Predicted MeHg in Downstream Food Web

Jim McCarthy
June 2018

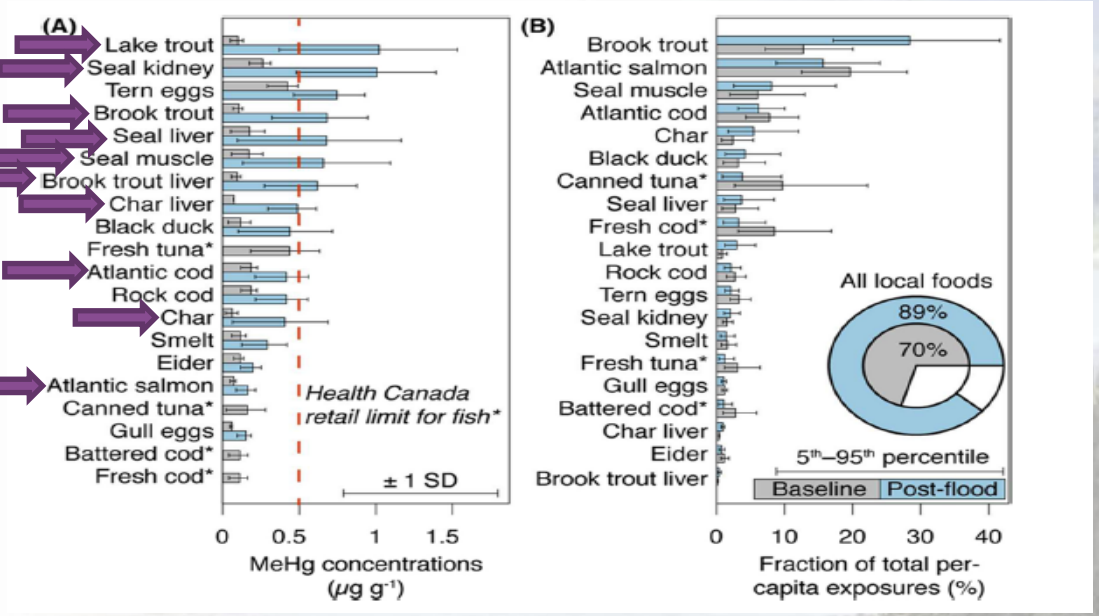
Fish MeHg Summary

- Model Considerations
- Fish Species Distribution and Relative Abundance
- Trophic Food Web and Prey Composition
- Predicted Fish Concentrations
    - Delivery MeHg in water
    - Estimates of Fish Exposure
    - “Bioaccumulation”

Model Considerations

Species Info Presented to IEC Sept 8, 2017 and Feb 15, 2018

- To Help Inform the IEC
- IEC Recommendation to revise modelling by Calder

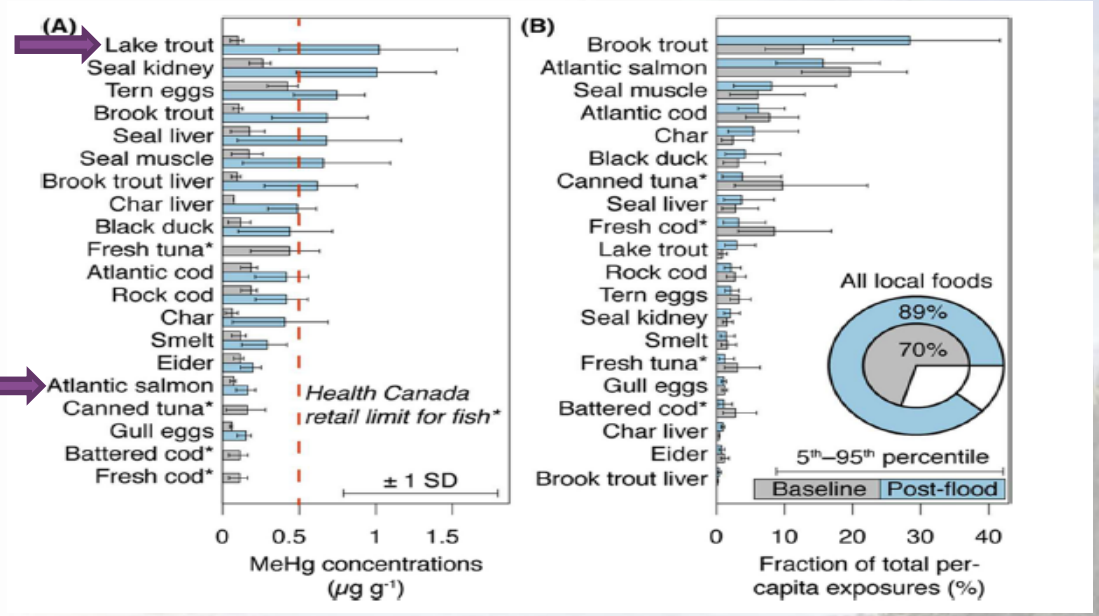


Calder et al. (2016)

Model Considerations

IEC species revisions not incorporated by Calder

- Only Lake Trout, Ouananiche, Atlantic Salmon
- Was not Unanimously agreed



Calder et al. (2016)

Model Considerations

IEC recommendations: Mitigation (March 5, 2018)

Table 1

Modeled MeHg production (reservoir)	Percent Change in MeHg intake for Rigolet subgroup (F 16-49; M/F <12)					
	(1) No-mitigation MeHg Scenario		(2) Mitigation MeHg Scenarios			
	Calder et al. (2016)	IEC Revised Exposure	Wetland (using Calder el al. 2016)	Wetland (using IEC Revised Exposure)	Soil Removal (using Calder et al. 2016)	Soil Removal (using IEC Revised Exposure)
Calder peak	+195%	+146%	-2% (+193%)	-2% (+144%)	-25% (+170%)	-26% (+120%)
Nalcor peak	+92%	+64%	-2% (+90%)	-2% (+62%)	-22% (+70%)	-26% (+38%)
Nalcor 1-yr mean	+52%	+31%	-1% (+51%)	-2% (+29%)	-18% (34%)	-24% (+7%)

Model Considerations

IEC recommendations: Mitigation (March 5, 2018)

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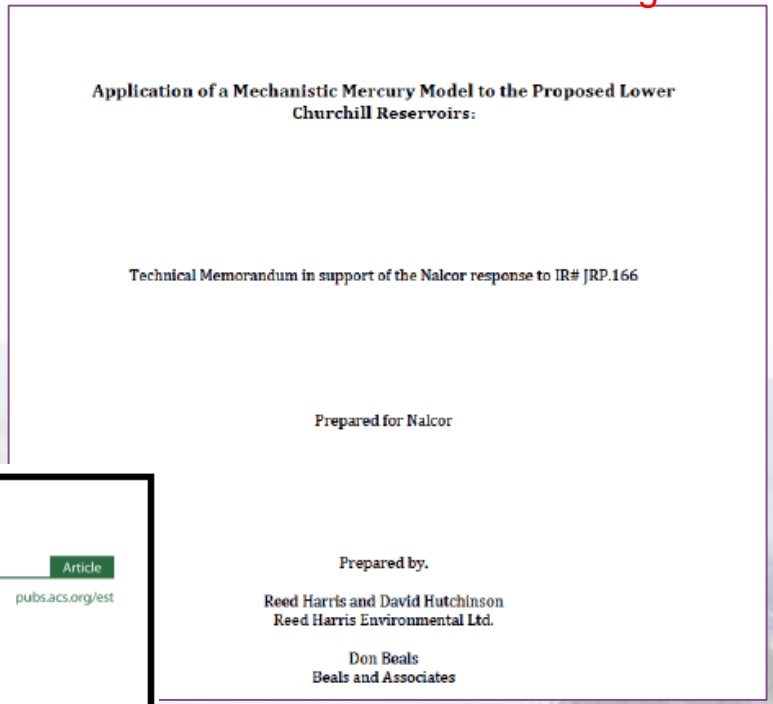
Nalcor peak						
Nalcor 1-yr mean						

Model Considerations

Biology is CRITICAL

- Potential Pathway
- Perspective



Application of a Mechanistic Mercury Model to the Proposed Lower Churchill Reservoirs:

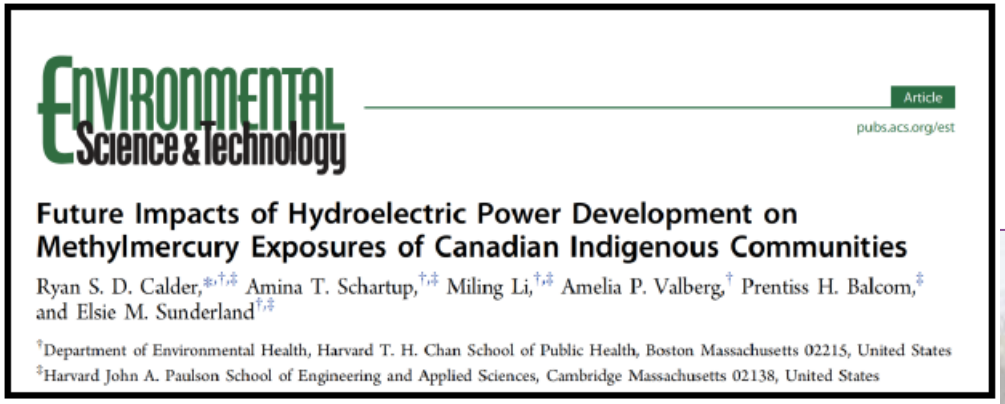
Technical Memorandum in support of the Nalcor response to IR# JRP.166

Prepared for Nalcor

Prepared by.

