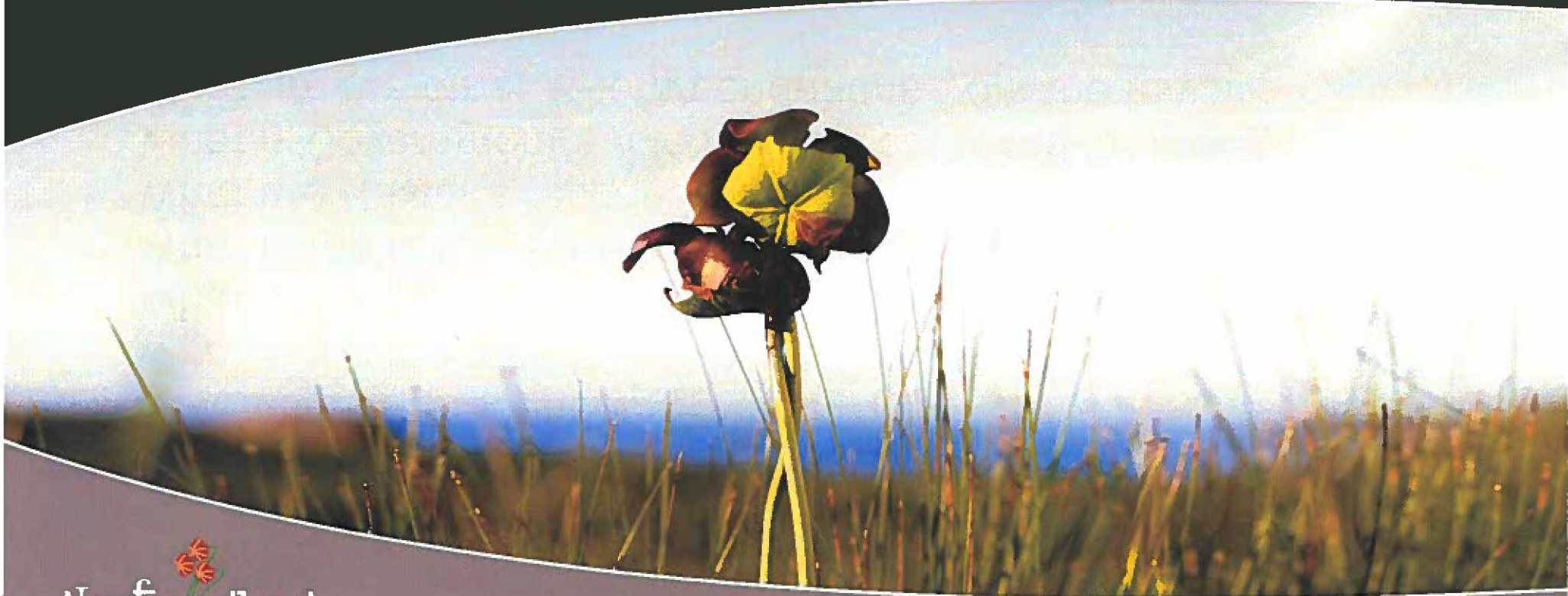


TAB 3

Technical Briefing: IEAC's Methylmercury Recommendations

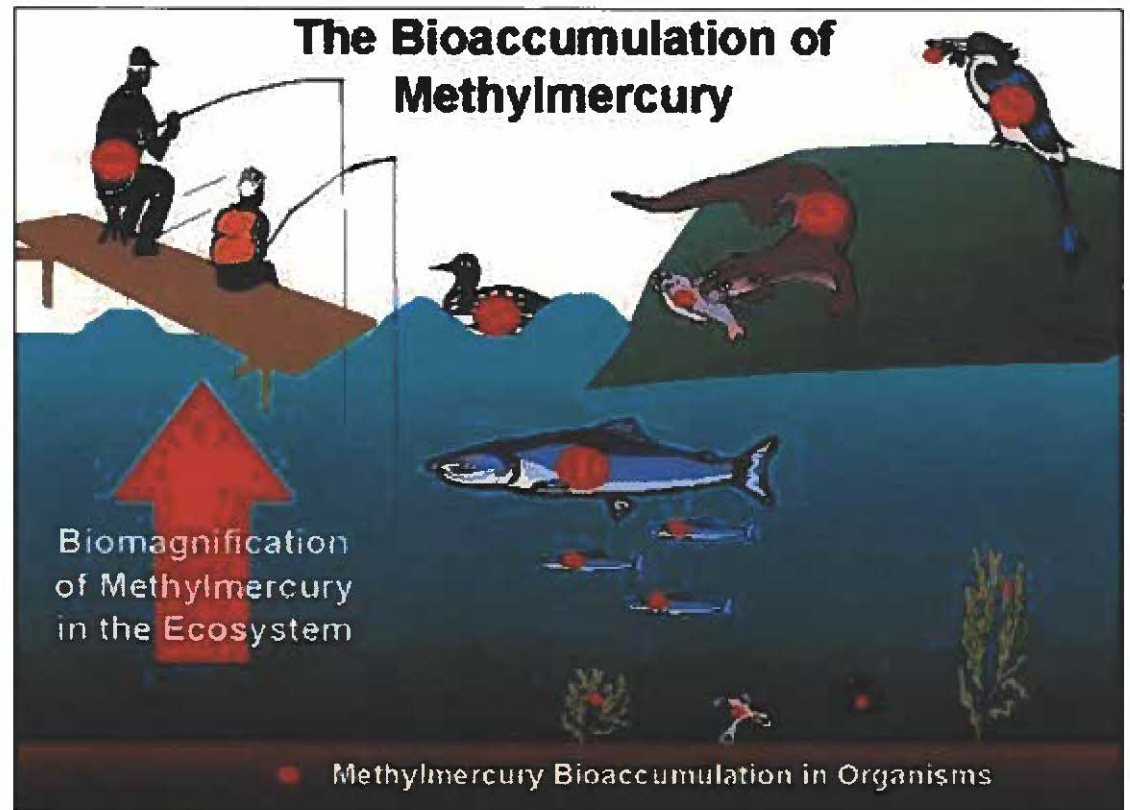


Overview

- What is methylmercury (MeHg)?
- How might it affect people's health?
- What is the Independent Experts Advisory Committee (IEAC)?
- What did the scientists tell us about MeHg at Muskrat Falls?
- What is the IEAC Recommendation for Mitigation?
- What are Nalcor's responsibilities for mitigating MeHg issues?
- What is Government's role in water sampling for MeHg?
- What are the other recommendations from the IEAC?
 - Monitoring
 - Impact Security Fund
 - Health Management

What is Methylmercury?

- Mercury occurs naturally in the environment (air, soil, and water)
- MeHg is formed from inorganic mercury by microbes.
- Newly flooded reservoirs provide nutrients.
- MeHg bio-accumulates in fish and bio-magnifies in the food web.



How might MeHg affect people's health?

- MeHg is almost completely absorbed by the gastrointestinal tract and is then readily distributed to all tissues including the brain and across the placenta.
- The developing nervous system is the most sensitive system affected by MeHg exposure; hence, infants and children, in whom the nervous system is developing, are at an increased risk of adverse health outcomes,.
- The primary concern about MeHg exposure at low doses is neurological effects.
- MeHg has a half life of 50-70 days.
- Exposure can be measured in hair samples.



