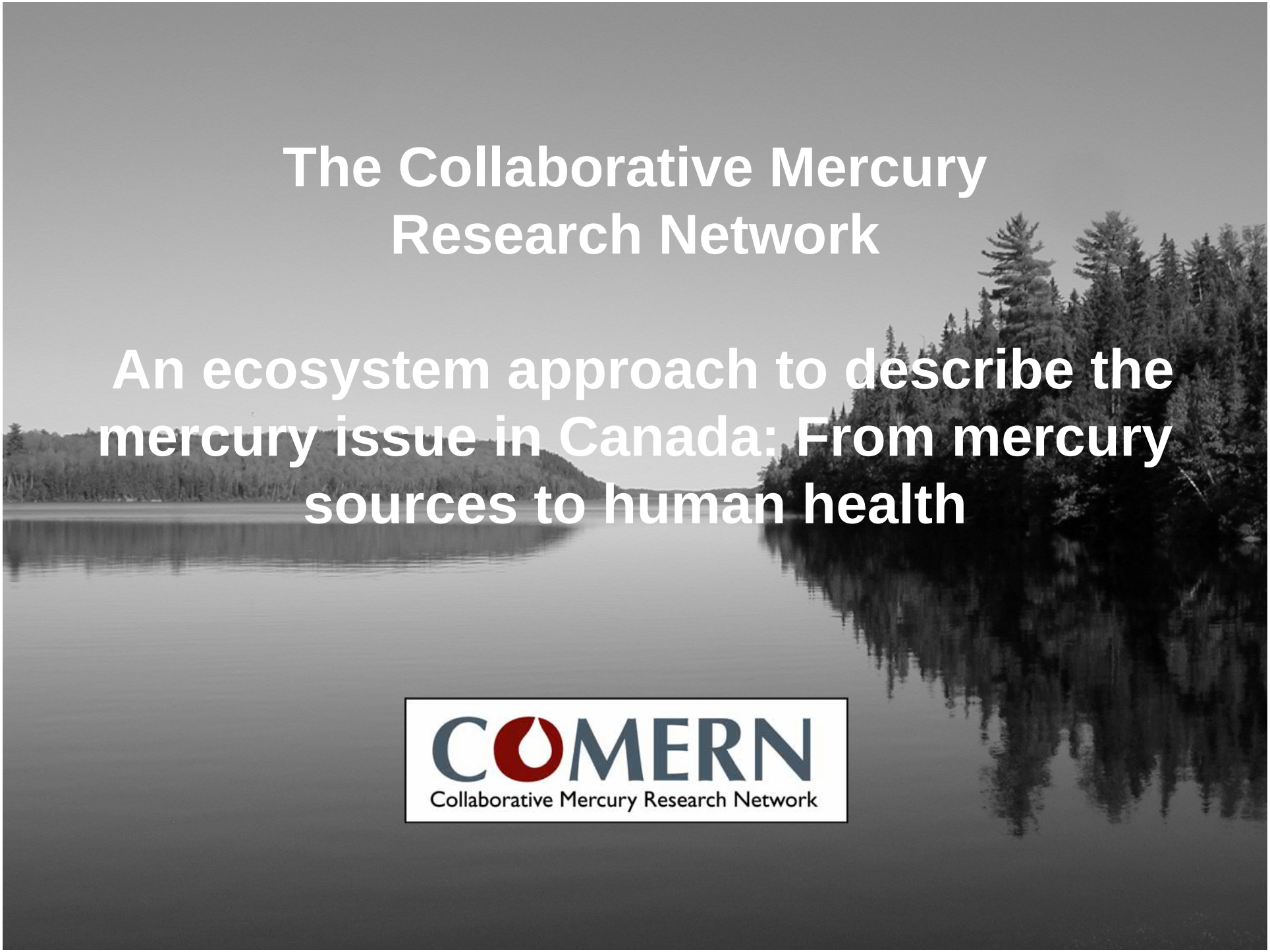


The Collaborative Mercury Research Network

An ecosystem approach to describe the mercury issue in Canada: From mercury sources to human health

COMERN
Collaborative Mercury Research Network

COMERN
Collaborative Mercury Research Network

A few numbers:

- **Over 60 researchers and Hg specialists**
- **from 14 Canadian universities**
- **in 7 provinces**
- **3 research centers**
- **7 ministries (provincial and federal)**
- **Involvement of over 150 « Canadian » graduate students, discovering the beauties of interdisciplinarity and … multiculturalism**
- **Active participation of First Nations and non First Nations communities**

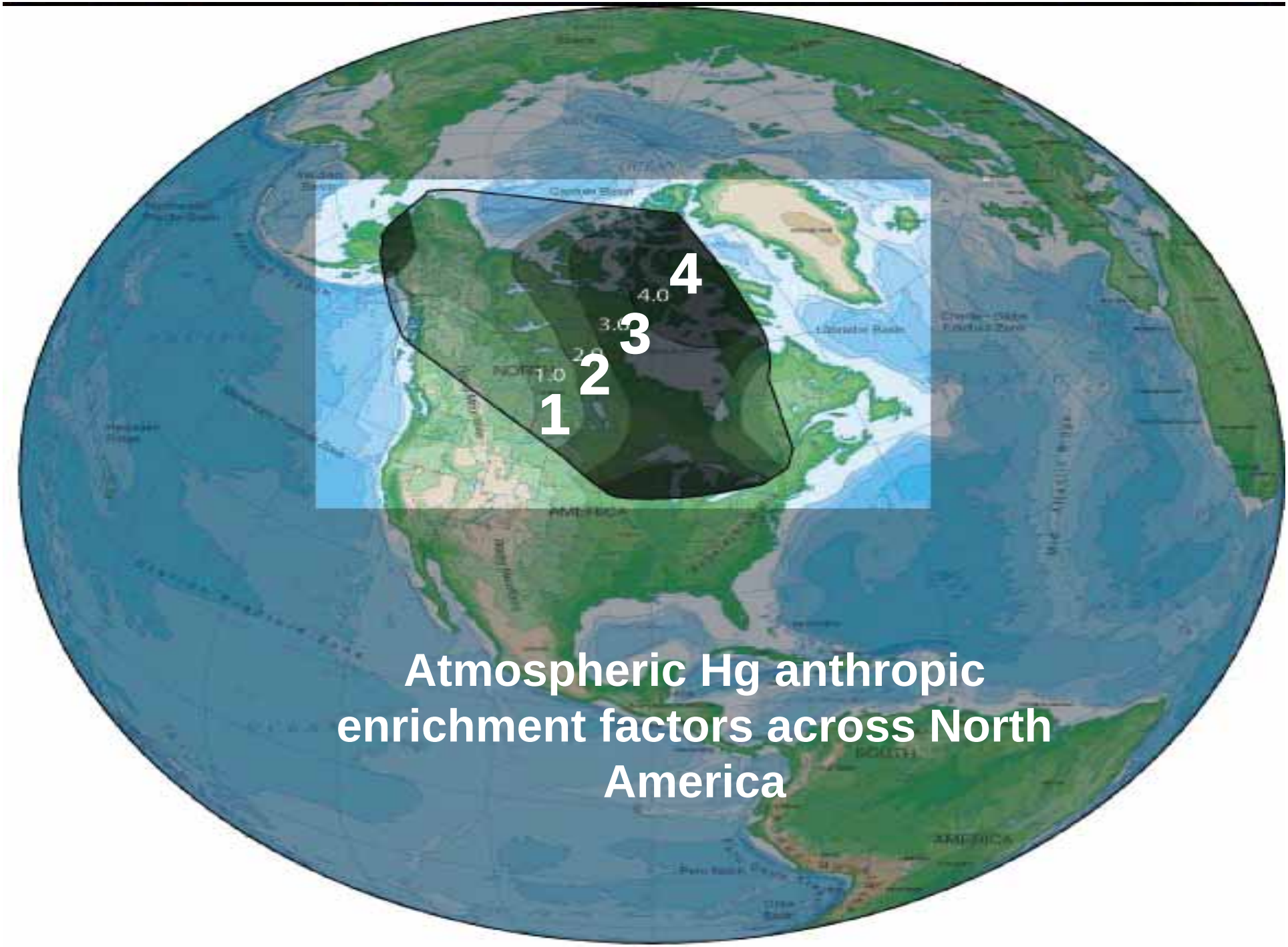

COMERN
Collaborative Mercury Research Network
Funding Over 5 Years
12.7 M$ from NSERC
Total budget: 18 M$

Preconceived ideas regarding Mercury in Canada:

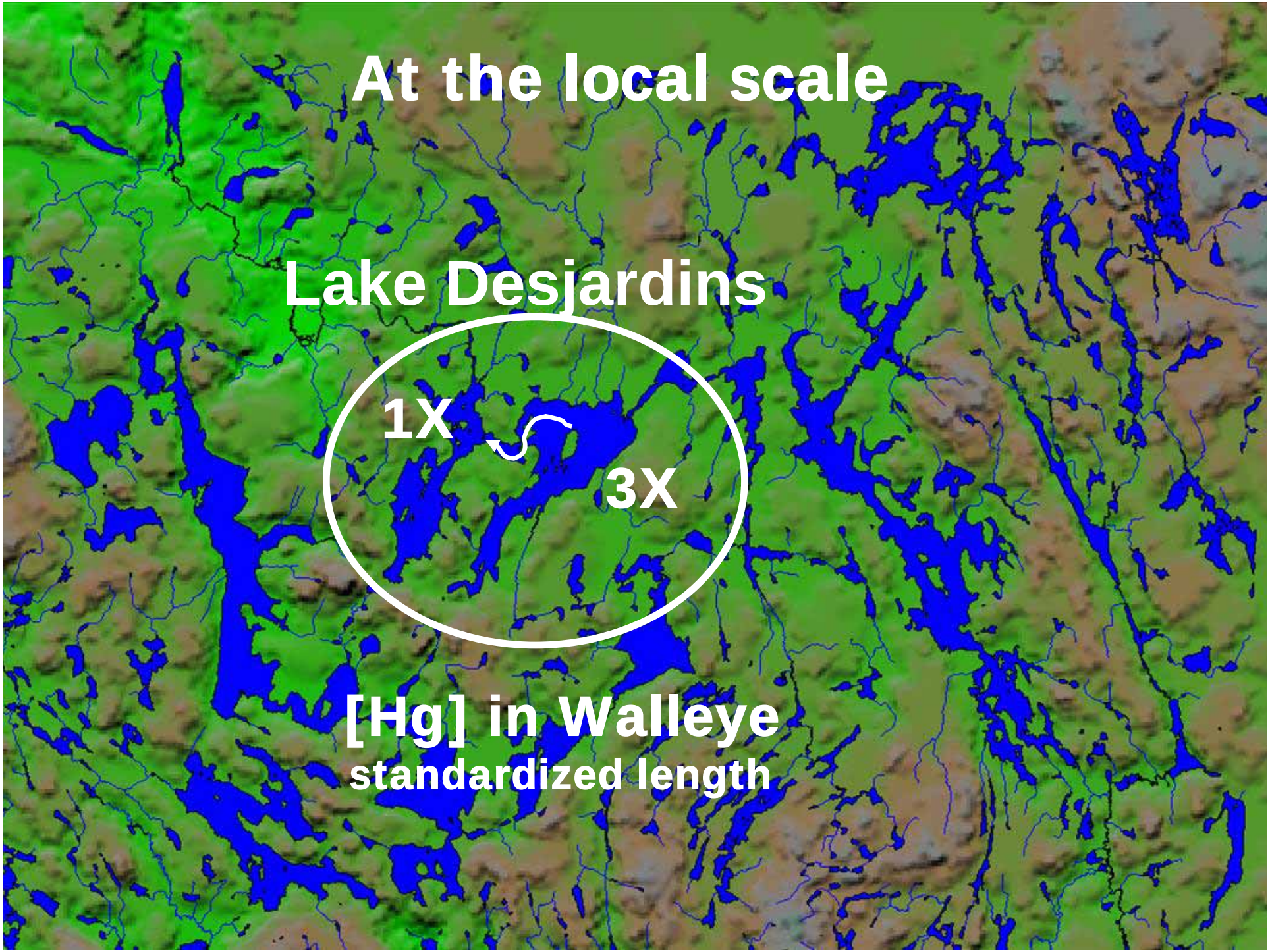
- High mercury concentrations in fish caught in “polluted” areas, near industries, cities or downwind major industrial-urban centers