Reed Harris and David Hutchinson
Reed Harris Environmental Ltd.

Don Beals
Beals and Associates



Environmental Science & Technology

Article

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Future Impacts of Hydroelectric Power Development on Methylmercury Exposures of Canadian Indigenous Communities

Ryan S. D. Calder,*[†,‡] Amina T. Schartup,[†,‡] Miling Li,[†,‡] Amelia P. Valberg,[†] Prentiss H. Balcom,[‡] and Elsie M. Sunderland[†,‡]

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Model ≠ Real World

Fish Species and Distribution

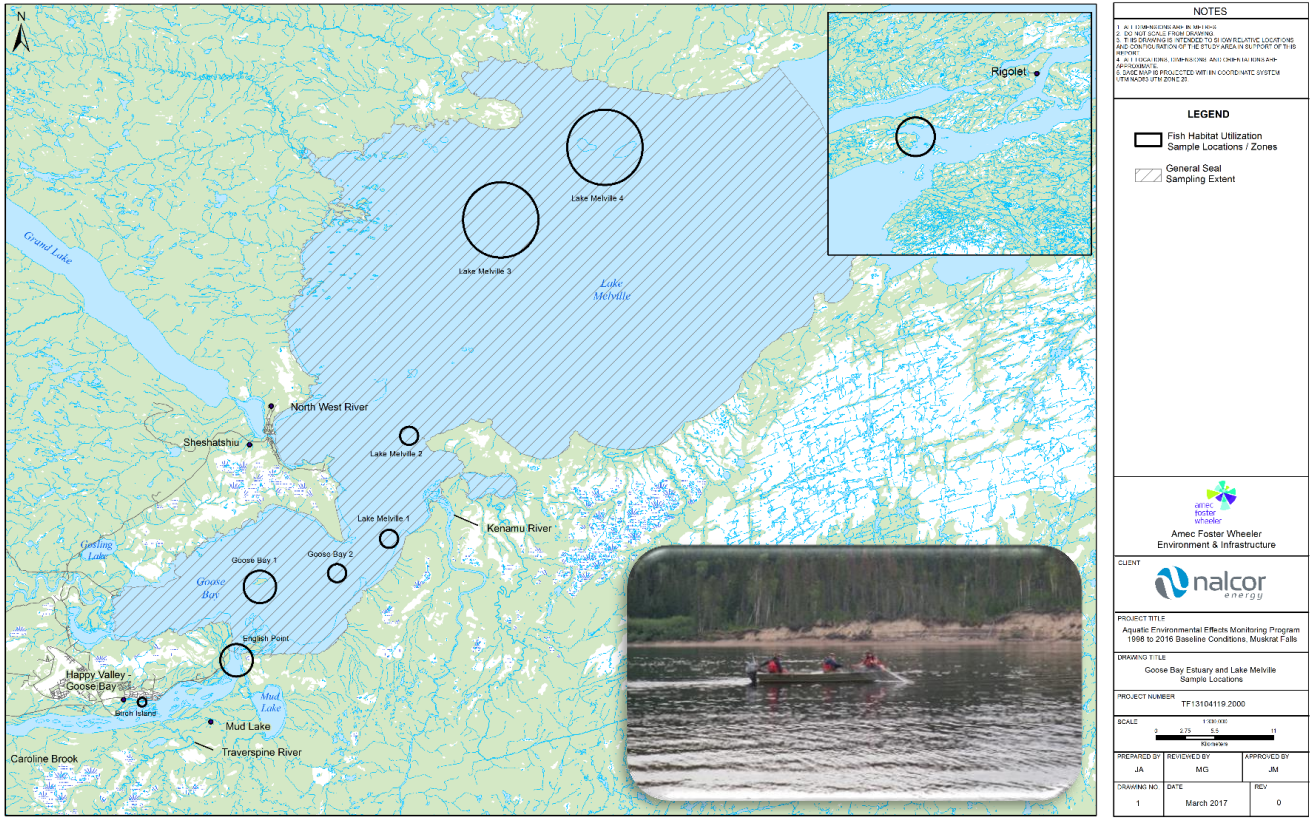
Fish Community (1998-2017)

Downstream Muskrat Falls

- Longnose Sucker (*Catostomus catostomus*)
- White Sucker (*Catostomus commersoni*)
- Northern Pike (*Esox lucius*)
- **Brook Trout (*Salvelinus fontinalis*)**
- **Atlantic Salmon (*Salmo salar*)**
- **Rainbow Smelt (*Osmerus mordax*)**
- Tom Cod (*Microgadus tomcod*)
- Winter Flounder (*Pseudopleuronectes americanus*)
- Lake Whitefish (*Coregonus clupeaformis*)
- Round Whitefish (*Prosopium cylindraceum*)
- Burbot (*Lota lota*)
- American Eel (*Anguilla rostrata*)
- Lake Chub (*Couesius plumbeus*)
- Threespine Stickleback (*Gasterosteus aculeatus*)
- Sculpin (*Cottus bairdi, Cottus cognatus*)

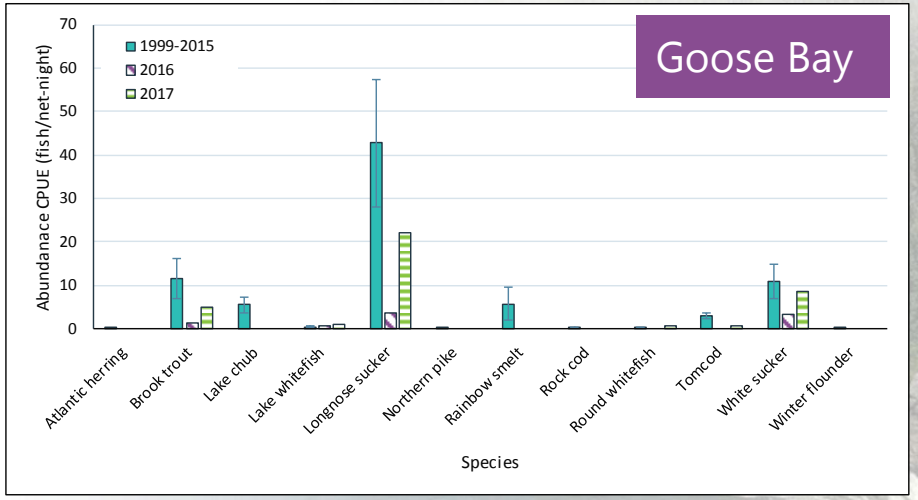
Fish Species and Distribution

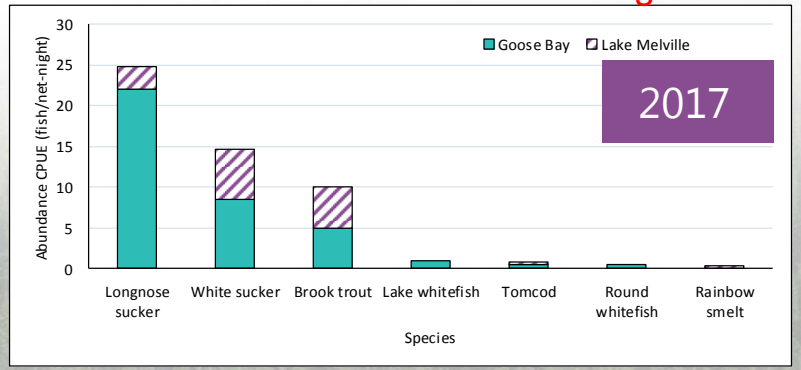
Sampling Effort (1998-2017)