Canadian MeHg Guidance Values

Group and age	Blood value µg/L	Corresponding hair value, µg/g	Recommended action
Pregnant Women Females, birth - 49 Males ≤ 18	< 8	< 2	No follow-up required
Pregnant Women Females, birth - 49 Males ≤ 18	8 - 40	2 - 10	Repeat hair/blood test in 6 months provide dietary advice
Pregnant Women Females, birth - 49 Males ≤ 18	> 40	> 10	Repeat hair/blood test immediately Schedule appointment with public health official
Females > 50 Males > 18	< 20	< 6	No follow-up required
Females > 50 Males > 18	20 - 100	6 - 30	Repeat hair/blood test in 6 months provide dietary advice
Females and males at any age	> 100	> 30	Repeat hair/blood test immediately Schedule appointment with public health official Refer to physician or medical toxicologist

Current Measured MeHg Hair Concentrations

- Population MeHg concentrations were measured in 2 surveys,
 - Golder & Associates, 2015 (contracted to Nalcor, using 293 participants),
 - Calder et al, 2016 (using 474 participants).
- According to C. Ollson, PhD, (2018, contracted IEAC), both surveys had very similar results.
- In Calder, one female exceeded the HC guidance value of 2 $\mu\text{g/g}$. One adult male exceeded 6 $\mu\text{g/g}$.
- No exceedances found in Golder survey.
- Majority of persons are well below HC guidance values.
- Average slightly higher than for Canada as a whole.
- Sensitive population (children, females) much lower on average.

What was the Independent Experts Advisory Committee?