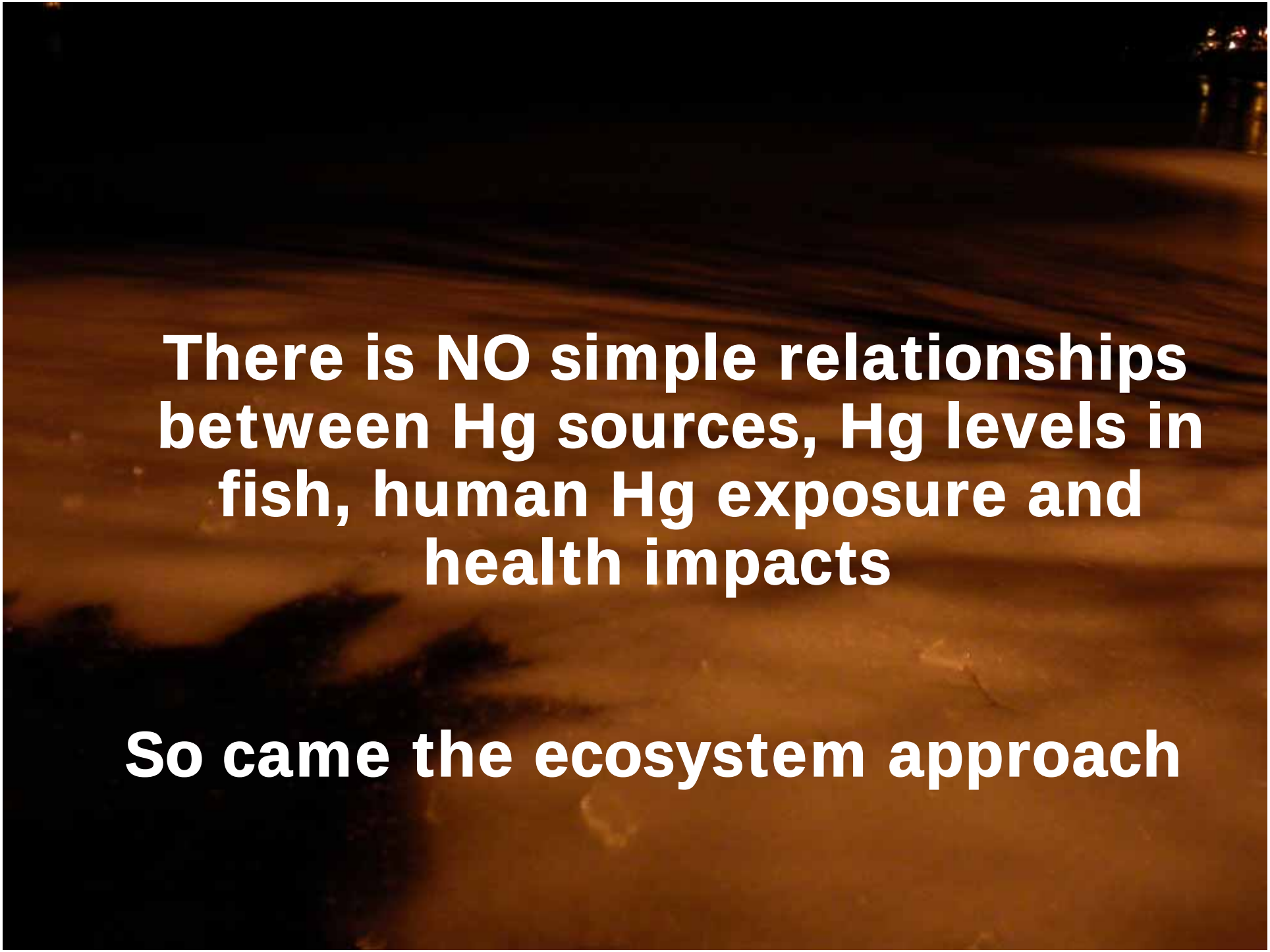
- Most exposed people are found in communities traditionally eating wild fish from these areas

- In the absence of Hg “point source”, there is a direct relationship between Hg atmospheric loading and ecosystems response



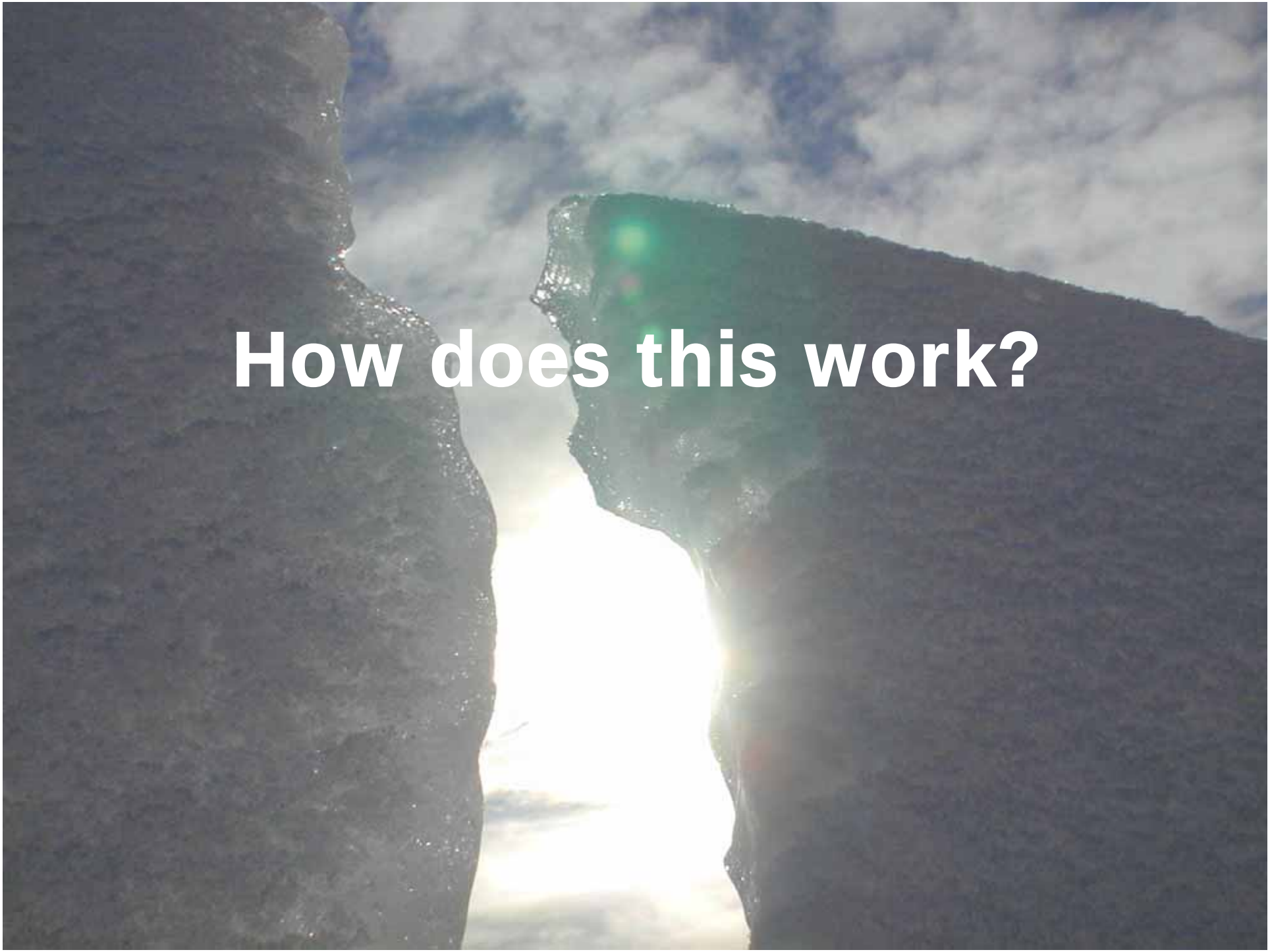
Atmospheric Hg anthropic enrichment factors across North America