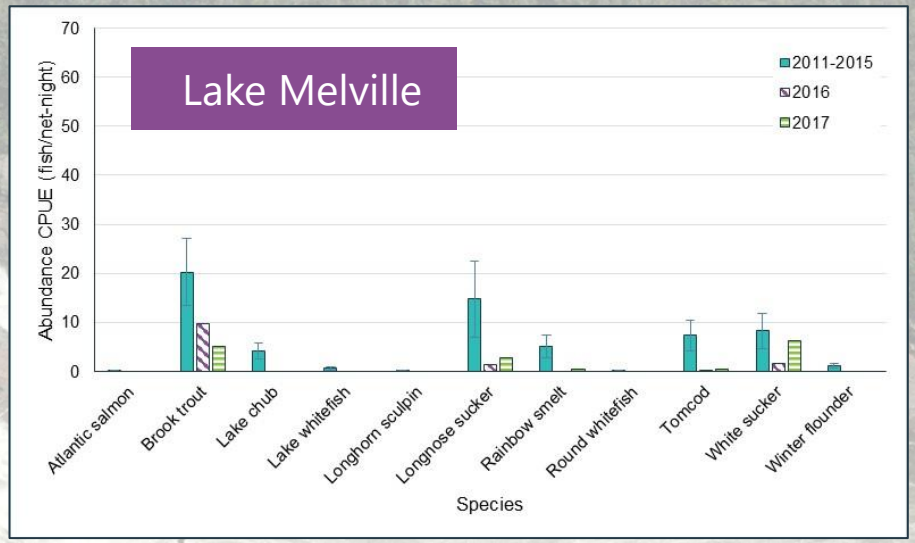


Abundance and Distribution

Gillnet Effort (1998-2017)



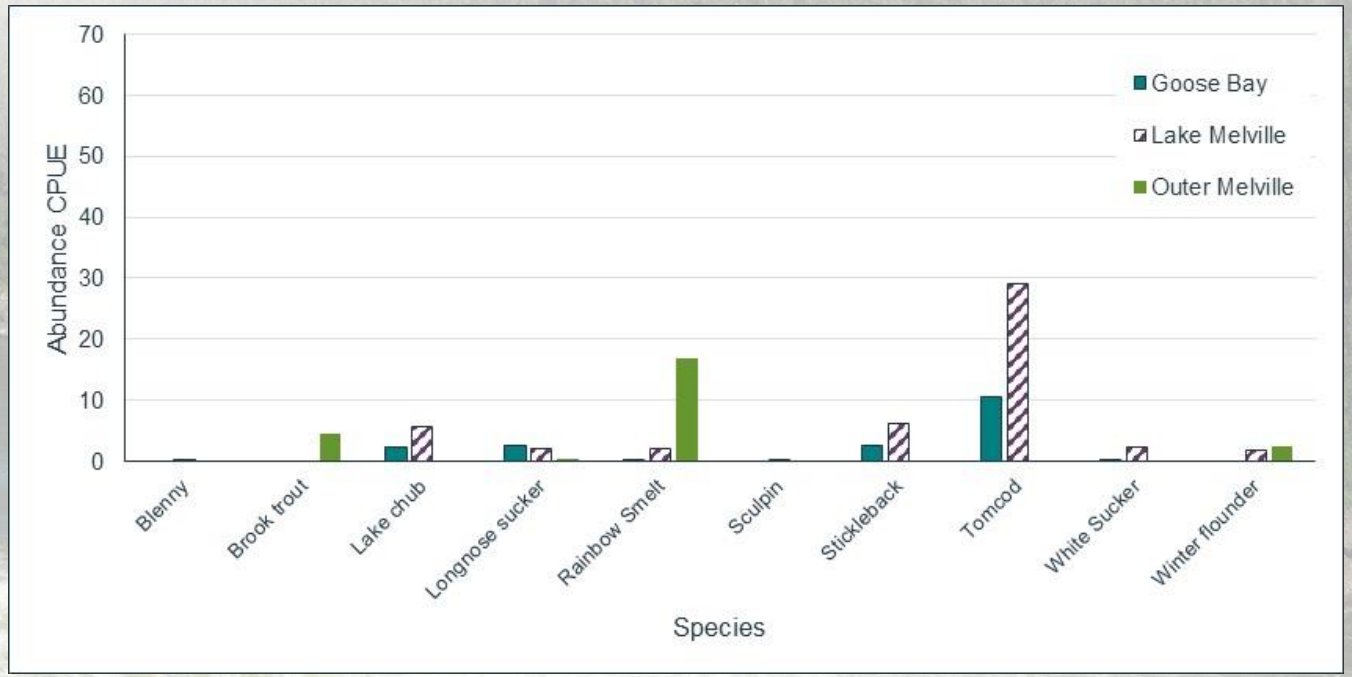




Suckers
Brook trout
Tomcod
Rainbow smelt
Winter Flounder

Abundance and Distribution

Fyke Net Effort (2011-2017)



Suckers
Brook trout
Tomcod
Rainbow smelt
Winter Flounder

Abundance and Distribution

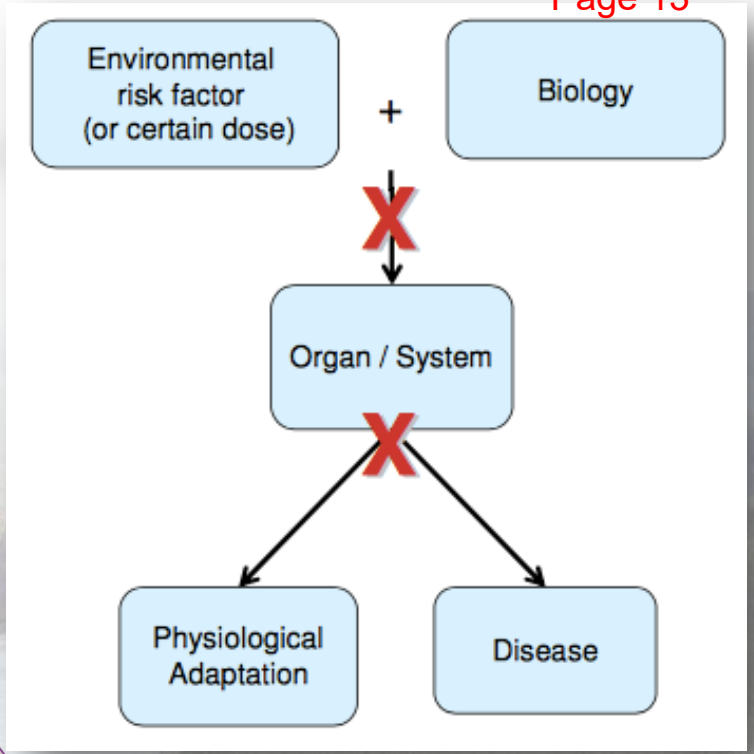
Ringed Seal (2006-2017)

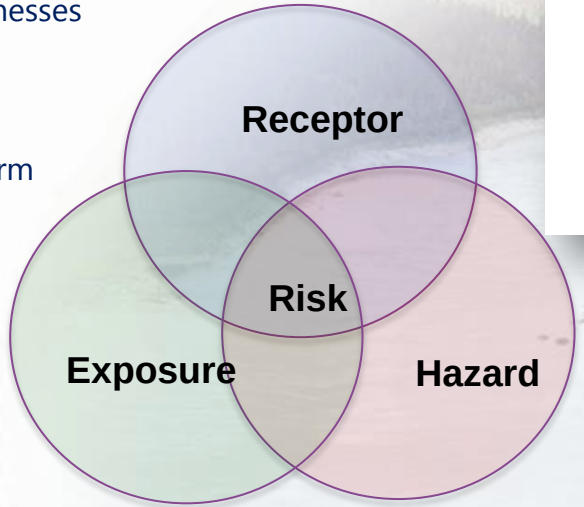
Sample Year	Total Observed	Relative abundance Estimate	95% Confidence Interval
2006	474	1,888	1,746 - 2,029
2013	535	2,140	2,081 - 2,199
2014	196	880	858 – 901
2015	161	644	621 – 666
2016	393	1,572	1,523 - 1,620
2017	814	3,256	3,136 – 3,376
2018	778		

"Risk Assessment 101"

Dr. Chris Ollson:

- Risk Assessment (RA) is a tool that can be used for estimating the potential for adverse effects that could arise from the presence of contamination in the environment
- Defining the extent and impact of exposure is the key to understanding environmental illnesses
- No harm without exposure
- Exposure does not always mean harm





Exposure Considerations

BAFs calculated and used based on fraction of a species lifespan spent in each environment

Arctic char:

- Spend 9/52 weeks in marine (Grant and Lee 2014)
  - Isotope C/N would still have remnant freshwater signal (Jardine et al. 2003)
  - Some reduced feeding by adults through the winter in freshwater
- None captured in Churchill River, Goose Bay or Lake Melville
  - Traditional Knowledge says they may be in Lake Melville in low abundance
  - Would not reside or spawn in lower Churchill River but may be in other freshwater tributaries of Lake Melville and Hamilton Inlet

Table S7a. Bioaccumulation factors (BAFs) between aquatic MeHg concentrations and measured concentrations in biota and the estimated fraction of lifespan for each species spent in the freshwater environment (River), Lake Melville (Estuary) and outer marine regions (Marine).