- The Independent Experts Advisory Committee (IEAC) on methylmercury (MeHg) was mandated at the meeting of Oct 25/26, 2016 between the Premier and leaders from three Indigenous groups.
- Structure agreed to included an oversight committee (IEAC) and a scientific sub-committee (Independent Experts Committee – IEC).
- The Committee would include representation from 3 Indigenous groups, Province, Canada, Nalcor, and area municipality reps.
- Terms of Reference and budget of approx. \$700,000 was agreed.
- The task of the IEAC as it was agreed was:
 - To oversee and provide independent assessment of the adequacy of mitigation, monitoring and management measures, and provide recommendations to the Responsible Ministers with respect to those and addition of any further such measures for the protection of the health of the Indigenous and local population impacted by the Lower Churchill Project, and in particular increases of methylmercury in country foods in the Churchill River near Muskrat Falls and downstream, all along the river and including Lake Melville.

IEAC Mandate

- The protection of the health of the Indigenous and local populations will guide the work of the IEAC. The mandate of the IEAC was:
 - to use the best available peer reviewed science and Indigenous knowledge, and may consider other relevant research only in addition to and not instead of the above-mentioned peer reviewed science, to assess and recommend options for mitigation of methylmercury impacts, including but not limited to discussing the feasibility, necessity and potential impacts of further clearing of the Muskrat Reservoir;
 - to review the plans for monitoring, monitoring results and key findings arising from research and monitoring, about or relevant for mitigation of methylmercury impacts; and,
 - to direct the research activities and recommend the design of new monitoring and mitigation measures for the protection of the health of Indigenous and local populations.

IEAC Membership

IEAC Staff

Dr. Ken Reimer – IEAC Chair

Marina Biasutti-Brown – Research Director

Roxanne Mitsuk – Senior Administrative Assistant

Oversight Committee Members and Alternatives

Greg Nuna, *Peter Penashue, Donna Paddon, Cathy Guirquis* – Innu Nation

Carl McLean, *Rodd Laing* – Nunatsiavut Government

George Russell, *Brigid Rowan* – NunatuKavut Community Council

Peter Madden, *David Haley* – Nalcor Energy

David Kieser, Mayor NW River, (*Jamie Snook, Mayor HVGB originally*) – Area Municipalities

Abla Hanna, *Jennifer Dorr, Isabelle LaPorte* – Government of Canada

Martin Goebel, *Haseen Khan* – MAE, Government of NL

Scientific Sub-Committee (IEC)

Scientists (Western Knowledge)

Dr. Jane Kirk (Environment Canada) – NG

Dr. Trevor Bell (MUN) – NG

Dr. Wolfgang Jansen (North/South Consultants) – IN

Dr. David Lean (Lean Environmental) – NCC

Dr. Maureen Baike, MD (Health Canada) – Municipalities

Mr. James McCarty (Amec Foster Wheeler) – Province

Traditional Knowledge Experts

Mr. Stewart Michelin – NunatuKavut Community Council

Mr. Dave Wolfrey – Nunatsiavut Government

Mr. Etienne Pone – Innu Nation

What were scientists telling us about MeHg at Muskrat Falls?



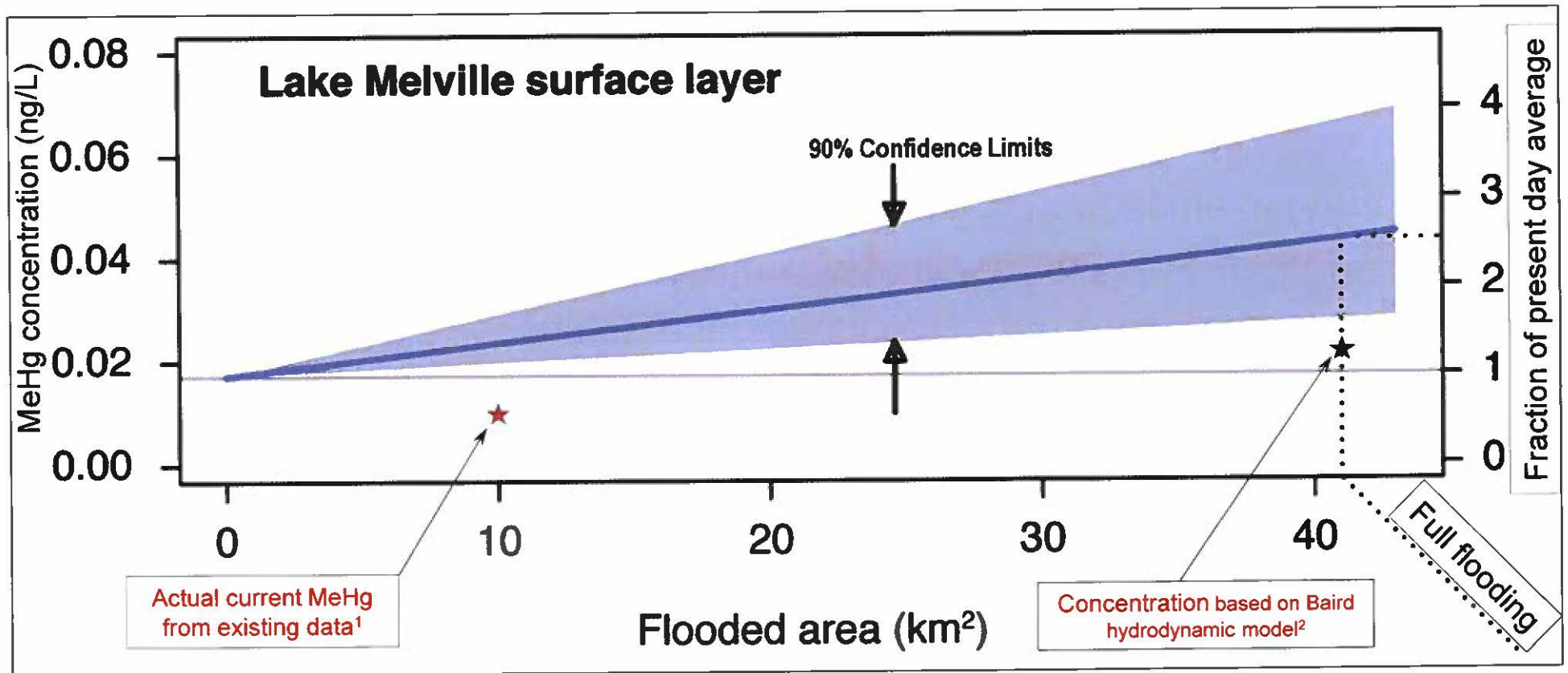
Calder et al, (formerly Harvard University):