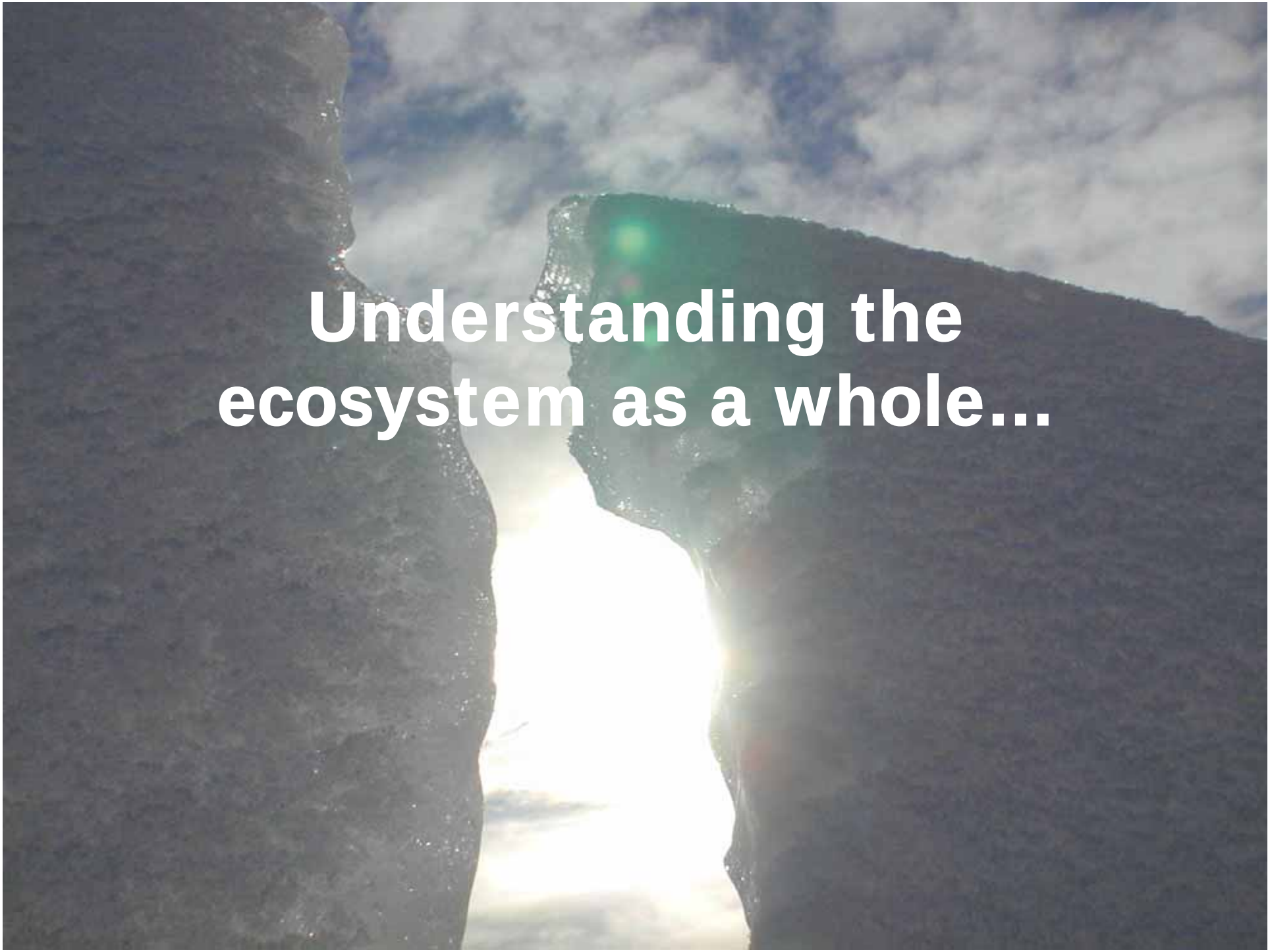

At the local scale
Lake Desjardins
1X
3X
[Hg] in Walleye
standardized length


There is NO simple relationships between Hg sources, Hg levels in fish, human Hg exposure and health impacts
So came the ecosystem approach

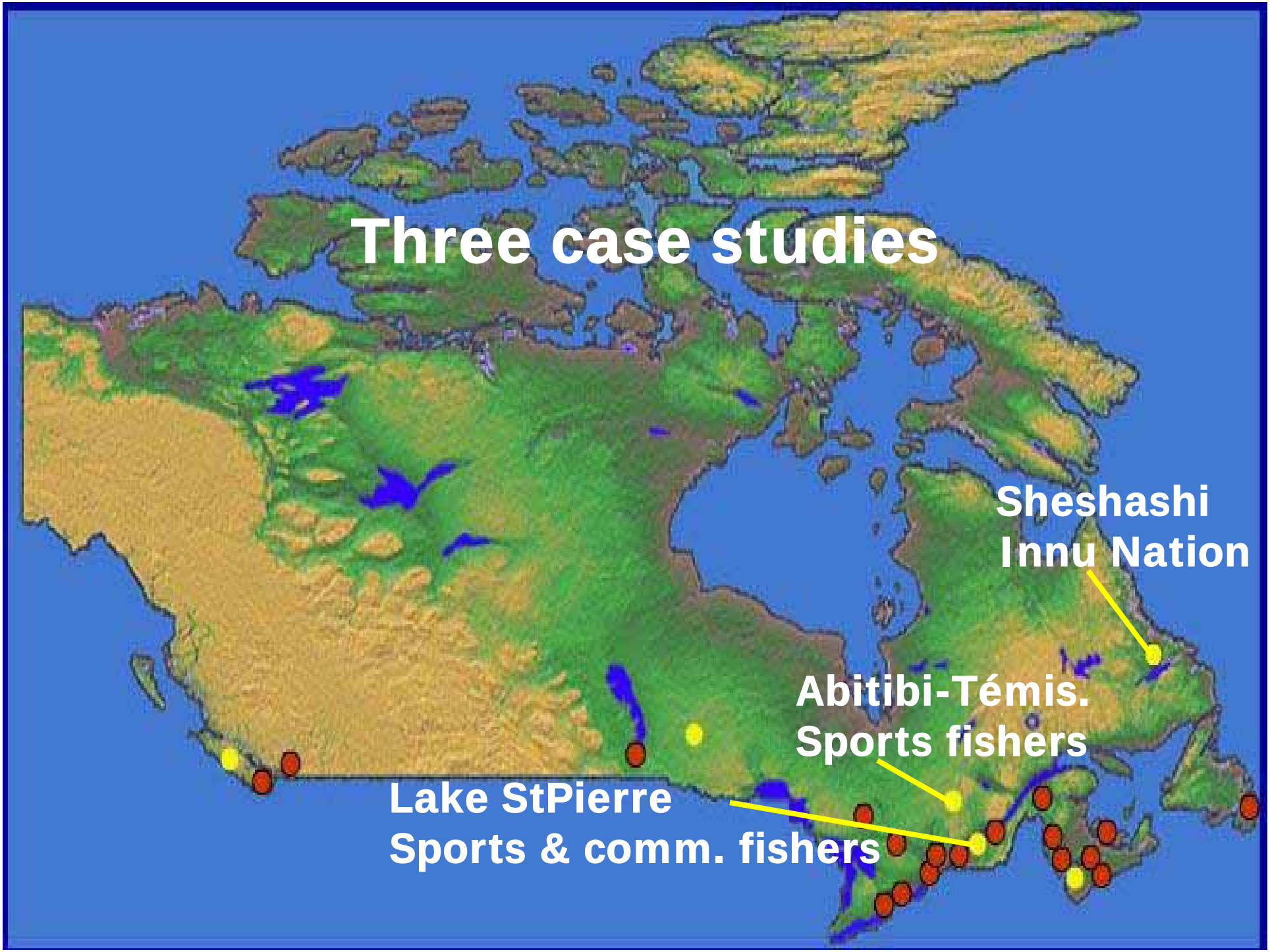

The structure of our research plan
A unique combination of critical gap studies feeding...

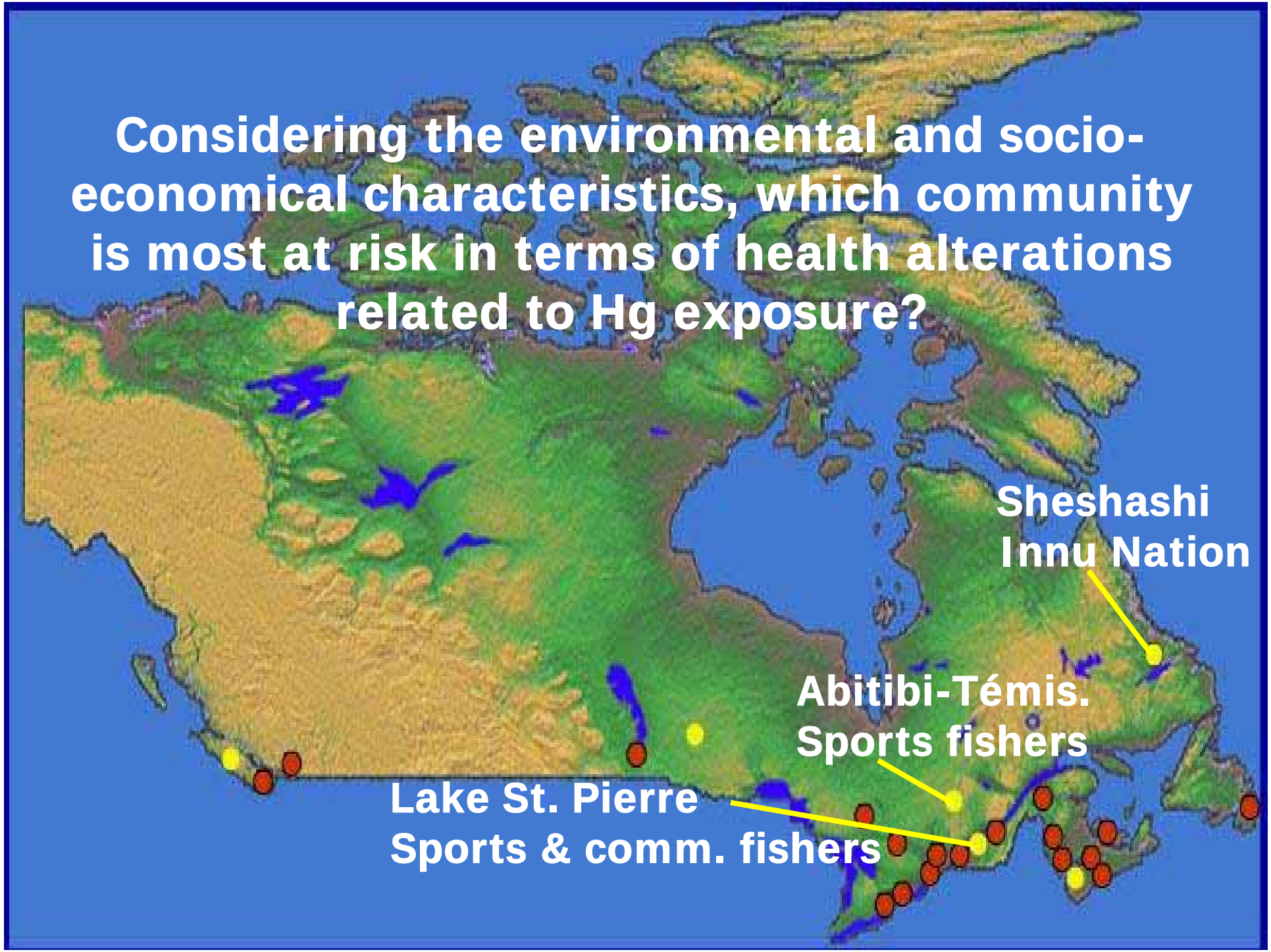

... and case studies
with the involvement of communities
Victoria Island
Retired Fishers
Grassy Narrows
Cree Nation
Sheshashi
Innu Nation
Abitibi-Témis.
Sports fishers
Lake St. Pierre
Sports & comm. fishers
Bay of Fundy


How does this work?