Species	log BAF	River	Estuary	Marine	References
Arctic char		0.5	0.5	0	Dunbar (46),
Muscle	6.6				Bradbury et al. (47)[a,b]
Liver	6.6				
Roe	5.6				
Atlantic cod	7.7	0	0–0.50	0–0.50	Li et al. (26)[c,d]
Atlantic salmon		0	0–0.50	0–0.50	Li et al. (26)[c,d]
Muscle	7.3				
Liver	7.4				
Roe	6.4				
Brook trout		0.5	0.5	0	Backus (48), Pilgrim
Muscle	6.8				et al. (49)[a,e]
Liver	6.7				
Roe	6.5				
Capelin		0	0.25	0.75	Li et al. (26)[c]
Muscle	6.0				
Roe	5.1				
Clams	5.8	0	1	0	Harvest location[f]
Black duck		0.5	0.5	0	Longcore et al. (50)[g]
Muscle	6.8				
Eggs	6.2				
Eider		0	0.5–1	0.5–1	BirdLife International
Muscle	6.9				(51)[d,g]
Flatfish	6.6	0	1	0	Armstrong and Starr (52)[a]
Green sea urchin	6.4	0	1	0	Harvest location[f]
Guillemot		0	0.5–1	0.5–1	Butler et al. (53)[d]
Muscle	7.4				
Eggs	7.2				
Gull		0	0.5–1	0.5–1	Baird et al. (54)[g]
Muscle	7.3				
Eggs	6.7				

[a] Stable Hg isotopes suggest mixed habitat (26).
[b] Time spent in open ocean is short (several weeks per year) (46, 47).
[c] Habitat is predominantly offshore and fish migrate into the estuary to feed and/or spawn.
[d] Habitats modeled probabilistically (see Table 2). Reported BAF is expected value.
[e] Habitat is predominantly freshwater. Radiotelemetry monitoring in the Churchill River revealed short (90% < 10 km) seasonal displacements (55).
[f] Sessile and low-motility species are based on predominant fishing location.
[g] Increased MeHg following flooding is scaled by time spent in region (0.5) for migratory species.

Exposure Considerations

BAFs calculated and used based on fraction of a species lifespan spent in each environment

Atlantic cod:

- Li et al. (2016) identifies them as marine species based on isotopes
- None captured in Churchill River, Goose Bay or Lake Melville
- Calder et al. (2016) baseline samples collected in St. Lewis Bay

- Traditional Knowledge….*Captured in Hamilton Inlet*

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Exposure Considerations

BAFs calculated and used based on fraction of a species lifespan spent in each environment

Atlantic salmon:

- Li et al. (2016) identifies adults as marine species based on isotopes
- Juveniles will migrate to marine environment and spend at least a year at sea before returning
- Will cease feeding as they enter the estuary
- Very few captured in the Churchill River (~4)

Table S7a. Bioaccumulation factors (BAFs) between aquatic MeHg concentrations and measured concentrations in biota and the estimated fraction of lifespan for each species spent in the freshwater environment (River), Lake Melville (Estuary) and outer marine regions (Marine).

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[g] Increased MeHg following flooding is scaled by time spent in region (0.5) for migratory species.

Exposure Considerations

BAFs calculated and used based on fraction of a species lifespan spent in each environment

Capelin:

- Li et al. (2016) identifies them as marine species based on isotopes
- Two captured in Churchill River, Goose Bay or Lake Melville
- Calder et al. (2016) did not collect baseline samples

- Traditional Knowledge….Chaulk et al. (2013) noted whales near Rigolet chasing capelin
- Haven't been seen in Lake Melville since 1970s (M. Clement pers comm.)

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[g] Increased MeHg following flooding is scaled by time spent in region (0.5) for migratory species.

Exposure Considerations

BAFs calculated and used based on fraction of a species lifespan spent in each environment

Lake Trout:

- One captured in Muskrat Falls reservoir area and downstream
- They would be in freshwater but not any affected by the reservoir

Table S7b. Bioaccumulation factors (BAFs = MeHg biota/aqueous MeHg) and the estimated fraction of lifespan for each species spent in the freshwater environment (river), Lake Melville (estuary) and outer marine regions (marine).

Species	log BAF	River	Estuary	Marine	Reference
Lake trout	6.8	1	0	0	Black et al. (56)
Loon		0.5	0.5	0	McIntyre et al. (57)[a]
Eggs	7.7				
Mussels	5.3	0	1	0	Harvest location[b]
Ouananiche	6.9	1	0	0	Bradbury et al. (47)
Periwinkles	6.4	0	1	0	Harvest location[b]
Porpoise		0	0.25	0.75	Read and Westgate (58)[c]
Muscle	8.1				
Liver	8.4				
Rainbow smelt	6.8	0	1	0	FishBase (59)[d]
Rock cod		0	0–0.50	0–0.50	Ferguson et al. (60)[e,f]
Muscle	7.7				
Liver	7.5				
Sandpiper	6.6	0.5	0.5	0	Gratto-Trevor et al. (61)[a]
Scallops	6.1	0	1	0	Harvest location[b]
Sculpin		0	0.25	0.75	Li et al. (26)[c]
Muscle	7.7				
Liver	7.2				
Seal		0–0.25	0.5–0.75	0.25	Sikumiut Environmental Management Ltd. (62)[f,g]
Muscle	7.1				
Liver	7.1				
Kidney	7.3				
Tern		0	0.5–1	0.5–1	Hatch et al. (63)[a,f]
Muscle	7.3				
Eggs	7.5				

[a] Increased MeHg following flooding is scaled by time spent in region (0.5) for migratory species.
[b] Sessile and low-motility species are based on predominant fishing location.
[c] Habitat is predominantly offshore and fish migrate into the estuary to feed and/or spawn. Habitat fraction is modeled probabilistically (see Table S2). Reported BAF is expected mean.
[d] Hg isotope signature in adults indicates mixed habitat (26).
[e] Same $\delta^{13}C$ and $\delta^{15}N$ stable isotope signature as Atlantic cod.
[f] Habitat fraction modeled probabilistically (see Table S2). Reported BAF is expected mean.
[g] Pups are found in sea ice in estuarine environment.

Exposure Considerations

BAFs calculated and used based on fraction of a species lifespan spent in each environment

Ouananiche:

- Less than 10 in 20 years captured in Muskrat Falls reservoir area
- They would be in freshwater but not any affected by the reservoir

Table S7b. Bioaccumulation factors (BAFs = MeHg biota/aqueous MeHg) and the estimated fraction of lifespan for each species spent in the freshwater environment (river), Lake Melville (estuary) and outer marine regions (marine).

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Sandpiper	6.6	0.5	0.5	0	Gratto-Trevor et al. (61)[a]
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Muscle	7.7				
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Muscle	7.1				
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Kidney	7.3				
Tern		0	0.5–1	0.5–1	Hatch et al. (63)[a,f]
Muscle	7.3				
Eggs	7.5				

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[f] Habitat fraction modeled probabilistically (see Table S2). Reported BAF is expected mean.
[g] Pups are found in sea ice in estuarine environment.

Species Summary

Brook trout:

- Up to 8/52 weeks in estuary (near natal stream) as adults (Bradbury et al. 1999)
- Very few captured in main stem Churchill River (~33)
  - Brook trout in Lake Melville are not produced in Churchill River main stem
  - Natal streams would be near estuary sites

- Relatively Abundant in Estuary (open-water feeding)
- 3-6 years old in Estuary
- Top-level Predator
- Marine-based Prey

Table S7a. Bioaccumulation factors (BAFs) between aquatic MeHg concentrations and measured concentrations in biota and the estimated fraction of lifespan for each species spent in the freshwater environment (River), Lake Melville (Estuary) and outer marine regions (Marine).