- Peak MeHg production in reservoir increased to 0.19 ng/L
- Up to 4-fold increase of MeHg in L. Melville (from 0.017 to 0.069 ng/L)
- 195% increase in MeHg exposure among 95th percentile of females and children <12 years old. (from 0.19 to 0.56 µg/kg BW/day)

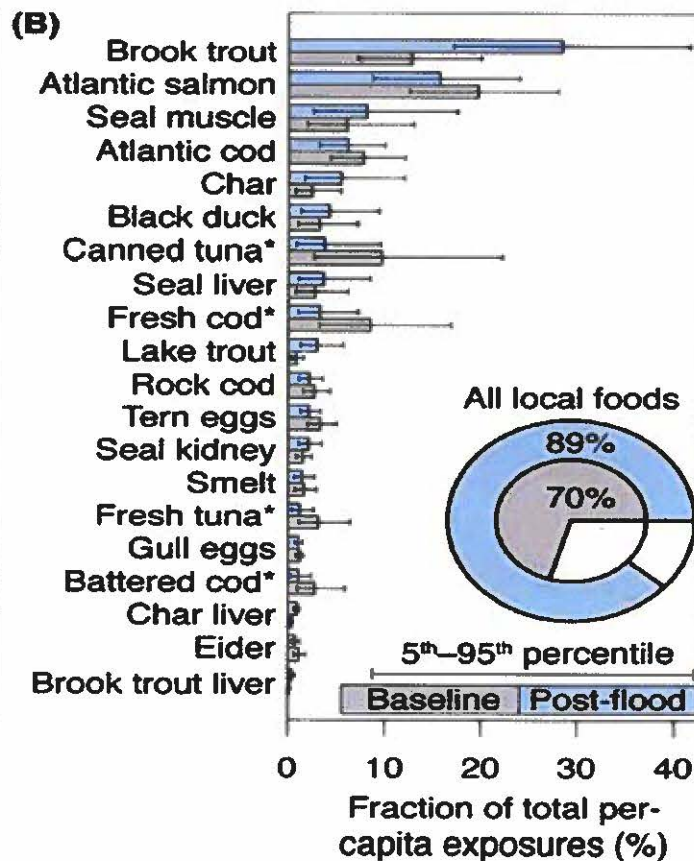
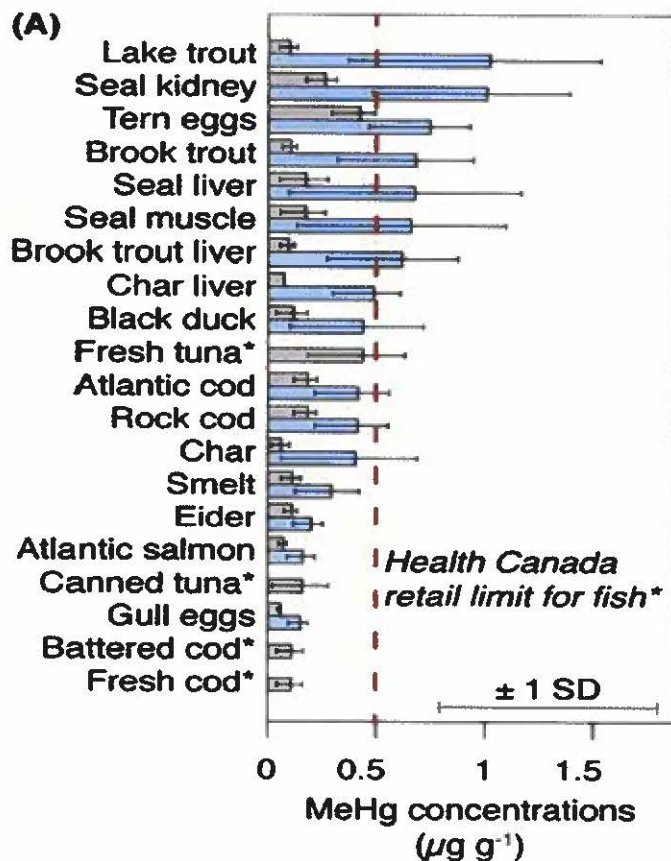
Nalcor scientists:

