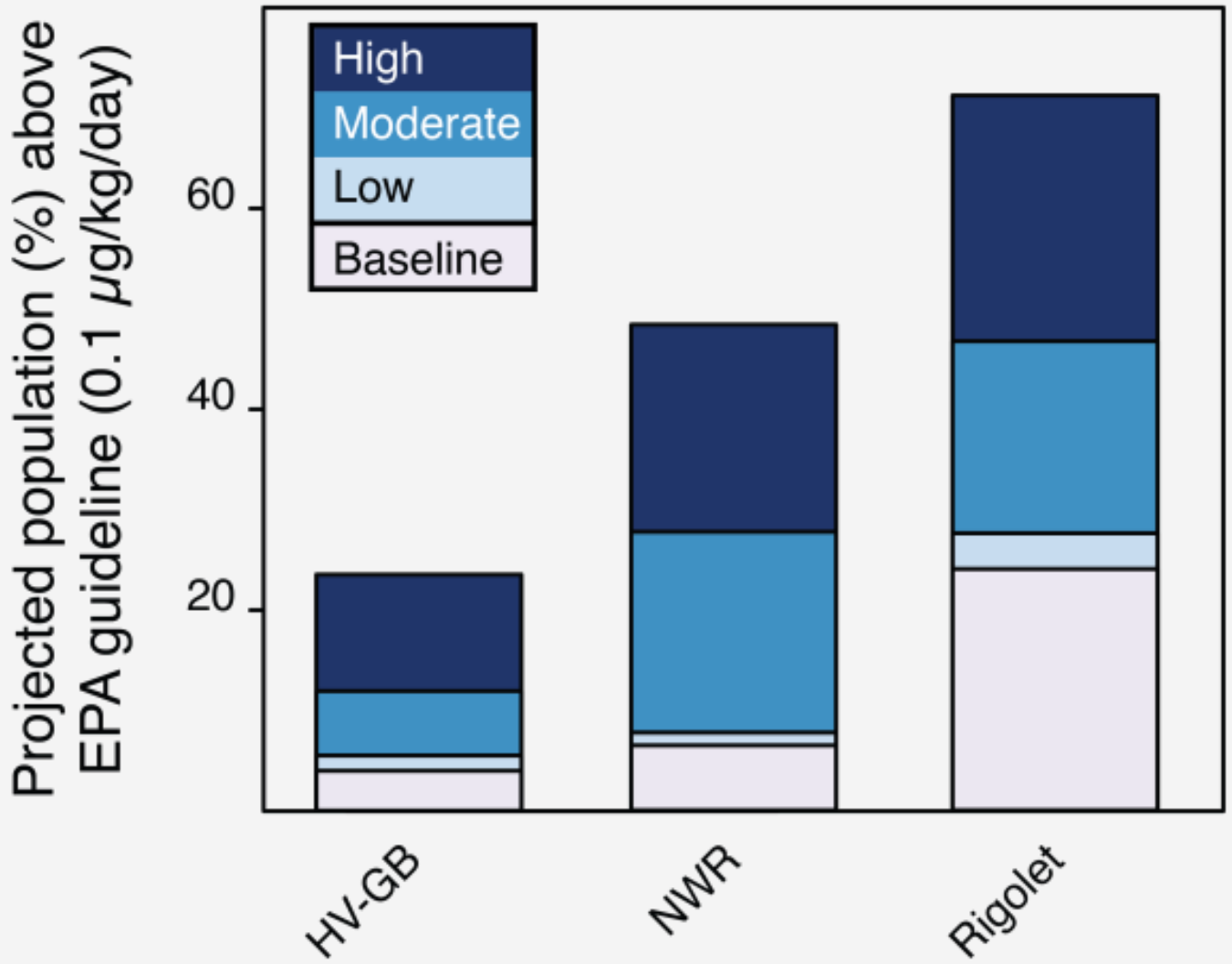
Highly exposed individuals disproportionately impacted



Fraction of Inuit > methylmercury guideline



Fraction of Inuit > methylmercury guideline



Acute toxicity possible

Number of individuals in each exposure range

MeHg intake (µg/kg/day)	Baseline	Low	Moderate	High
1 – 3	0	14	19	249
3 – 5	0	0	0	17
> 5	0	0	0	16

Comparison of Human Heath Risk Assessments: current exposure

Lake Melville (Harvard Univ.)

- >1000 participants
- Inuit or child/spouse of Inuit
- Diet survey & hair samples
- 3 seasons in 1 year (2014)
- With reservoir clearing
  - The expected number of Inuit exceeding national guideline will decrease by two-thirds

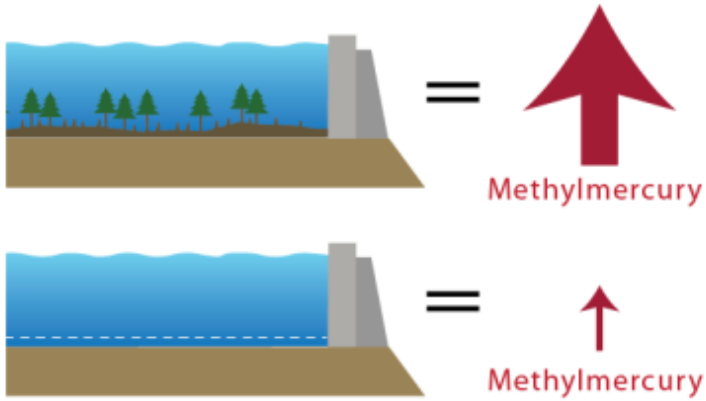
Nalcor Energy (Golder Assoc.)