Species	log BAF	River	Estuary	Marine	References
Arctic char		0.5	0.5	0	Dunbar (46),
Muscle	6.6				Bradbury et al. (47)[a,b]
Liver	6.6				
Roe	5.6				
Atlantic cod	7.7	0	0–0.50	0–0.50	Li et al. (26)[c,d]
Atlantic salmon		0	0–0.50	0–0.50	Li et al. (26)[c,d]
Muscle	7.3				
Liver	7.4				
Roe	6.4				
Brook trout		0.5	0.5	0	Backus (48), Pilgrim
Muscle	6.8				et al. (49)[a,e]
Liver	6.7				
Roe	6.5				
Capelin		0	0.25	0.75	Li et al. (26)[c]
Muscle	6.0				
Roe	5.1				
Clams	5.8	0	1	0	Harvest location[f]
Black duck		0.5	0.5	0	Longcore et al. (50)[g]
Muscle	6.8				
Eggs	6.2				
Eider		0	0.5–1	0.5–1	BirdLife International
Muscle	6.9				(51)[d,g]
Flatfish	6.6	0	1	0	Armstrong and Starr (52)[a]
Green sea urchin	6.4	0	1	0	Harvest location[f]
Guillemot		0	0.5–1	0.5–1	Butler et al. (53)[d]
Muscle	7.4				
Eggs	7.2				
Gull		0	0.5–1	0.5–1	Baird et al. (54)[g]
Muscle	7.3				
Eggs	6.7				

[a] Stable Hg isotopes suggest mixed habitat (26).
[b] Time spent in open ocean is short (several weeks per year) (46, 47).
[c] Habitat is predominantly offshore and fish migrate into the estuary to feed and/or spawn.
[d] Habitats modeled probabilistically (see Table 2). Reported BAF is expected value.
[e] Habitat is predominantly freshwater. Radiotelemetry monitoring in the Churchill River revealed short (90% < 10 km) seasonal displacements (55).
[f] Sessile and low-motility species are based on predominant fishing location.
[g] Increased MeHg following flooding is scaled by time spent in region (0.5) for migratory species.

Species Summary

Ringed Seal:

- No Ringed seal observed in Churchill River (that includes Sikumiut Environmental Management Ltd (2008))
- Chaulk et al. (2013) states that elders reported that Ringed Seals are rarely observed in Lake Melville during the summer, compared to early spring.
- Chaulk et al. (2013) also noted that B. Sjare tracking data suggested that Ringed Seals move in and out of Lake Melville from other areas of coastal Labrador over the course of the ice-free period

- Relatively Abundant in Lake Melville (uncommon in Goose Bay)
- Pups are preferred for consumption but up to 32 years old
- Top-level Predator (above all fish sampled)
- Marine-based Prey

Table S7b. Bioaccumulation factors (BAFs = MeHg biota/aqueous MeHg) and the estimated fraction of lifespan for each species spent in the freshwater environment (river), Lake Melville (estuary) and outer marine regions (marine).

Species	log BAF	River	Estuary	Marine	Reference
Lake trout	6.8	1	0	0	Black et al. (56)
Loon		0.5	0.5	0	McIntyre et al. (57)[a]
Eggs	7.7				
Mussels	5.3	0	1	0	Harvest location[b]
Ouananiche	6.9	1	0	0	Bradbury et al. (47)
Periwinkles	6.4	0	1	0	Harvest location[b]
Porpoise		0	0.25	0.75	Read and Westgate (58)[c]
Muscle	8.1				
Liver	8.4				
Rainbow smelt	6.8	0	1	0	FishBase (59)[d]
Rock cod		0	0–0.50	0–0.50	Ferguson et al. (60)[e,f]
Muscle	7.7				
Liver	7.5				
Sandpiper	6.6	0.5	0.5	0	Gratto-Trevor et al. (61)[a]
Scallops	6.1	0	1	0	Harvest location[b]
Sculpin		0	0.25	0.75	Li et al. (26)[c]
Muscle	7.7				
Liver	7.2				
Seal		0–0.25	0.5–0.75	0.25	Sikumiut Environmental Management Ltd. (62)[f,g]
Muscle	7.1				
Liver	7.1				
Kidney	7.3				
Tern		0	0.5–1	0.5–1	Hatch et al. (63)[a,f]
Muscle	7.3				
Eggs	7.5				

[a] Increased MeHg following flooding is scaled by time spent in region (0.5) for migratory species.
[b] Sessile and low-motility species are based on predominant fishing location.
[c] Habitat is predominantly offshore and fish migrate into the estuary to feed and/or spawn. Habitat fraction is modeled probabilistically (see Table S2). Reported BAF is expected mean.
[d] Hg isotope signature in adults indicates mixed habitat (26).
[e] Same $\delta^{13}C$ and $\delta^{15}N$ stable isotope signature as Atlantic cod.
[f] Habitat fraction modeled probabilistically (see Table S2). Reported BAF is expected mean.
[g] Pups are found in sea ice in estuarine environment.

Species Summary

Rainbow Smelt:

- Relatively Abundant in Estuary (open-water feeding)
- 3-8 Year old in Estuary "catchable" (150mm+)
- Can Enter Goose Bay during spawning run but majority time in Lake Melville
- Top-level Predator (same a brook trout)
- Marine-based Prey

Table S7b. Bioaccumulation factors (BAFs = MeHg biota/aqueous MeHg) and the estimated fraction of lifespan for each species spent in the freshwater environment (river), Lake Melville (estuary) and outer marine regions (marine).

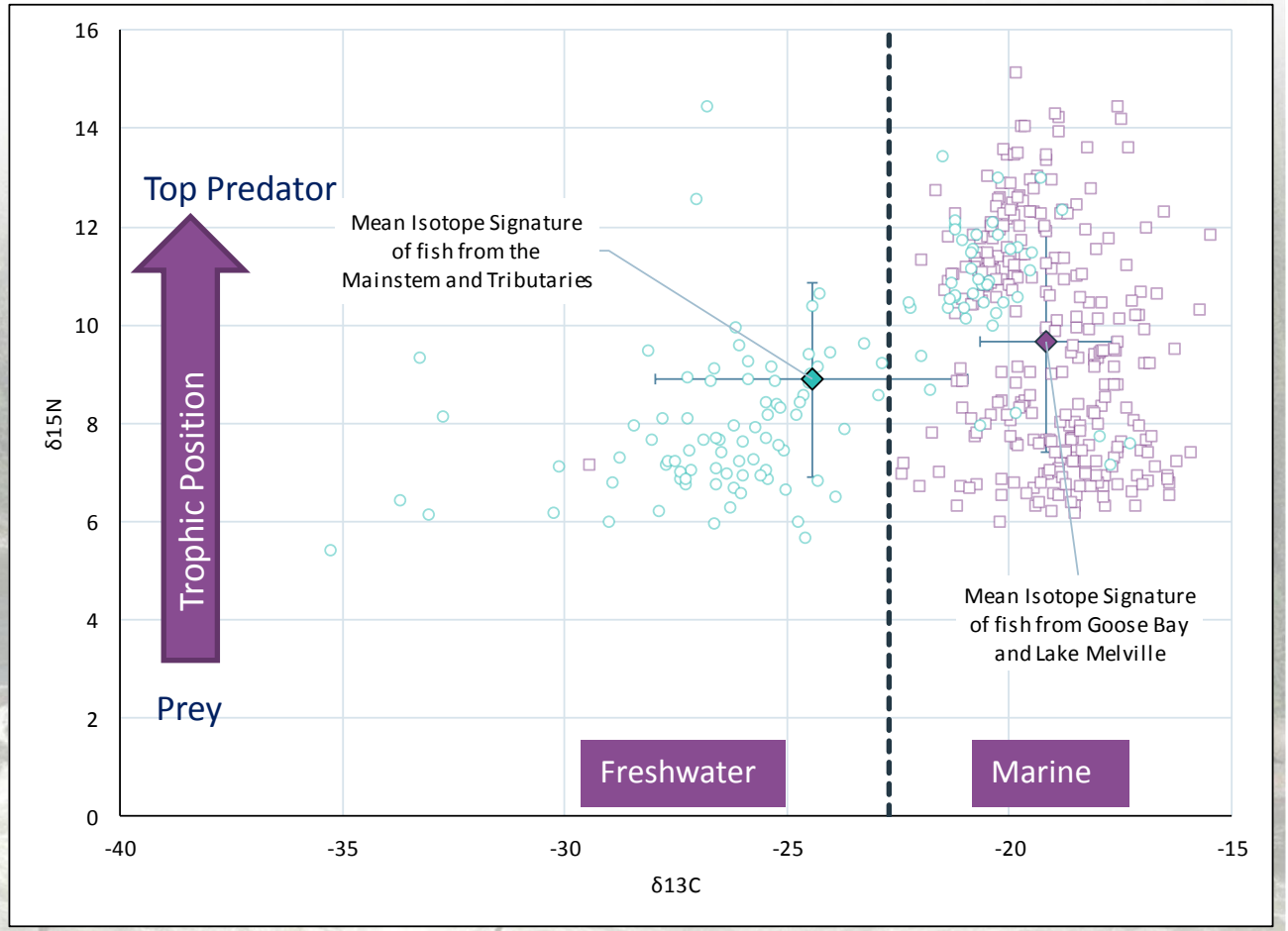
Species	log BAF	River	Estuary	Marine	Reference
Lake trout	6.8	1	0	0	Black et al. (56)
Loon		0.5	0.5	0	McIntyre et al. (57)[a]
Eggs	7.7				
Mussels	5.3	0	1	0	Harvest location[b]
Ouananiche	6.9	1	0	0	Bradbury et al. (47)
Periwinkles	6.4	0	1	0	Harvest location[b]
Porpoise		0	0.25	0.75	Read and Westgate (58)[c]
Muscle	8.1				
Liver	8.4				
Rainbow smelt	6.8	0	1	0	FishBase (59)[d]
Rock cod		0	0–0.50	0–0.50	Ferguson et al. (60)[e,f]
Muscle	7.7				
Liver	7.5				
Sandpiper	6.6	0.5	0.5	0	Gratto-Trevor et al. (61)[a]
Scallops	6.1	0	1	0	Harvest location[b]
Sculpin		0	0.25	0.75	Li et al. (26)[c]
Muscle	7.7				
Liver	7.2				
Seal		0–0.25	0.5–0.75	0.25	Sikumiut Environmental Management Ltd. (62)[f,g]
Muscle	7.1				
Liver	7.1				
Kidney	7.3				
Tern		0	0.5–1	0.5–1	Hatch et al. (63)[a,f]
Muscle	7.3				
Eggs	7.5				