- 1 year average concentration in reservoir 0.067ng/L.
- Effect not expected to extend beyond mouth of Churchill River.
- No human exposure predictions made.

Calder's MeHg Increase Prediction



How Increased MeHg Affects Country Foods (Calder 2016)





Summary of predicted increases in MeHg in muscle tissue concentration (J. McCarthy, Wood Environment and Infrastructure Solutions, July 2018)

Species	Goose Bay			West Lake Melville			East Lake Melville		
	Predicted MeHg Increase	Baseline MeHg (mg/kg)	Predicted MeHg Concn. (mg/kg)	Predicted MeHg Increase	Baseline MeHg (mg/kg)	Predicted MeHg Concn. (mg/kg)	Predicted MeHg Increase	Baseline MeHg (mg/kg)	Predicted MeHg Concn. (mg/kg)
Brook Trout	1.78x	0.07	0.125	1.25x	0.04	0.050	1.20x	0.03	0.036
Rainbow Smelt	2.12x	0.02	0.043	1.50x	0.02	0.030	1.46x	0.04	0.058
Ringed Seal Tissue	1.32x	-	-	1.21x	0.13	0.157	1.21x	0.13	0.157
Ringed Seal Liver	1.32x	-	-	1.21x	13.42	16.24	1.21x	13.42	16.24

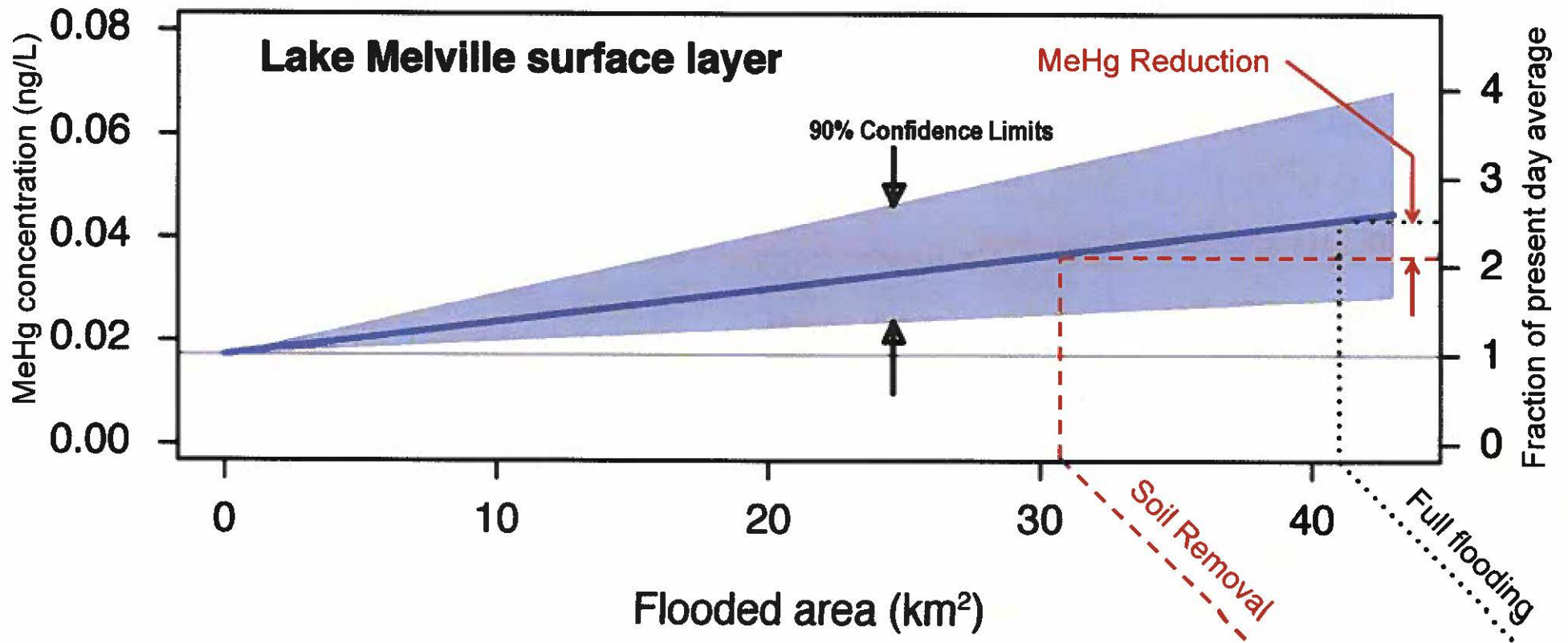
IEAC Recommendation (Mitigation)