Understanding the
ecosystem as a whole...

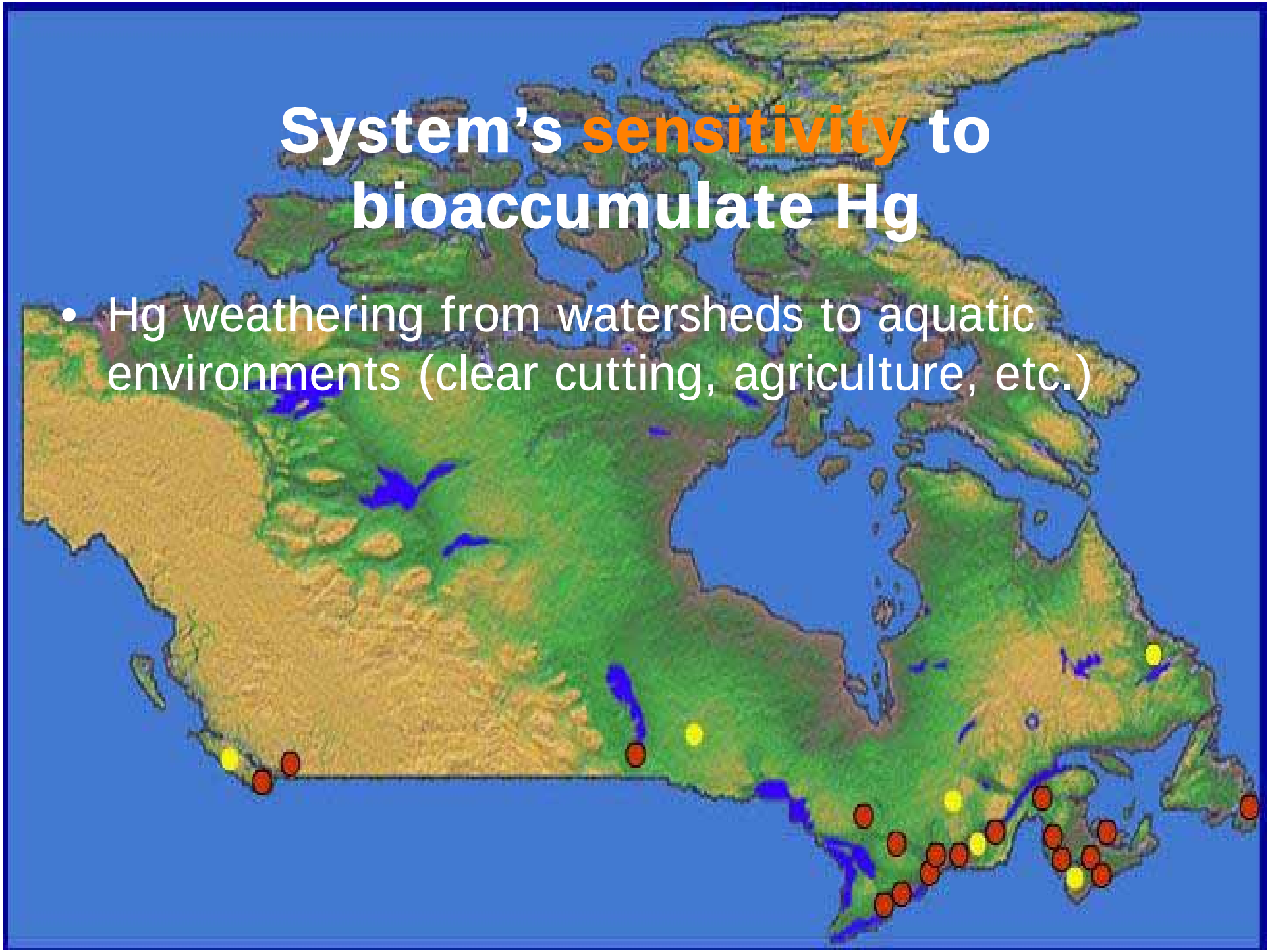

Including humans...


Three case studies
Sheshashi
Innu Nation
Abitibi-Témis.
Sports fishers
Lake StPierre
Sports & comm. fishers


Considering the environmental and socio-economical characteristics, which community is most at risk in terms of health alterations related to Hg exposure?
Sheshashi
Innu Nation
Abitibi-Témis.
Sports fishers
Lake St. Pierre
Sports & comm. fishers

System's sensitivity to bioaccumulate Hg

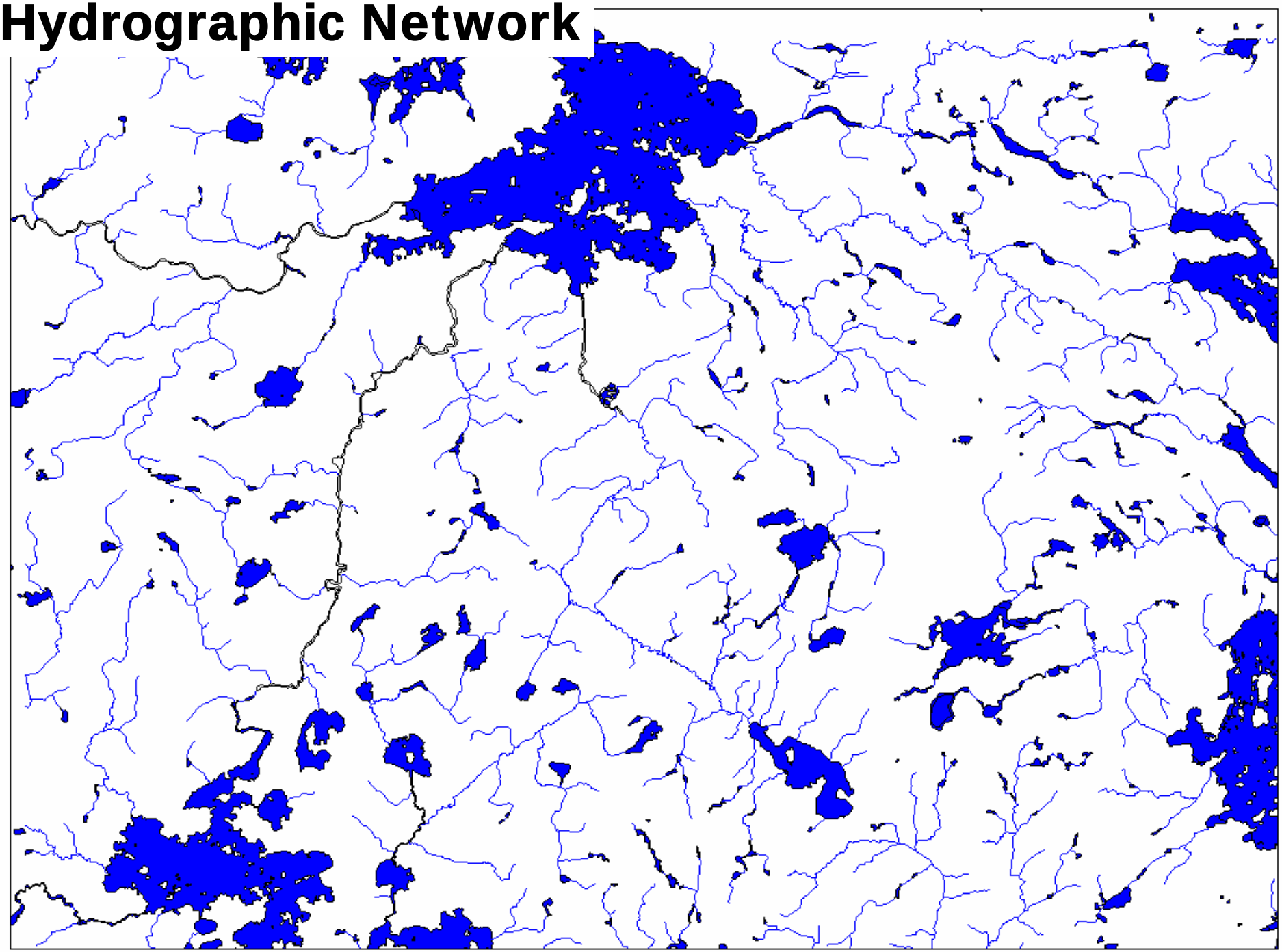
- Hg weathering from watersheds to aquatic environments (clear cutting, agriculture, etc.)