[a] Increased MeHg following flooding is scaled by time spent in region (0.5) for migratory species.
[b] Sessile and low-motility species are based on predominant fishing location.
[c] Habitat is predominantly offshore and fish migrate into the estuary to feed and/or spawn. Habitat fraction is modeled probabilistically (see Table S2). Reported BAF is expected mean.
[d] Hg isotope signature in adults indicates mixed habitat (26).
[e] Same $\delta^{13}C$ and $\delta^{15}N$ stable isotope signature as Atlantic cod.
[f] Habitat fraction modeled probabilistically (see Table S2). Reported BAF is expected mean.
[g] Pups are found in sea ice in estuarine environment.

Food Chain

Stable Isotopes (2017)

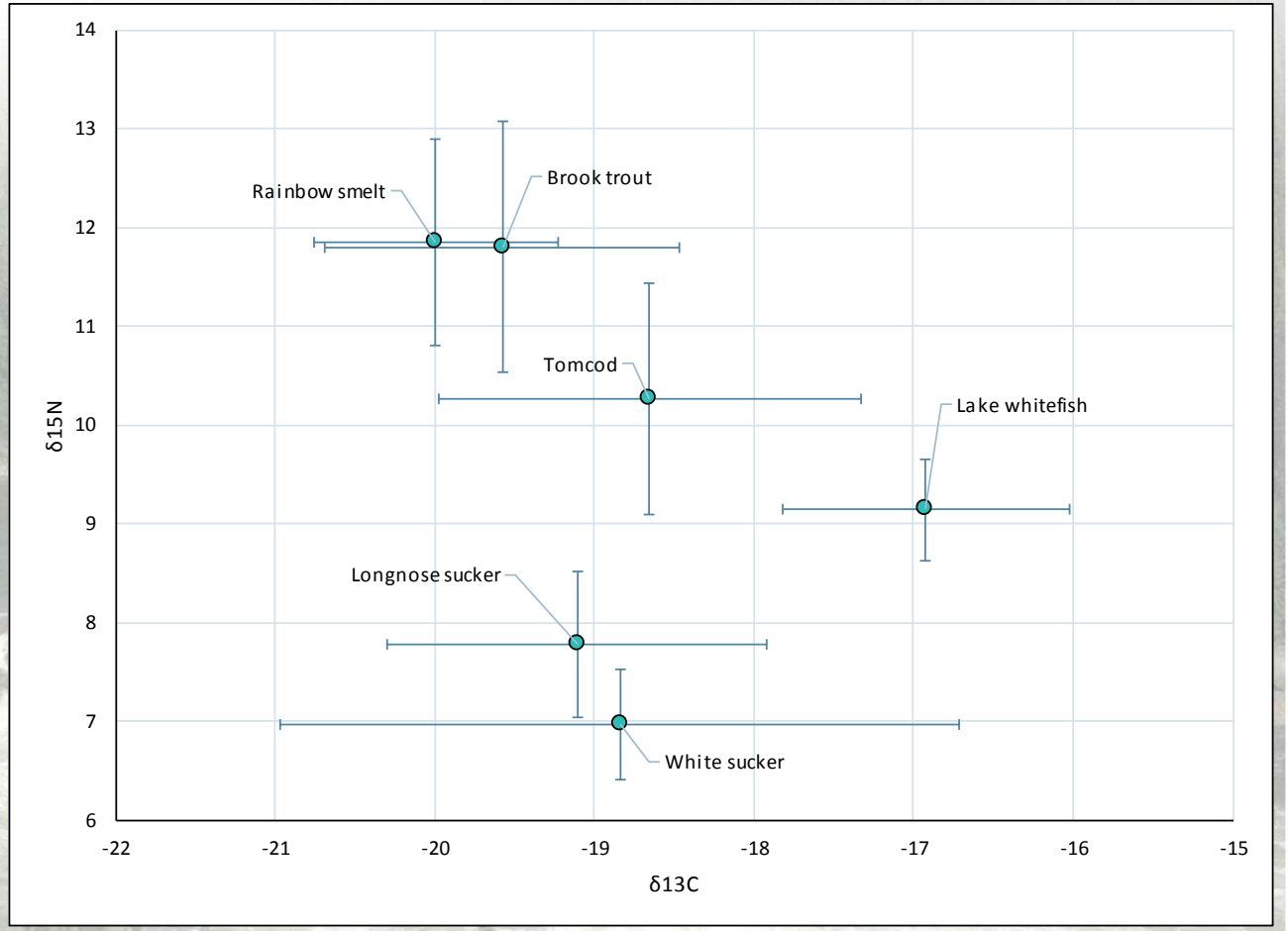
$\delta^{13}C$ and $\delta^{15}N$



Food Chain

Stable Isotopes (2017)

$\delta^{13}C$ and $\delta^{15}N$

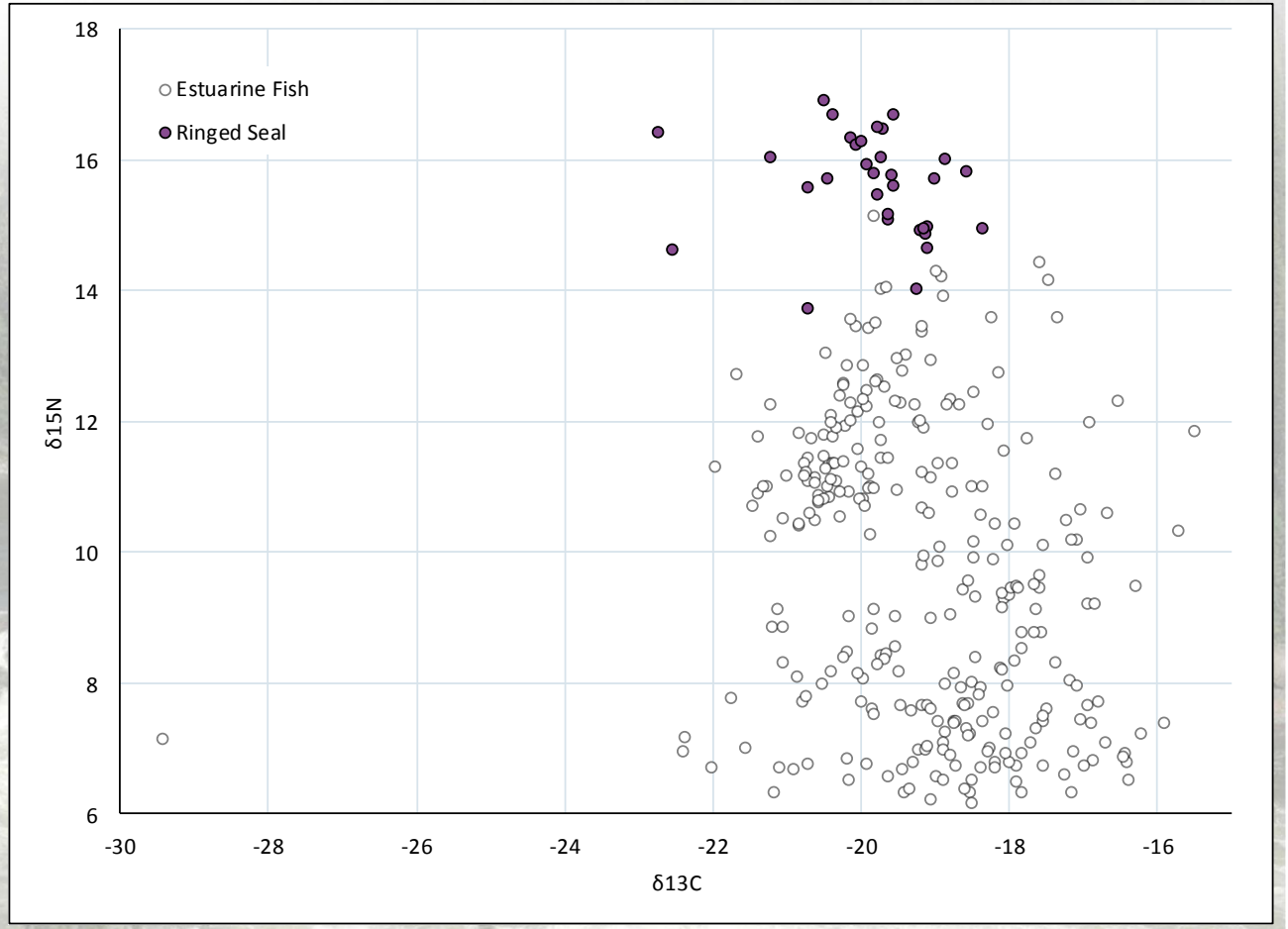


Goose Bay and Lake Melville

Food Chain

Stable Isotopes (2017)