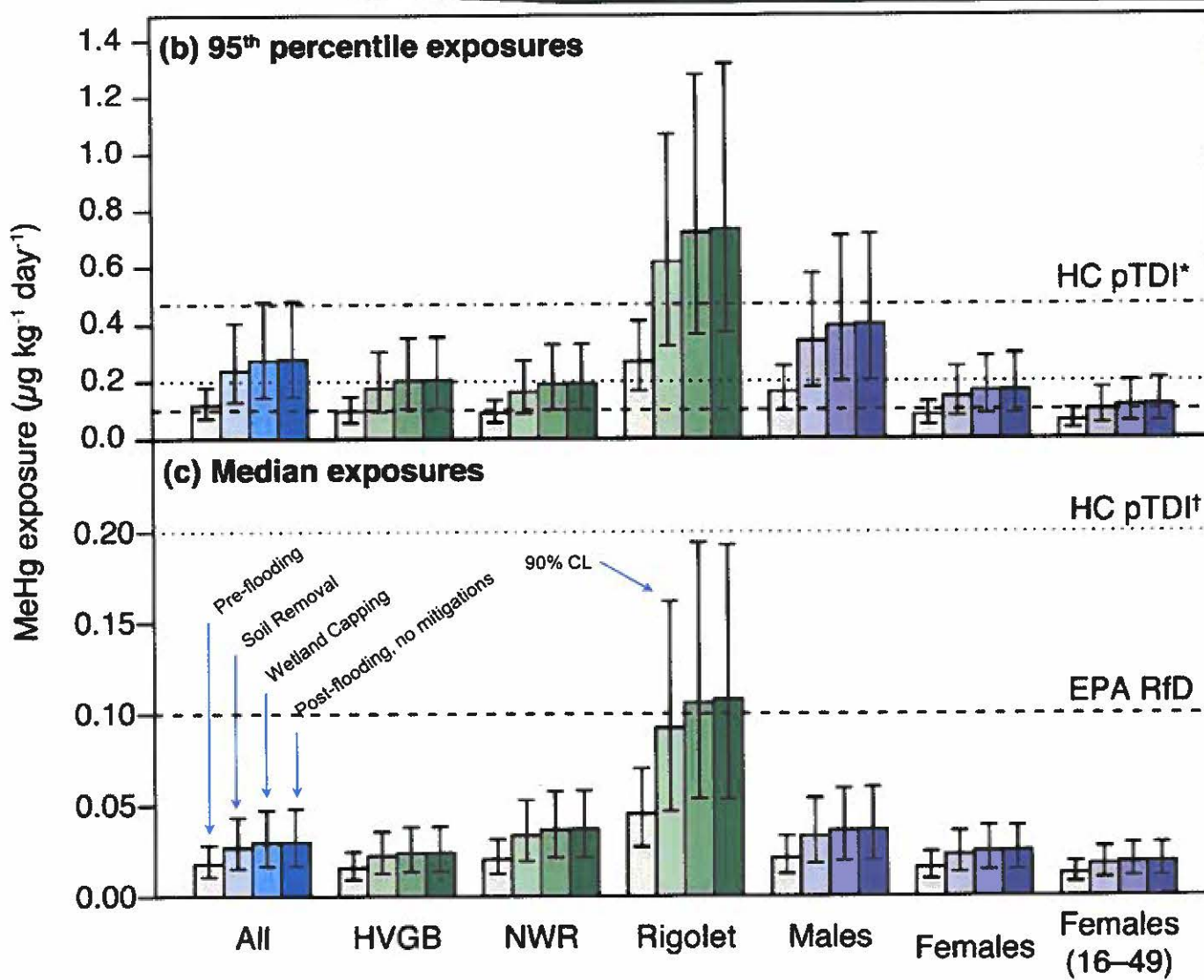
- Based on votes by 3 of the 4 IEAC voting members (Nunatsiavut Government, NunatuKavut Community Council, Affected Municipalities)
- Nalcor undertake targeted removal of soil and capping of wetlands for the reduction of both the amount and duration of methylmercury production in the Muskrat Falls Reservoir as outlined in Annex A.
- These details have been discussed with Nalcor and its consultants.
- Innu Nation voted for the option of capping wetlands only.
- The remaining (non-voting) members of the IEAC (Province, Canada and Nalcor) supported moving forward without any further physical mitigation.