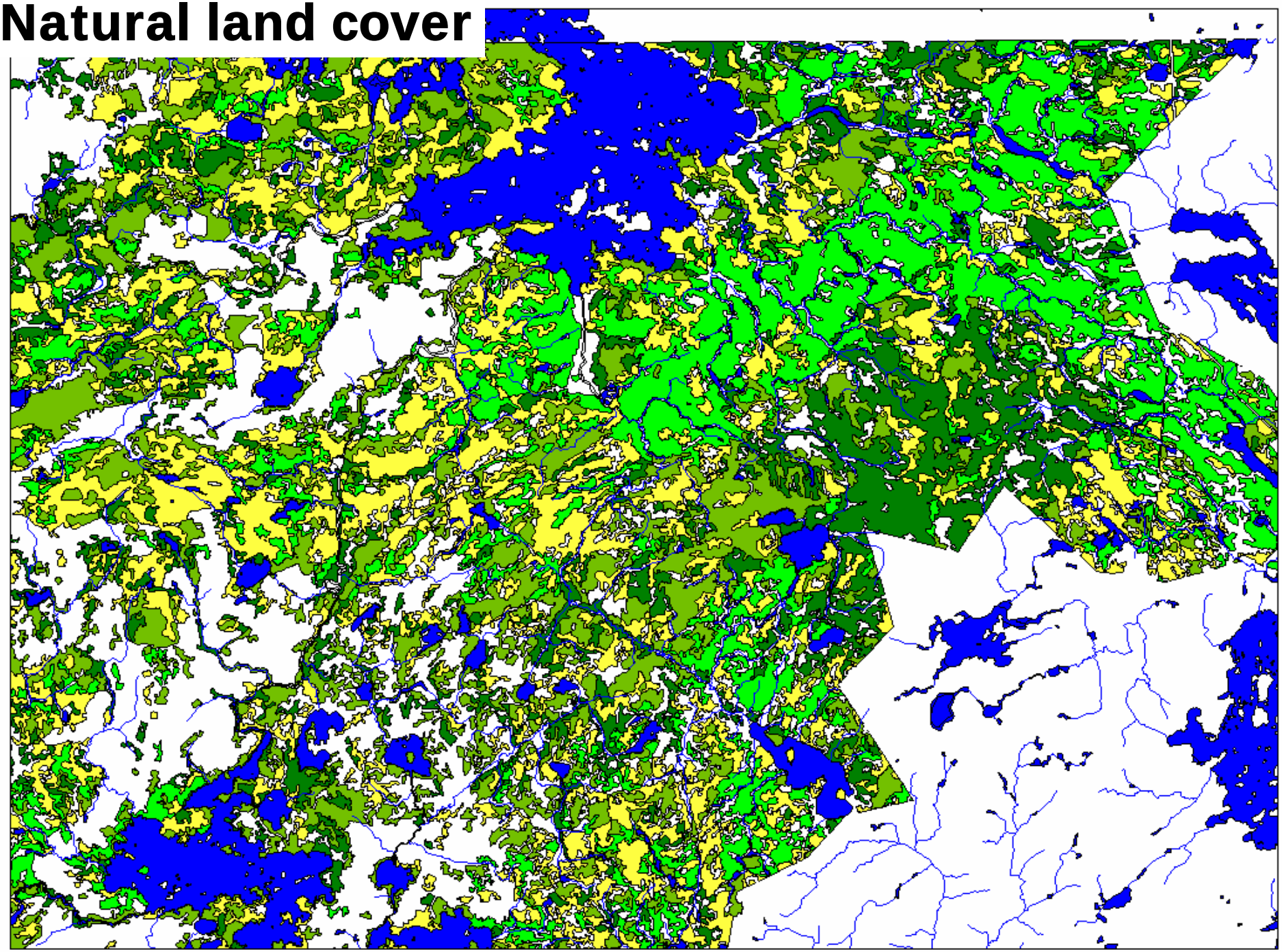
Lakes under study

	Malartic	Dupar-quet	Preissac	Noname	Panch	Rocky pond	Shipiskan	St. Pierre
Region	Abitibi			Labrador				St. Lawrence
Lake area (ha)	11440	4847	8251	2743	1407	621	1721	31130
Watershed area (10^3 ha)	307,1	172,4	99,4	36,2	131,4	30,7	360,4	75050
Mean slope (%)	3,00	5,24	1,06	2,73	5,08	2,43	3,70	2,3*
Ratio lake /watershed	27	36	12	13	93	50	209	2411
Wetland area (% watershed)	8	3	5	NA	NA	14	NA	1*
Exploitation	Sports-fishing	Sports-fishing	Sports-fishing	Subsistence	Subsistence	Subsistence	Subsistence	Sports Commercial
agriculture (% watershed)	3	1	1	0	0	0	0	27
Forestry (% watershed)	3	7	2	0	0	0	0	NA
Population density (nb/km2)	1 to 9,9	1 to 9,9	1 to 9,9	0 to 0,9	0 to 0,9	0 to 0,9	0 to 0,9	10 to 69,9
Ethnic groups	Caucasian & First Nations	Caucasian & First Nations	Caucasian & First Nations	Innu	Innu	Innu	Innu	Caucasian