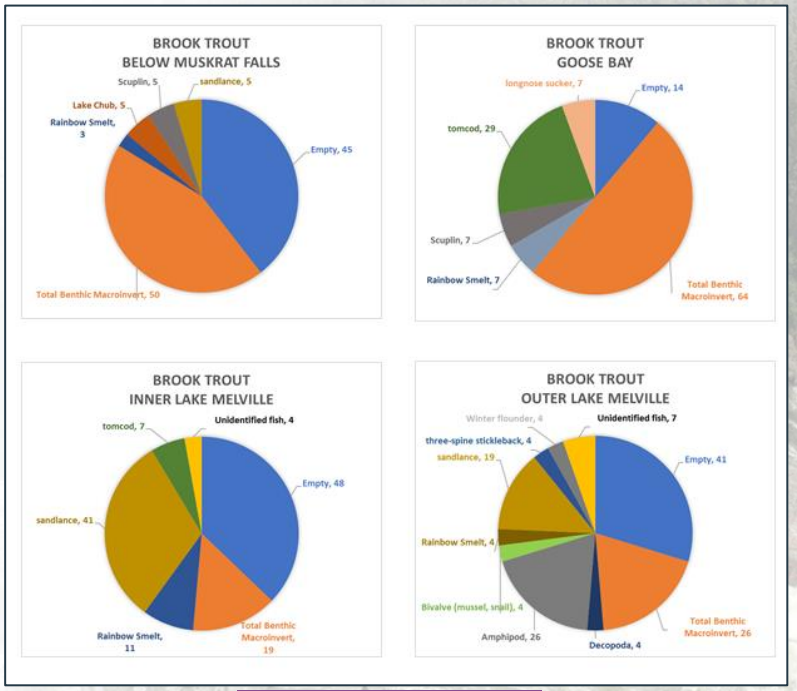
$\delta^{13}C$ and $\delta^{15}N$



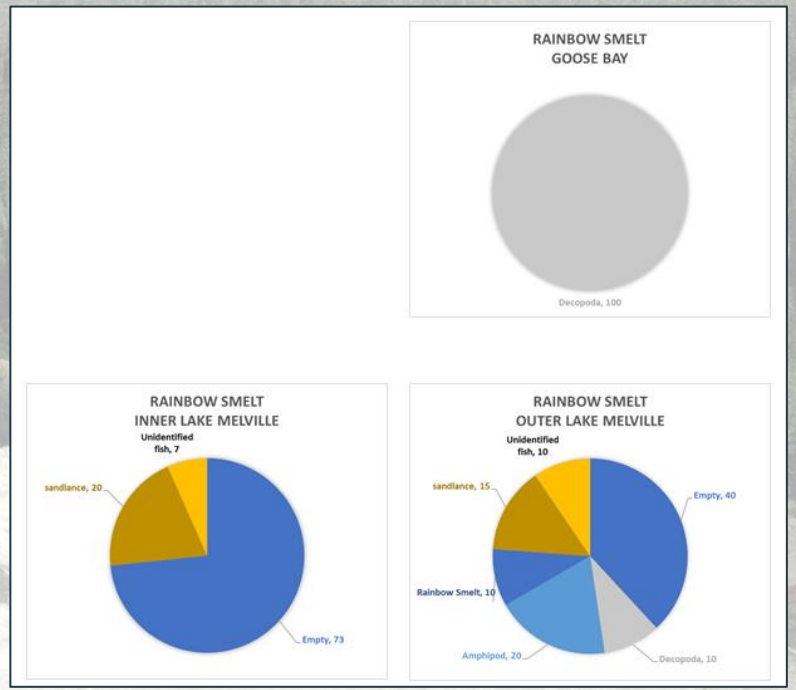
Goose Bay and Lake Melville

Food Web

Stomach Content Analysis



Brook Trout



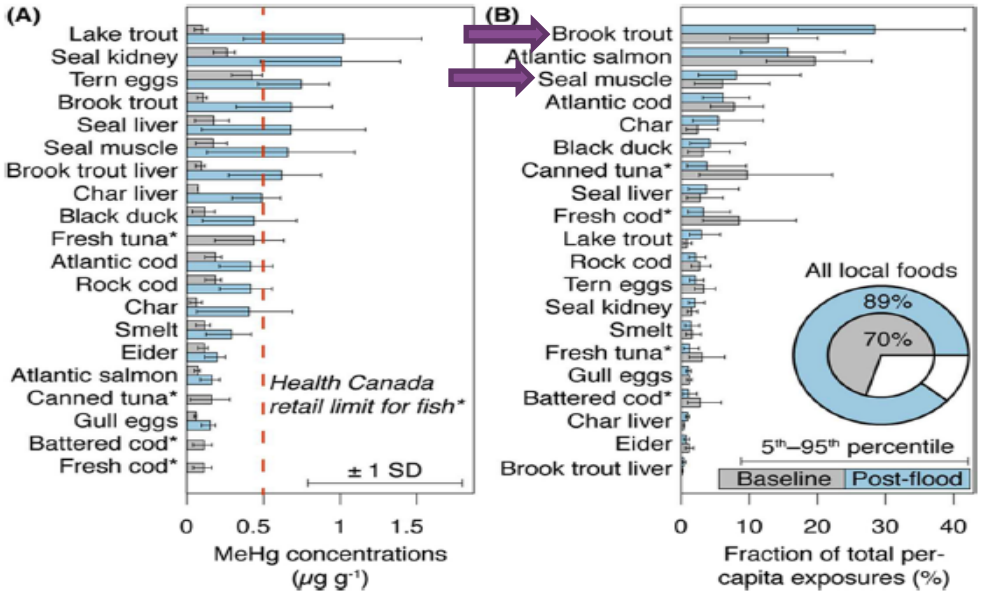
Rainbow Smelt

"Risk Assessment 101"

- Defining the extent and impact of exposure is the key to understanding environmental illnesses
- No harm without exposure
- Exposure does not always mean harm

- **Brook Trout**
- **Rainbow Smelt**
- **Ringed Seal**

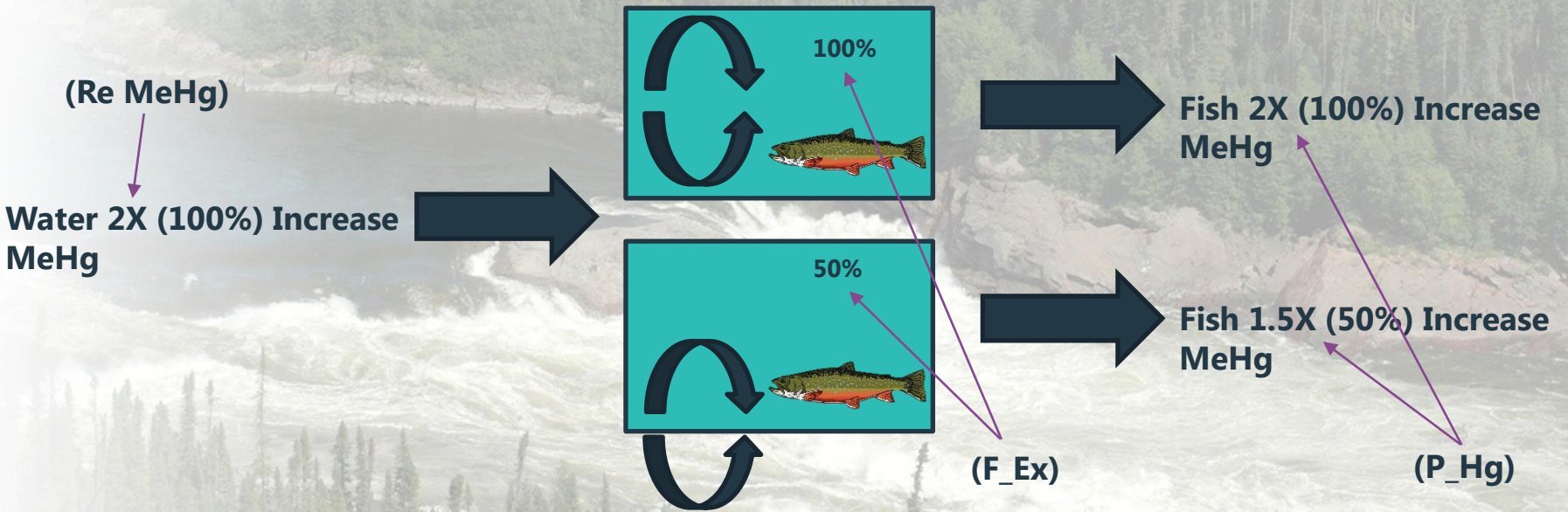
Calder et al. (2016)