Mitigation Analysis on Soil Removal

- Soil removal is intended to remove the carbon that feeds the microbes that create MeHg. Not intended to remove mercury as such. Challenging project unlike anything ever attempted before.
- Up to 15,465,000m³. (481 football fields 6 m deep assuming 1.5m removal. Cost up to \$742M. Up to additional \$19.4M for wetland capping.
- Modelled benefit of removal only reduces MeHg in Lake Melville by 6 - 26 % depending on the model parameters used.
- Model does not account for environmental effects of soil disposal along shoreline.
- A worse outcome within the realm of possibility, soil flux experiment is inconclusive at best. 3 of 4 samples increased MeHg flux upon soil removal.

Effect of Soil Removal on MeHg Concentration





Effect of Mitigation Options on MeHg Exposures

Additional factors considered using the Calder Model as a base



- Peak MeHg in MF reservoir in Harris model was much lower than Calder.
- Calder used peak MeHg (absolute value) vs a 1 year mean as presented by Harris (latter is more consistent with how MeHg behaves in nature).
- IEAC also asked for re-evaluation using new fish and seal data, but not all of the data was used. (see next slide)

Scenario comparisons

Effectiveness of mitigation options on exposure for 95th percentile of females 16-49 and children <12* ($\mu\text{g}/\text{kg BW}/\text{day}$)

	original parameters	IEAC parameters	Wetland Mitigation		Soil and Vegetation Removal	
	1	2	Wetland 1	Wetland 2	Soil Removal 1	Soil Removal 2
Calder Peak	0.560	0.467	0.553	0.461	0.469	0.395
Harris Peak	0.364	0.311	0.361	0.308	0.326	0.280
Harris 1-year Mean	0.288	0.248	0.287	0.247	0.271	0.234
			% change from baseline at 0.19 $(a-b)/(a-0.19)*100$			
	1	2	Wetland 1	Wetland 2	Soil Removal 1	Soil Removal 2
Calder Peak	195%	146%	-2%	-2%	-25%	-26%
Harris Peak	92%	64%	-2%	-2%	-22%	-26%
Harris 1-year Mean	52%	31%	-1%	-2%	-18%	-24%

* Health Canada pTDI = 0.2 $\mu\text{g}/\text{kg BW}/\text{day}$ for females <49 and children <18



Scenario comparisons expressed as true percentage changes

Effectiveness of mitigation options on exposure for 95th percentile of females 16-49 and children <12* ($\mu\text{g}/\text{kg BW}/\text{day}$)

	original parameters	IEAC parameters	Wetland Mitigation		Soil and Vegetation Removal	
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Harris 1 year Mean	0.288	0.248	0.287	0.247	0.271	0.234
			Change expressed as %			
	1	2	Wetland 1	Wetland 2	Soil Removal 1	Soil Removal 2
Calder Peak	195%	146%	-1%	-1%	-16%	-15%
Harris Peak	92%	64%	-1%	-1%	-10%	-10%
Harris 1 year Mean	52%	31%	-0.3%	-0.4%	-6%	-6%

* Health Canada pTDI = 0.2 $\mu\text{g}/\text{kg BW}/\text{day}$ for females <49 and children <18

Additional factors **NOT** considered in the Calder mitigation modelling exercise

- Soil flux experiment did not support soil removal effectiveness.
- Mass balance approach, ie. there is simply not be enough mercury in the system to create the concentrations given the bio-mass of Lake Melville.
- Canadian Reservoirs Comparison Matrix (CRCM) places MFR in low MeHg category.
- Actual data collected by surface monitoring program to date such as temporal behavior, correlation with other parameters including temperature, suspended solids, elemental mercury, nutrients etc.
- Soil removal assumed to be 100%, as if it were removed from the watershed, whereas the soil will be placed near the shoreline.
- Other impacts such as siltation, slope instability, mercury mobilization.
- No consideration of cost/benefit analysis. Is the proposed mitigation the best way to achieve the desired health outcome?