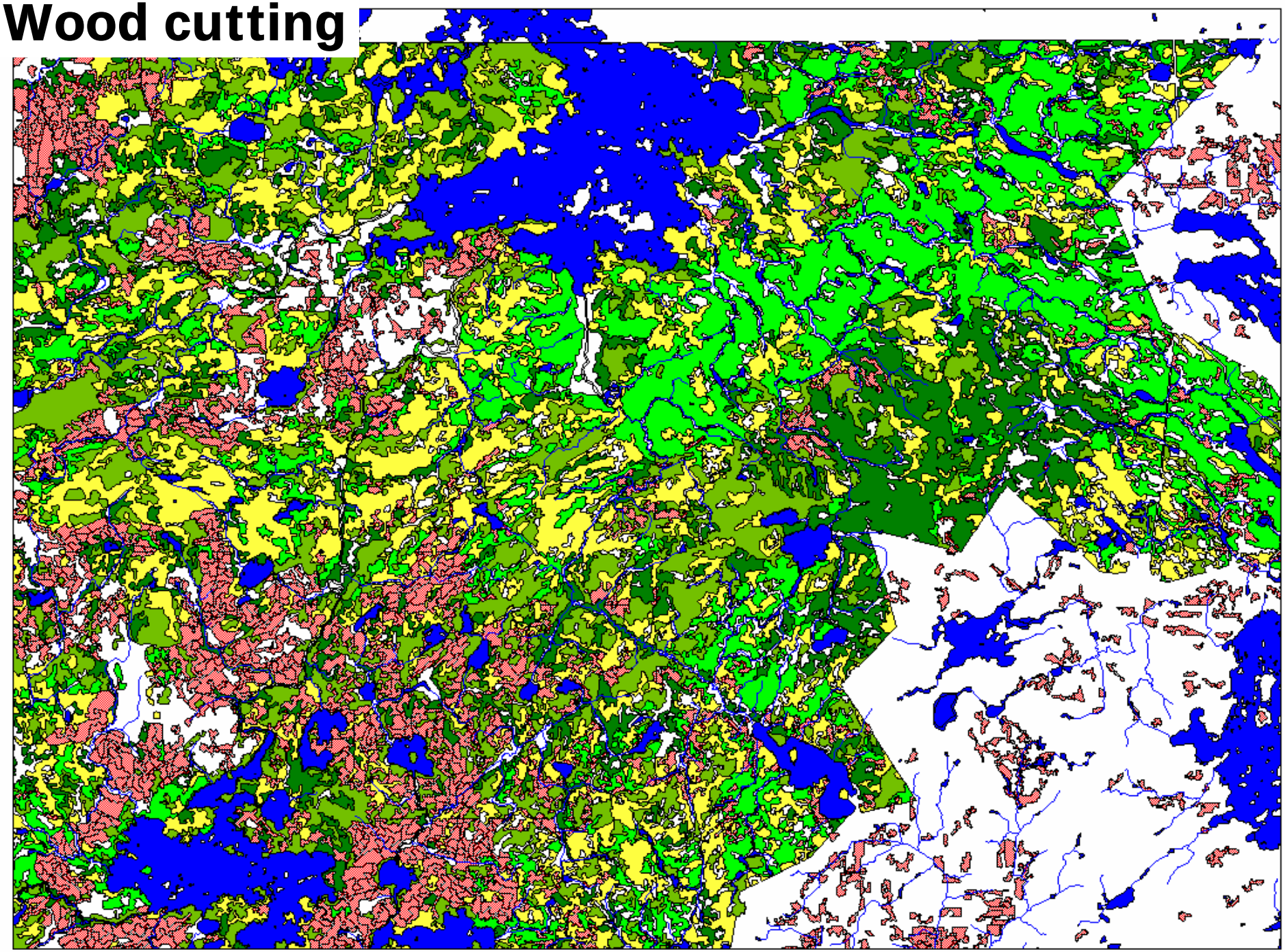
Hydrographic Network



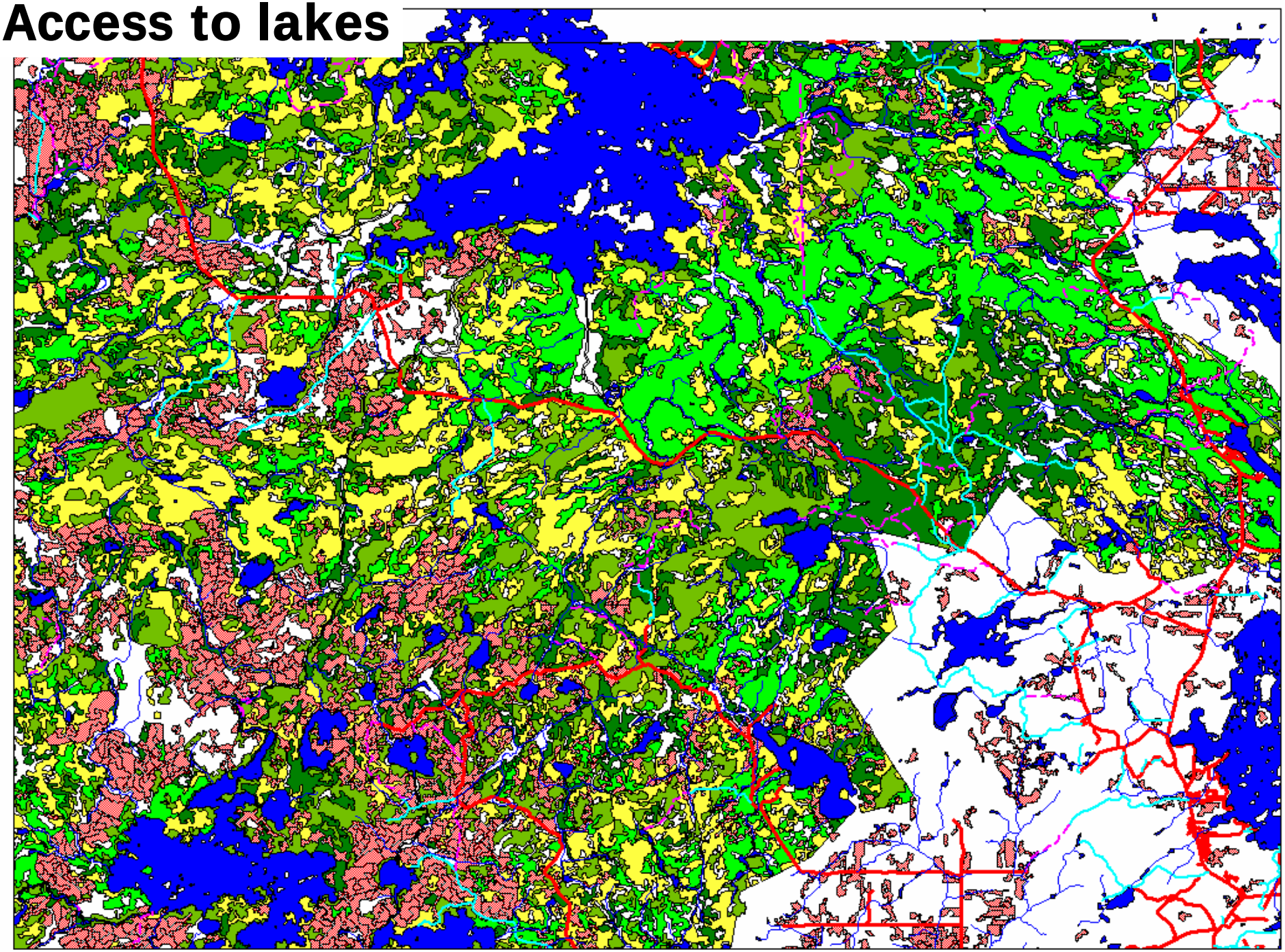
Natural land cover



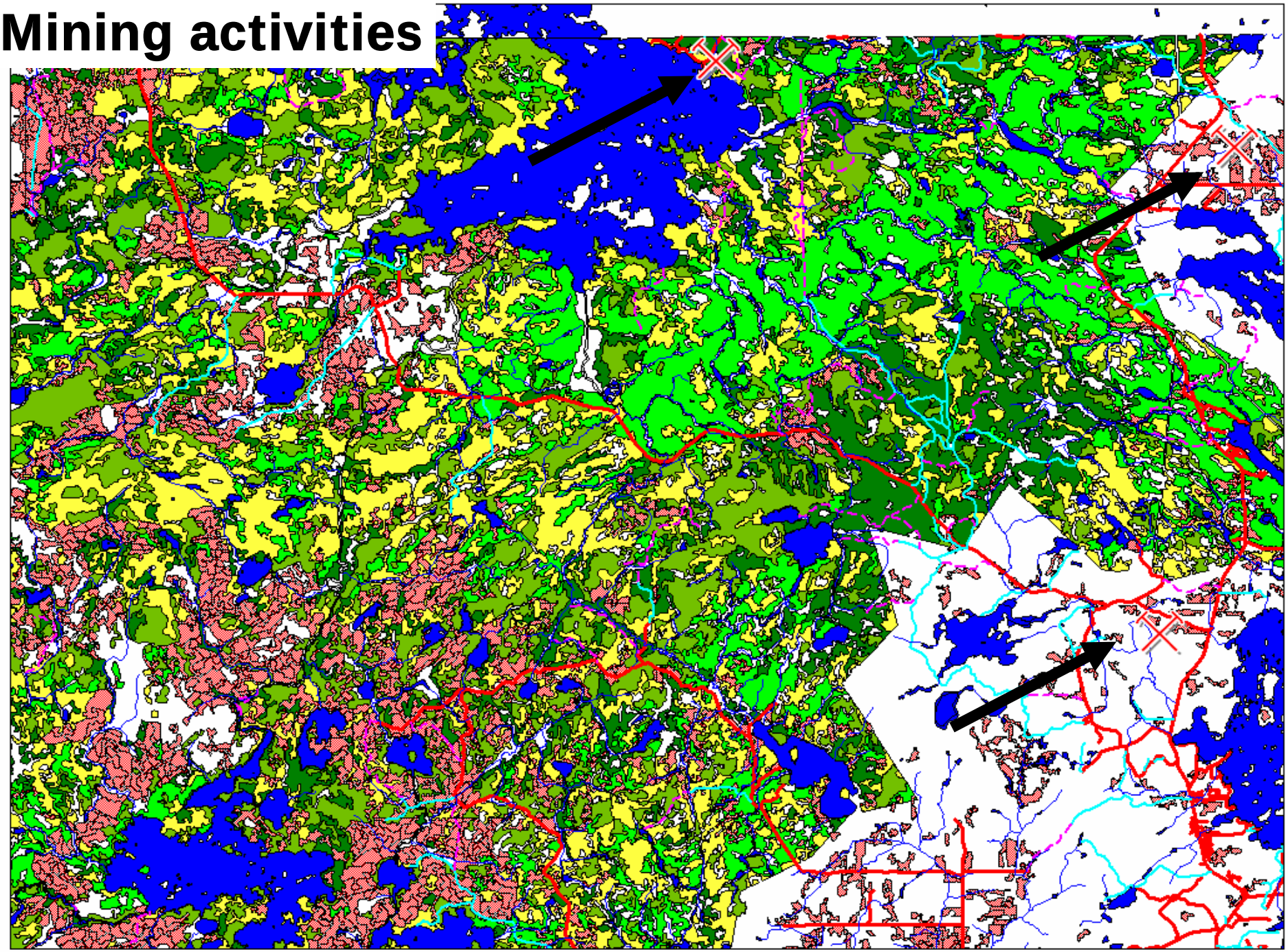
Wood cutting



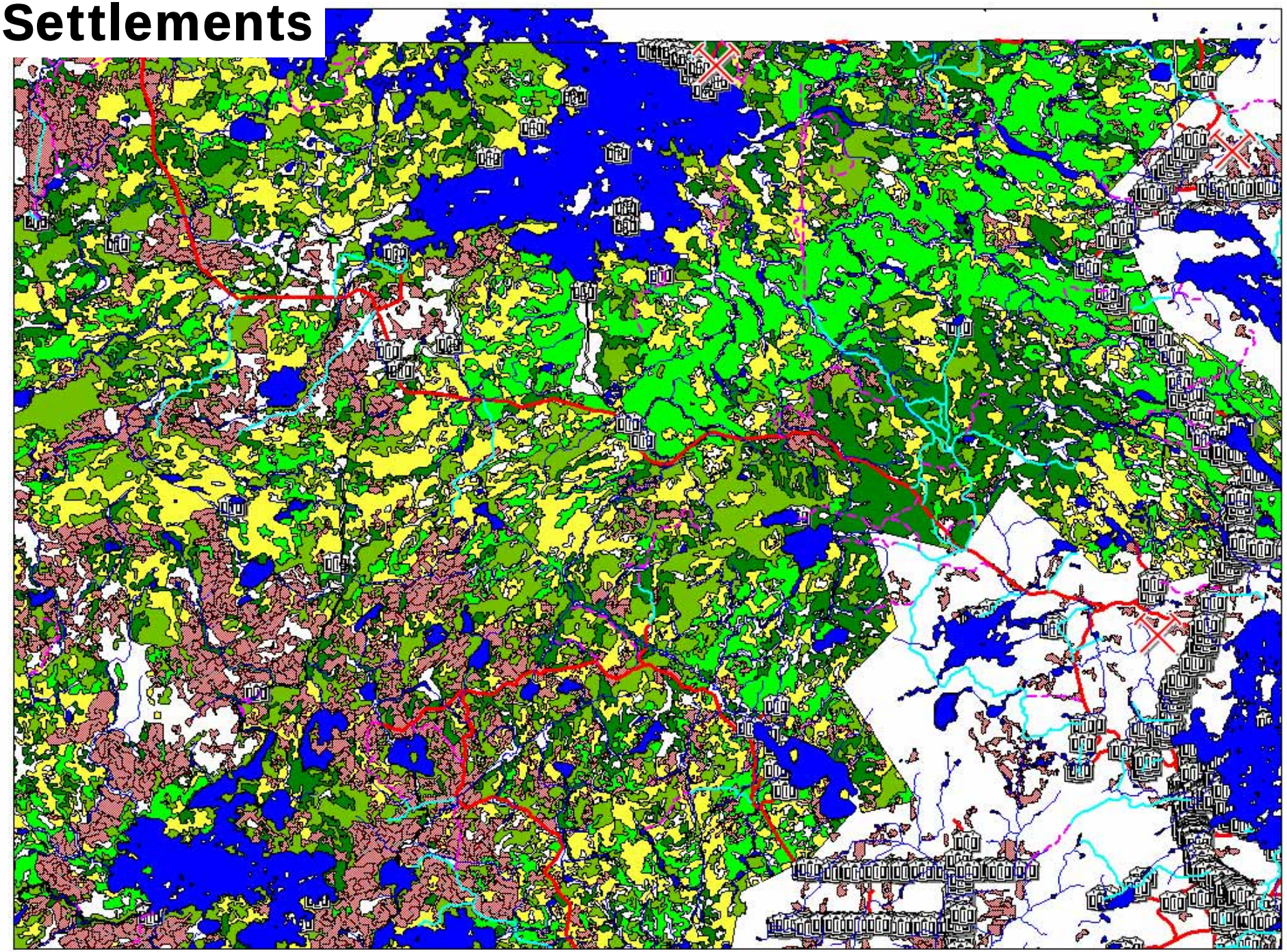
Access to lakes



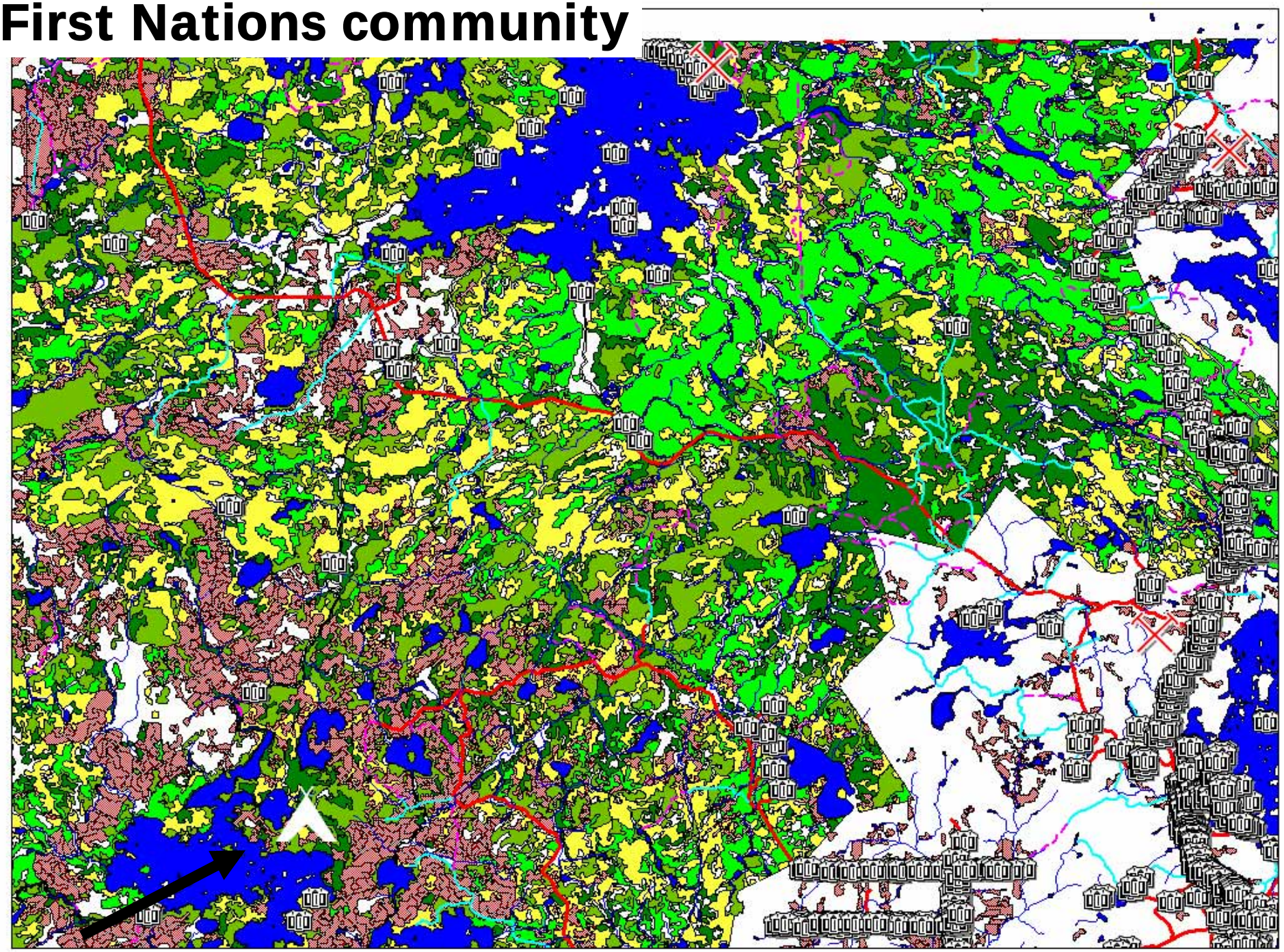
Mining activities



Settlements