Fish Hg Predicted Relative Increases (P_Hg)

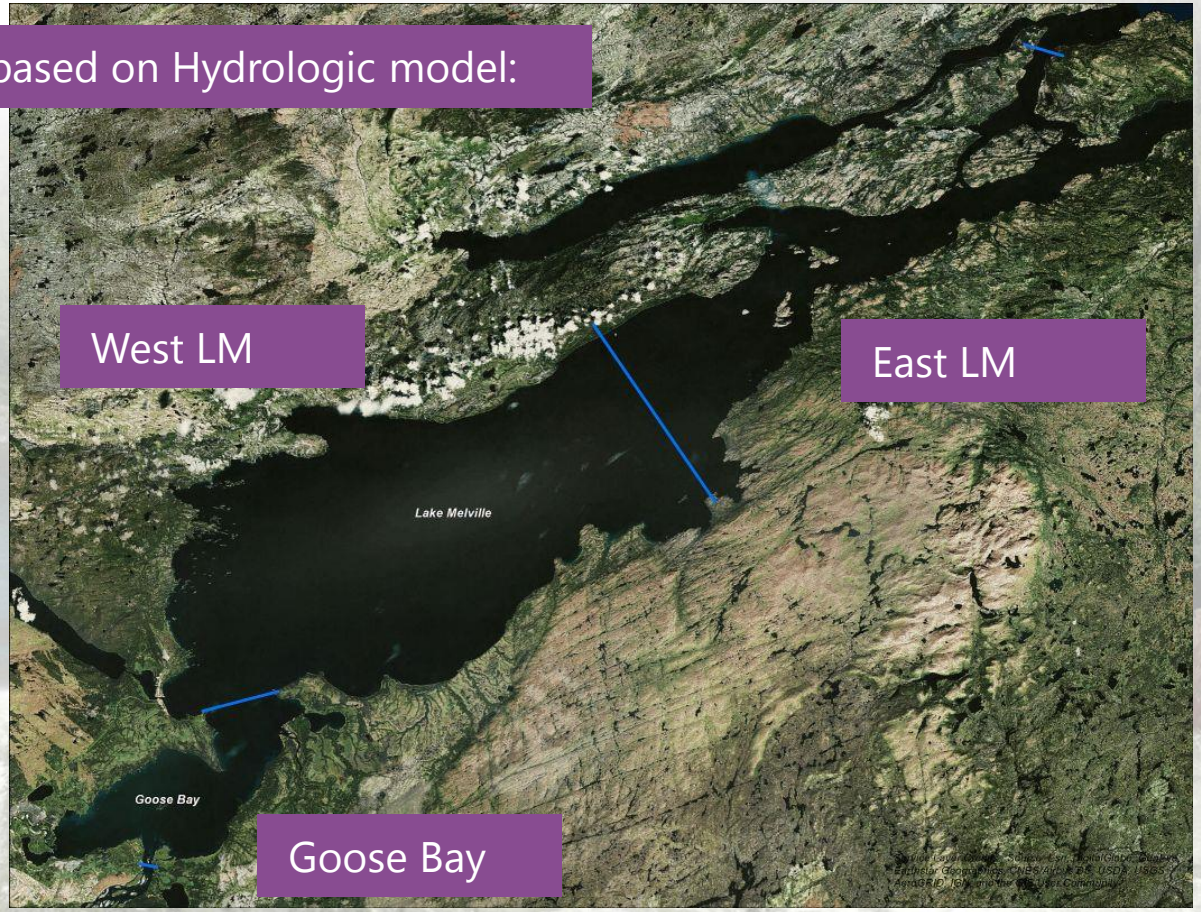
Predicted Increases in fish MeHg will be affected by:

- Increases in water MeHg concentration (Re MeHg)
- Exposure level of fish (F_Ex)



Increases in MeHg Water Concentration

Three Zones based on Hydrologic model:



Increases MeHg Water Concentration (0-20m)

	Goose Bay	West Lake Melville	East Lake Melville
Baseline MeHg Water Concentration (Calder et al. 2016; ng/L)	0.017	0.017	0.017
Peak Concentration (max 3-yr mean; ng/L) (Reservoir, Hydrodynamics, photodegradation, settling)	0.019	0.006	0.005
Relative MeHg Increase in Water	**2.12x**	**1.35x**	**1.29x**

Three Year Mean
Water Increase x exposure = Fish Increase

Exposure Level of Fish (F_Ex)

	Habitat Not Influenced by Muskrat Falls	Goose Bay	West Lake Melville	East Lake Melville
Brook Trout Time spent in each area of Exposure (annual)	30%	70%	70%	70%
Rainbow Smelt Time spent in each area of Exposure (annual)	0%	20% / 100%	80%	80%
Ringed Seal Time spent in each area of Exposure (annual)	34%	-	66%	66%
Arctic Char	Very uncommon in Estuary – primarily along coast of Labrador			
Atlantic Salmon	Captured in Estuary but cease feeding during spawning migration			
Atlantic Cod	Not captured in Estuary – primarily along coast of Labrador			
Capelin	None seen in Estuary since ~ mid-1970s (M. clement pers comm)			
Rock Cod / Tomcod	Not identified in diet surveys			
Lake Trout	None in Estuary or lower Churchill River below Winokapau			
Ouananiche	None in Estuary or lower Churchill River below Grizzle Rapids			

Predicted Hg Increases for Human Risk Assessment

- Brook Trout – Would not migrate through different zones therefore three different P_Hgs based on habitat used
  - Goose Bay = **1.78x (78%) increase**
  - West Lake Melville = **1.25x (25%) increase**
  - East Lake Melville = **1.20x (20%) increase**

- Rainbow Smelt – Those resident in Goose Bay would be Exposed to Goose Bay MeHg fully, those in Lake Melville assumed to congregate in Goose Bay prior to spawning (20%) and then 80% in respective Lake Melville zones (weighted average)
  - Goose Bay Residents = **2.12x (112%) increase**
  - West Lake Melville = **1.50x (50%) increase**
  - East Lake Melville = **1.46x (46%) increase**

- Ringed Seals – Assumed 2/3 of time in Lake Melville with migration between zones (1/3 each zone weighted average)
  - Lake Melville (with migration between zones) = **1.32x (32%) increase**

Baseline Hg in Fish (mg/kg)

Species	Goose Bay	West Lake Melville	East Lake Melville
Brook Trout Hg Baseline (2017; mg/kg)	0.07	0.04	0.03
Rainbow Smelt Hg Baseline (2016; mg/kg)	0.02	0.02	0.04
Ringed Seal Hg Baseline (muscle 2017; mg/kg)	-	0.13	0.13

Predicted Increase in Fish Hg (mg/kg)

Species	Goose Bay			West Lake Melville			East Lake Melville		
	P_Hg	Baseline Hg	Predicted Hg (mg/kg)	P_Hg	Baseline Hg	Predicted Hg (mg/kg)	P_Hg	Baseline Hg	Predicted Hg (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[a]	**0.043**	1.50x	0.02	**0.030**	1.46x	0.04	**0.058**
Ringed Seal[b]	1.32x	-	**-**	1.32x	0.13	**0.172**	1.32x	0.13	**0.172**

All based on 2017 data except:
a. 2016 Hg data
b. 2017 seal Hg muscle (all ages)

These predicted increases have been carried through the Human Health Assessment

Predicted Increase in Fish Hg (mg/kg)

Species	Goose Bay			West Lake Melville			East Lake Melville		
	P_Hg	Baseline Hg	Predicted Hg (mg/kg)	P_Hg	Baseline Hg	Predicted Hg (mg/kg)	P_Hg	Baseline Hg	Predicted Hg (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[a]	**0.043**	1.50x	0.02	**0.030**	1.46x	0.04	**0.058**
Ringed Seal[b]	1.32x	-	**-**	1.32x	0.13	**0.172**	1.32x	0.13	**0.172**

- Biology and Ecosystem play Critical Roles in Ultimate Exposure for Fish and Humans
- Water Concentration Increases are Reduced the further from Muskrat Falls Reservoir
  - Fish Concentration Increases are Reduced the further from Muskrat Falls Reservoir
- These Factors need to be Considered in Human Health Risk / Benefit to Country Foods