Intangible benefits of wetland capping

- Effectiveness of wetland capping is very limited based on the model output but there is some additional long term benefit on MeHg reduction.
- Lower cost – \$11.7 to \$19.4 m but only a very small area (39.5 ha).
- Supported by all 3 Indigenous groups including Innu Nation and municipalities representative.
- Some areas can be combined with habitat restoration/compensation as required by DFO.

What are Nalcor's responsibilities for mitigating MeHg issues?



Monitoring:

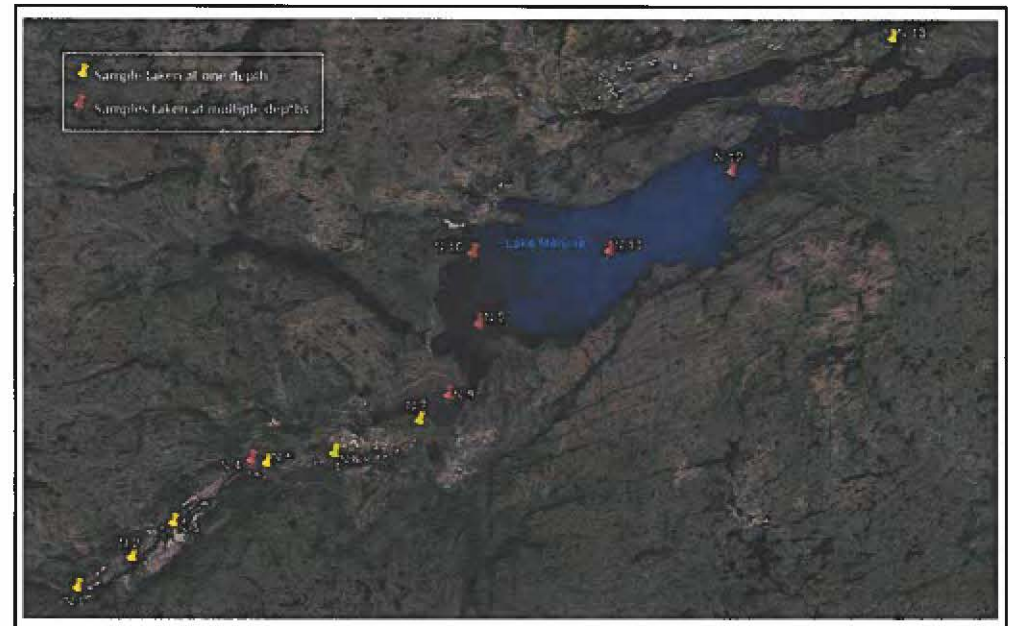
- MeHg Environmental Effects Monitoring Plan - Osprey and River Otter (top predators)
- Aquatic Environmental Effects Monitoring Plan – Hg in water, key fish species, seal, plankton
- Human Health Risk Assessment – MeHg in country foods, human hair samples, dietary surveys
- MeHg monitoring Plan for Surface Water – MeHg, Hg and other water quality parameters throughout the Churchill and Lake Melville system

Commitment (required by Minister Trimper as condition of HHRAP release June 14, 2016):

“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.”

What is Government's role in water sampling for MeHg?

- Initial surface water monitoring plan was developed by WRMD environmental scientists and after refinements proposed by NG, was accepted by the IEAC.
- Sample collection and laboratory analysis paid for by Nalcor.
- 13 stations, 6 with multiple depths and 15 parameters
- Bi-monthly sampling minimum
- Results are posted on MAE website.
- MAE continues to provide technical oversight.



IEAC Recommendation on Monitoring



- Recommend the design of a community-based monitoring program that answers questions about key indicators (i.e. water, key fish species, seal).
- Provide ongoing oversight to the implementation of the monitoring program.
- Develop pre-established benchmarks and appropriate responses to those results.

IEAC Recommendation on Impact Security Fund



- A significant fund to replace loss of country food and compensate for loss of traditional practices related to the harvesting of that food, and to compensate for impacts on human health, both physical and mental if there are impacts to country foods resulting from impoundment of the Muskrat Falls reservoir.

IEAC Recommendation on Health Management



- Standard advice be provided to pregnant women and the community at large that it is important and safe to eat country foods
- An independent body developing and assisting with the dissemination of communication materials.
- Work with Indigenous and local populations to develop benchmarks for action to ensure an appropriate response and communication plan should methylmercury increases in country food be detected through monitoring.

Questions?