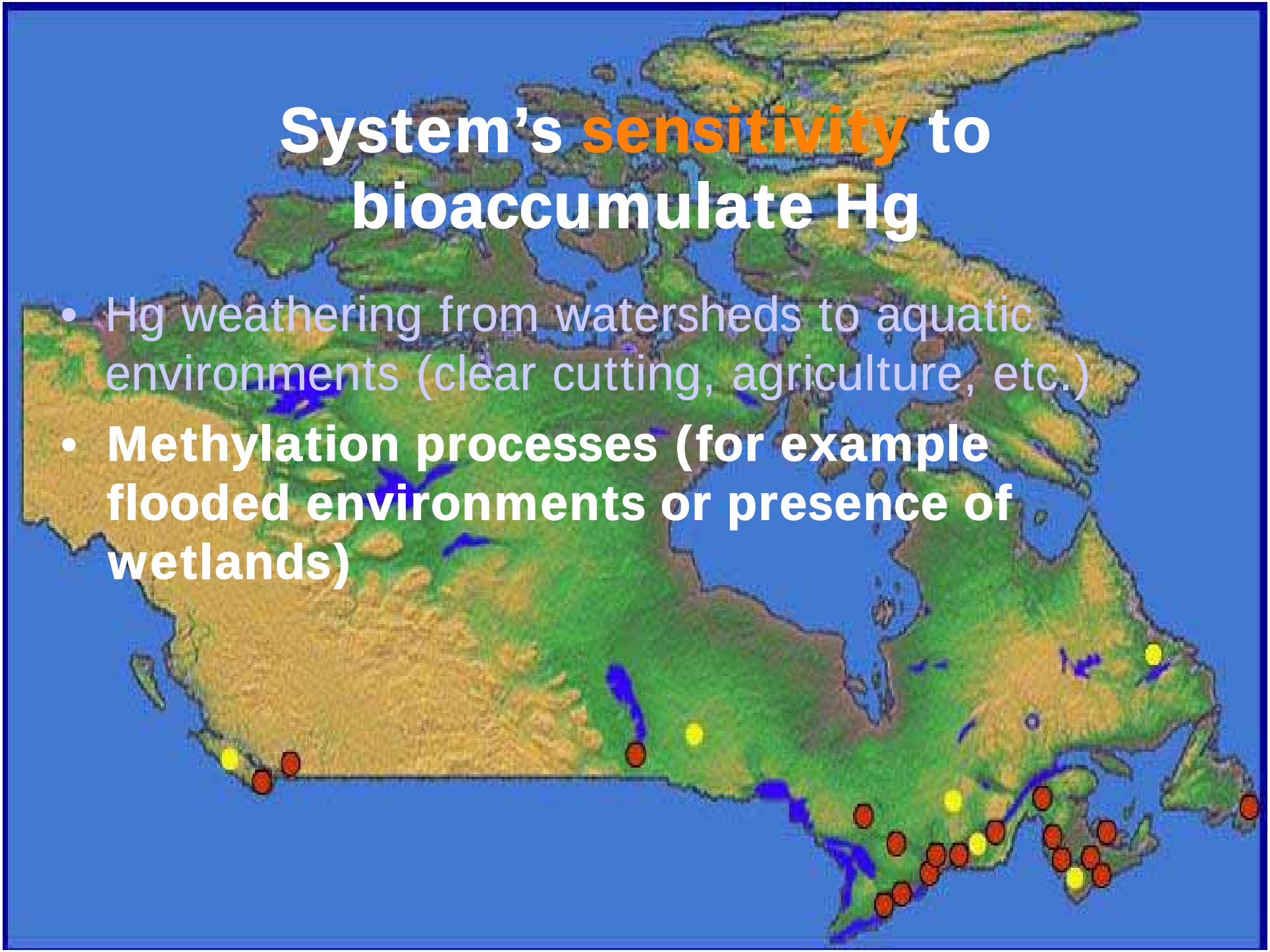


First Nations community



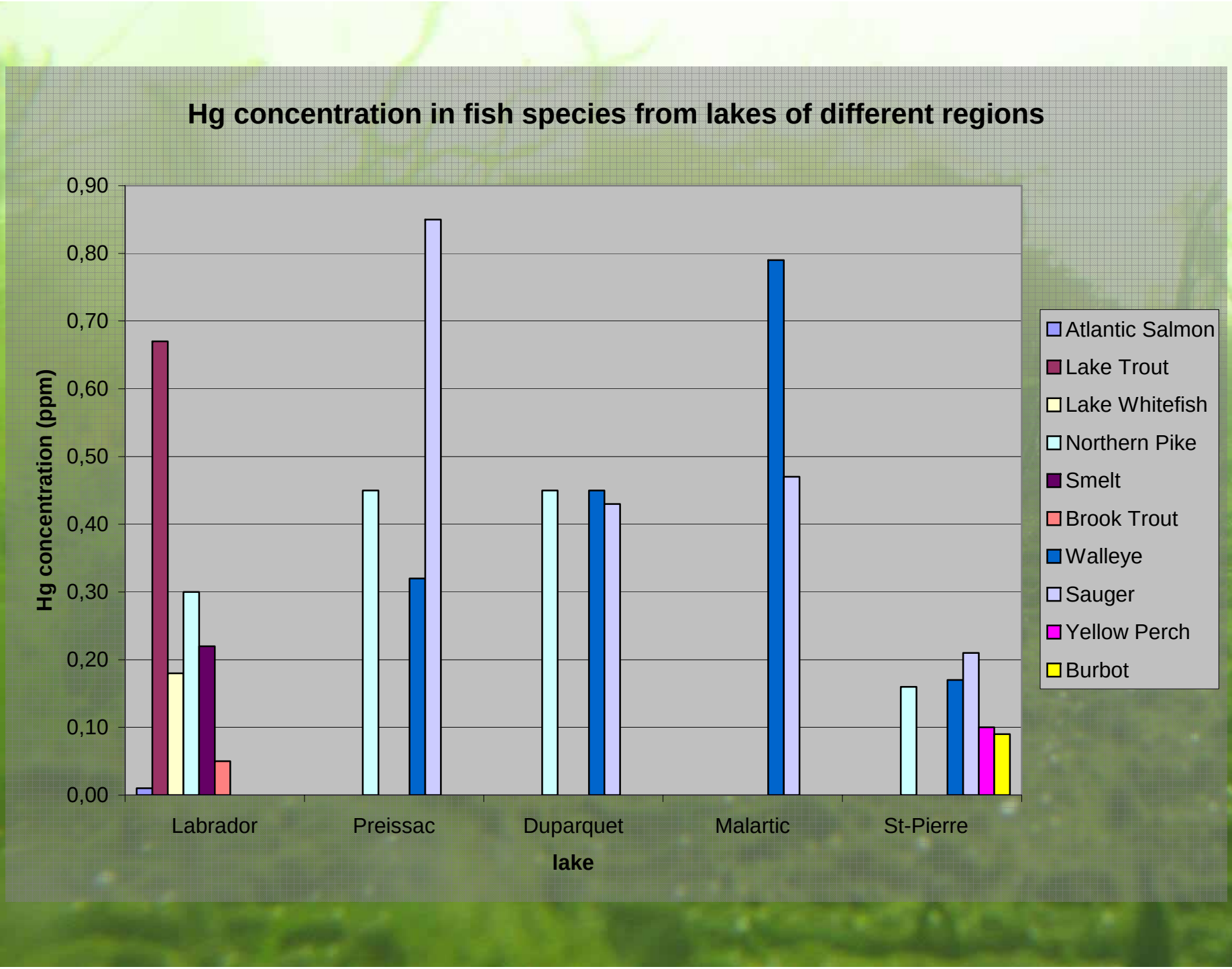
System's sensitivity to bioaccumulate Hg

- Hg weathering from watersheds to aquatic environments (clear cutting, agriculture, etc.)
- **Methylation processes (for example flooded environments or presence of wetlands)**