- 293 participants
- 196/293 (66%) Aboriginal*
- Diet survey & hair samples
- Winter only (2014/15)
- No conclusions can be made about Inuit-specific future exposure or those most vulnerable

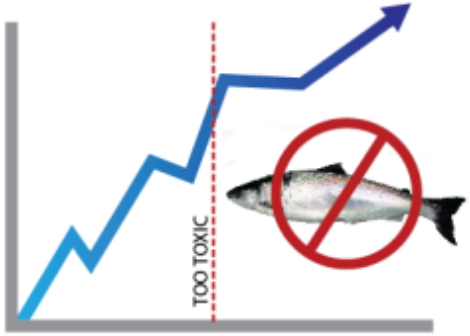
Nunatsiavut Government's science-based recommendations to Make Muskrat Right

Governments to require Nalcor to:

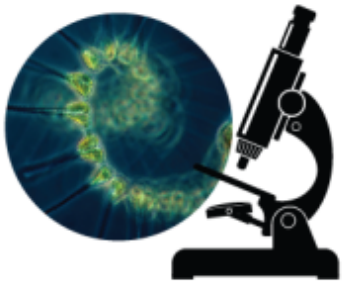
1. Fully clear the Muskrat Falls reservoir of wood, brush, vegetation, and topsoil before flooding to mitigate increases in methylmercury exposures for downstream Inuit populations, as recommended by the environmental assessment panel



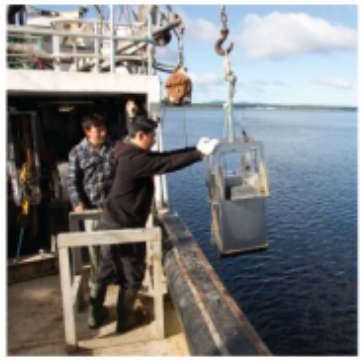
2. Negotiate an Impact Management Agreement with Inuit, as recommended by the environmental assessment panel



3. Establish an independent Expert Advisory Committee for advising on downstream monitoring and mitigation



4. Grant Inuit joint decision-making authority over downstream environmental monitoring and management



Newfoundland Labrador

Methylmercury Mitigation and Muskrat Falls: A discussion of Practical Solutions

Environmental Assessment Process – Lower Churchill

Newfoundland Labrador

- Registered on December 1, 2006.
- Numerous Departments/Agencies appointed to Assessment Committee.
- Joint Review Panel (JRP) established on January 8, 2009 to review Nalcor's Environmental Impact Statement.
  - Public hearings were held from March 3 to April 15, 2011.
  - Final Report released on August 25, 2011 with 83 recommendations, including:
    - Rec. # 4.5 – Full clearing of the Muskrat Falls reservoir.
    - Rec. # 6.7 – Assessment of downstream effects.
    - Rec. #13.9 – Possible requirement for consumption advisories in Goose Bay or Lake Melville.

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- Provincial government responded to the JRP report on March 15, 2012.
  - Rec. # 4.5 – Agree with principle but with limited opportunities to use the resource, and insignificant MeHg reduction, government supports partial clearing.
  - Rec. # 6.7 – Assessment of downstream effects is directed to DFO.
  - Rec. #13.9 – Accepted intent; if consumption advisories are required as a result of 6.7, then Nalcor should consult on further mitigation including potential for compensation.

Environmental Assessment Process - Lower Churchill

- The Project was released on March 15, 2012 subject to the *Lower Churchill Hydroelectric Undertaking Order*.
- Key conditions in Order are:
  - Environmental Protection Plan (EPP).
  - Environmental Effects Monitoring Plans (EEMP).
  - Environmental Monitoring and Community Liaison Committee.
- 26 EEMPs; 25 completed to date.

What is Methylmercury?

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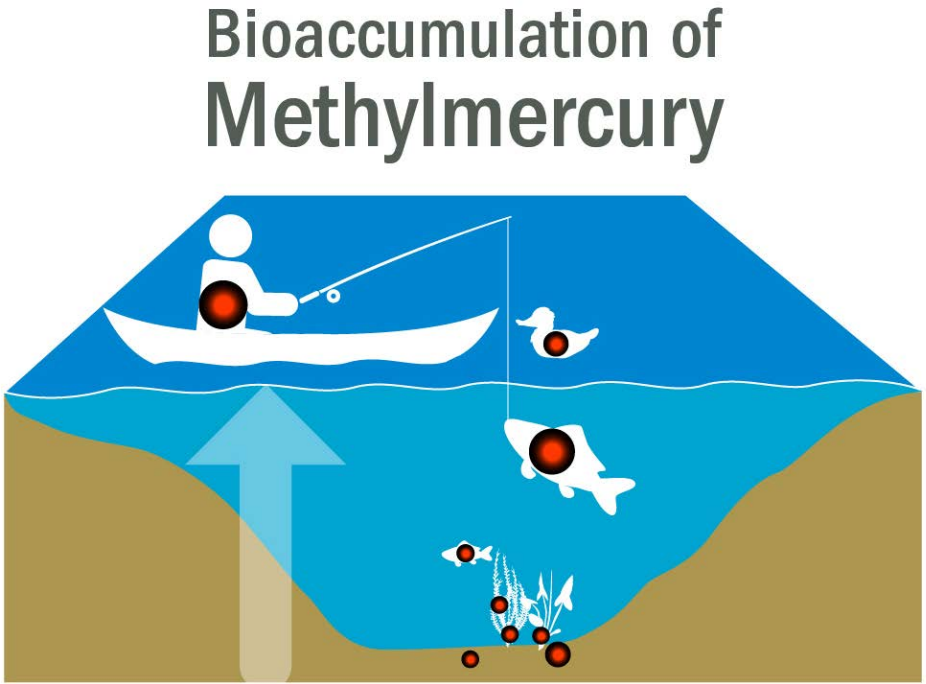

How does Muskrat Falls Project affect Methylmercury?

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- The river upstream of the dam will become a reservoir and land will be flooded. The newly flooded soil will release mercury into the water, some of which will be converted to methylmercury, for a number of years after flooding. For a while, therefore, fish may have more methylmercury in their bodies.
- This was a factor examined during the environmental assessment of the project.
- Downstream methylmercury effect not predicted by Nalcor to extend beyond Goose Bay.
- To ensure mitigation is in place to protect human health, a number of conditions were placed on Nalcor when the project was released that related to methylmercury.

What is the Human Health Risk Assessment Plan (HHRAP)?

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- The HHRAP submitted by Nalcor proposes to address conditions of the environmental release order, namely, environmental effects monitoring plans for:
  - methylmercury;
  - country foods; and
  - human health.

Key components:

- Dietary survey, and a human biomonitoring program (hair sampling).
- Objective to determine the potential human health effects of downstream exposure to methylmercury in fish and other country foods (e.g. seal, waterfowl).

HHRAP Decision

- Acceptance of the HHRAP dated April 12, 2016, with the following condition:
  - *Should downstream methylmercury monitoring identify the need for consumption advisories as a result of the project, Nalcor shall consult with relevant parties representing Lake Melville resource users. Based on the location of the consumption advisories these users could include Aboriginal Governments and organizations as well as other stakeholder groups. Following consultation, Nalcor shall provide reasonable and appropriate compensation measures to address the impact of the consumption advisory.*

Analysis and Key Considerations

- Scientific Workshop (March 22, 2016) Participants:
  - ENVC, NL-HCS, DFO, HC, Nalcor, Dillon Consulting, Reed Harris Environmental, OPE
  - Expertise included environmental health, food safety, ecological aquatic science, toxicology, health risk assessment, hydrology, environmental research, MeHg modelling and fisheries.
- Key findings:
  - Schartup et al. (2015) and Nalcor's modelling predicted similar results but there were differences in how far the effects would be detected downstream.
  - Removing all topsoil from the reservoir would have other potentially significant adverse environmental effects, including the elimination of fish habitat.
- NG facilitated research:
  - High quality work of renowned researchers.
  - The Schartup et al. (2015) study is noteworthy in providing insight into potential mechanisms for methylmercury production and uptake in Lake Melville.
  - The recent NG Scientific Report confirms that regardless of mitigation, monitoring for methylmercury is still necessary to ensure we protect human health.

Analysis and Key Considerations

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- Federal and provincial agency comments:
  - Health Canada finds HHRAP is acceptable and will review monitoring results.
  - Health and Community Services finds HHRAP is acceptable.

- Other key considerations:
  - CCME Aquatic Life guideline for methylmercury is 4 ng/L.
  - NG research predicts methylmercury levels of up to 0.06 ng/L.
  - The prediction is 66 times less than the Canadian guideline.

Full Clearing Analysis (Timber)

Newfoundland Labrador

- Full timber clearing:
  - Effectively the same reduction in methylmercury for either full and partial clearing, when compared to no clearing.
  - Safety concerns (i.e. working on steep slopes).

Full Clearing Analysis (Soil)

Newfoundland Labrador

- Soil clearing:
  - Environmental concerns (i.e. sedimentation, erosion).
  - Loss of fish habitat due to sterile reservoir.
  - Stripping 25 cm of accessible soil from half the flooded area = 5,000,000 m^3.
  - Monitoring still necessary.

Conclusion

- EA Process examined MeHg issues extensively
- Reservoir clearing was considered
- Key future mitigation is the HHRAP
- HHRAP includes downstream monitoring