Lakes under study

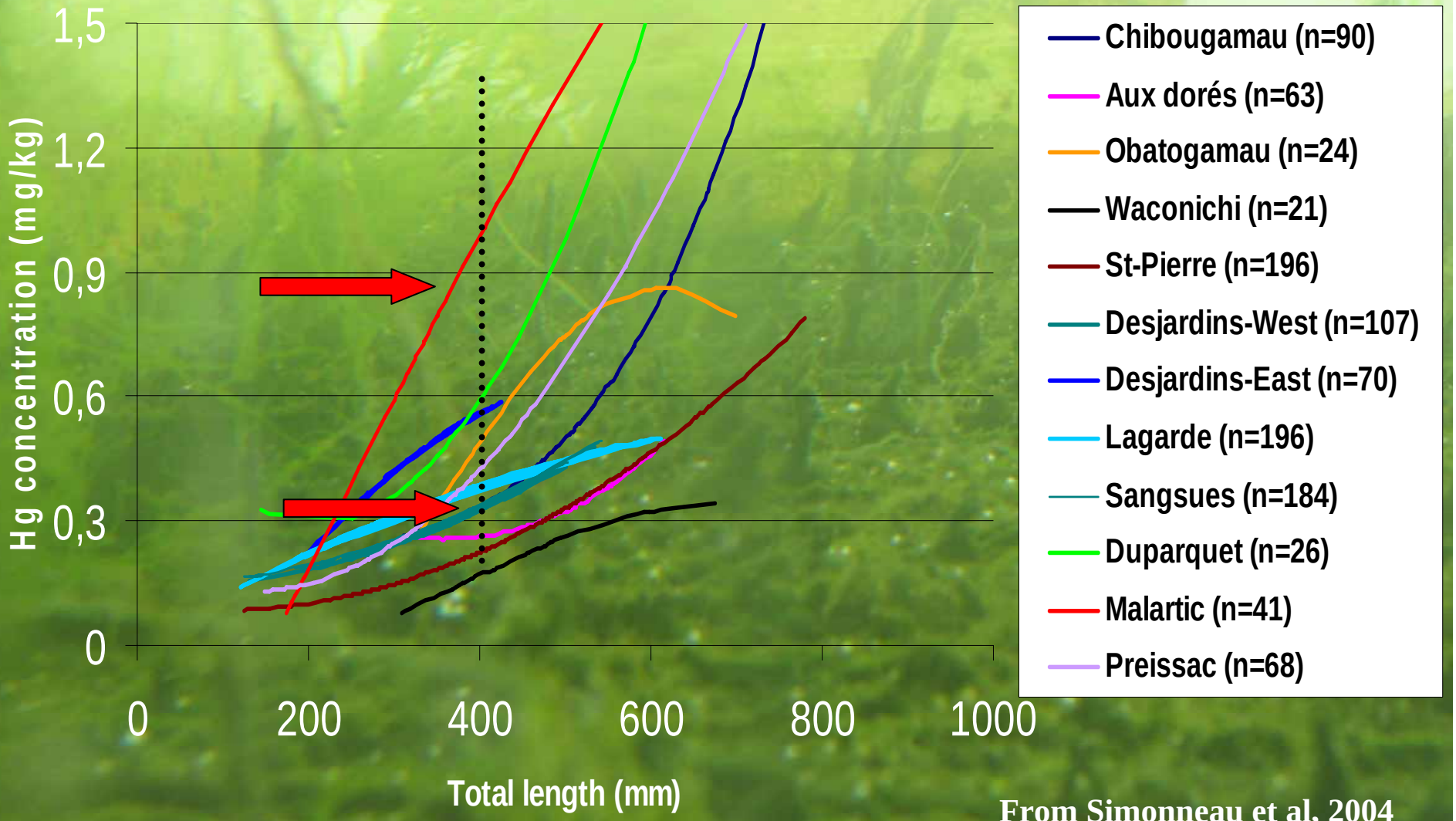
	Malartic	Du-parquet	Preis-sac	Noname	Panch	Rocky Pond	Shipiskan	St. Pierre
Region	**Abitibi**			**Labrador**				**St Lawrence**
Water color (Pt mg/L)	**83,7**	58,5	58,5	5,9	**1,7**	6,3	2,1	50,1
PO4 (umol / l -- P)	0,66	0,68	0,44	NA	NA	NA	NA	1,48
DOC (ppm -- C)	10,86	10,92	9,05	NA	NA	NA	NA	7,67
Diss. Hg (ng/L)	1,19	1,67	**0,75**	**2,8**	2,2	2,7	2,2	1,10
pH	7,0	7,4	7,1	**5,8**	6,0	5,9	6,3	**7,6**
Conductivity (µS/cm)	85,99	95,45	110,00	16,52	NA	18,00	35,92	317,24
SPM (mg/L)	11,85	11,58	3,65	1,55	0,21	0,93	0,14	18,61
Hg SPM (ppb)	116,50	349,70	155,20	NA	NA	NA	NA	548,33
chl@	3,07	4,52	3,16	2,68	0,82	1,94	**0,67**	**4,78**
Hg Atm. loadings ug/m2/yr	**5**			**5**				**4.1**


Hg concentration in fish species from lakes of different regions
Hg concentration (ppm)
0,90
0,80
0,70
0,60
0,50
0,40
0,30
0,20
0,10
0,00
Labrador
Preissac
Duparquet
Malartic
St-Pierre
lake
Atlantic Salmon
Lake Trout
Lake Whitefish
Northern Pike
Smelt
Brook Trout
Walleye
Sauger
Yellow Perch
Burbot

System's sensitivity to bioaccumulate Hg

- Hg weathering from watersheds to aquatic environments (clear cutting, agriculture, etc.)
- Methylation processes (presence of wetlands)
- **Structure of aquatic trophic web**

Walleye total length versus Hg concentration



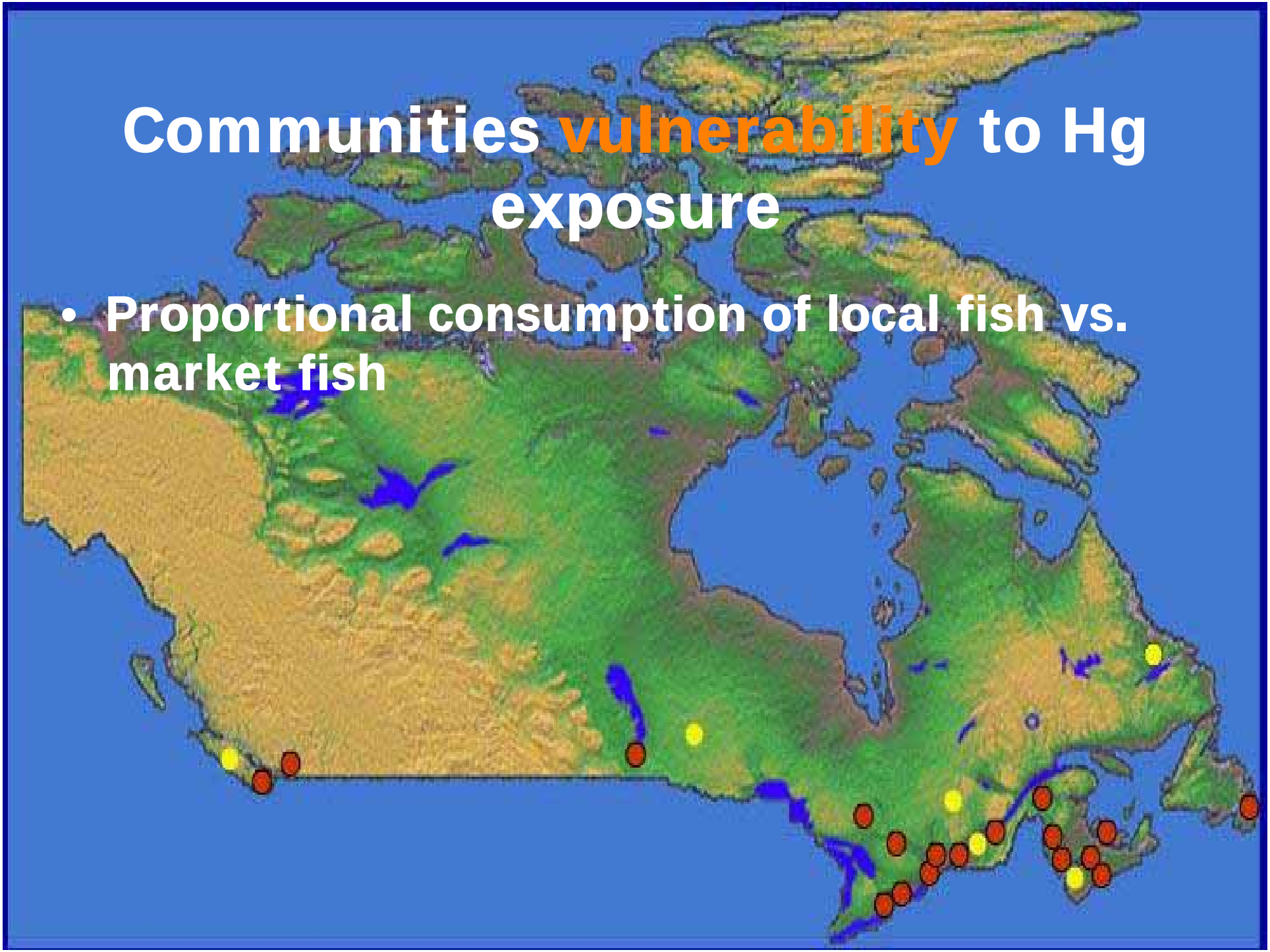
From Simonneau et al, 2004

Walleye Growth

From Simonneau et al, 2004

Communities vulnerability to Hg exposure

- Proportional consumption of local fish vs. market fish



Region	Lakes	Species	Standard length (mm)	Hg levels (ppm)	% of total fish meals from the regions	Food web structure
Labrador	Data combined	Atlantic Salmon[2]	715	0.01	100 %	Salmonidae Simple
		Lake Trout	590	0.67		
		Lake Whitefish	420	0.18		
		Northern Pike	660	0.30		
		Smelt[2]	170	0.22		
		Brook Trout	440	0.05		
Abitibi	Preissac	Walleye	350	0.32	47,8 % Other sources : Tuna : 7,2 % F.W. fish: 11,7 % Mar. fish : 35,3 % Seafood: <1 %	Percidae Simple
		Sauger	350	0.85		
		Northern Pike	545	0.45		
	Duparquet	Walleye	350	0.45		
		Sauger	350	0.43		
		Northern Pike	545	0.45		
	Malartic	Walleye	350	0.79		
		Sauger	350	0.47		
		Northern Pike	545	NA		
St. Lawrence	St. Pierre	Walleye	350	0.17	44 % Other sources : Tuna : 4,9 % F.W. fish:11,7 % Mar. fish : 24,4 % Seafood:15 %	Percidae Complex
		Sauger	350	0.21		
		Northern Pike	545	0.16		
		Yellow Perch	155	0.10		
		Burbot	253	0.09		

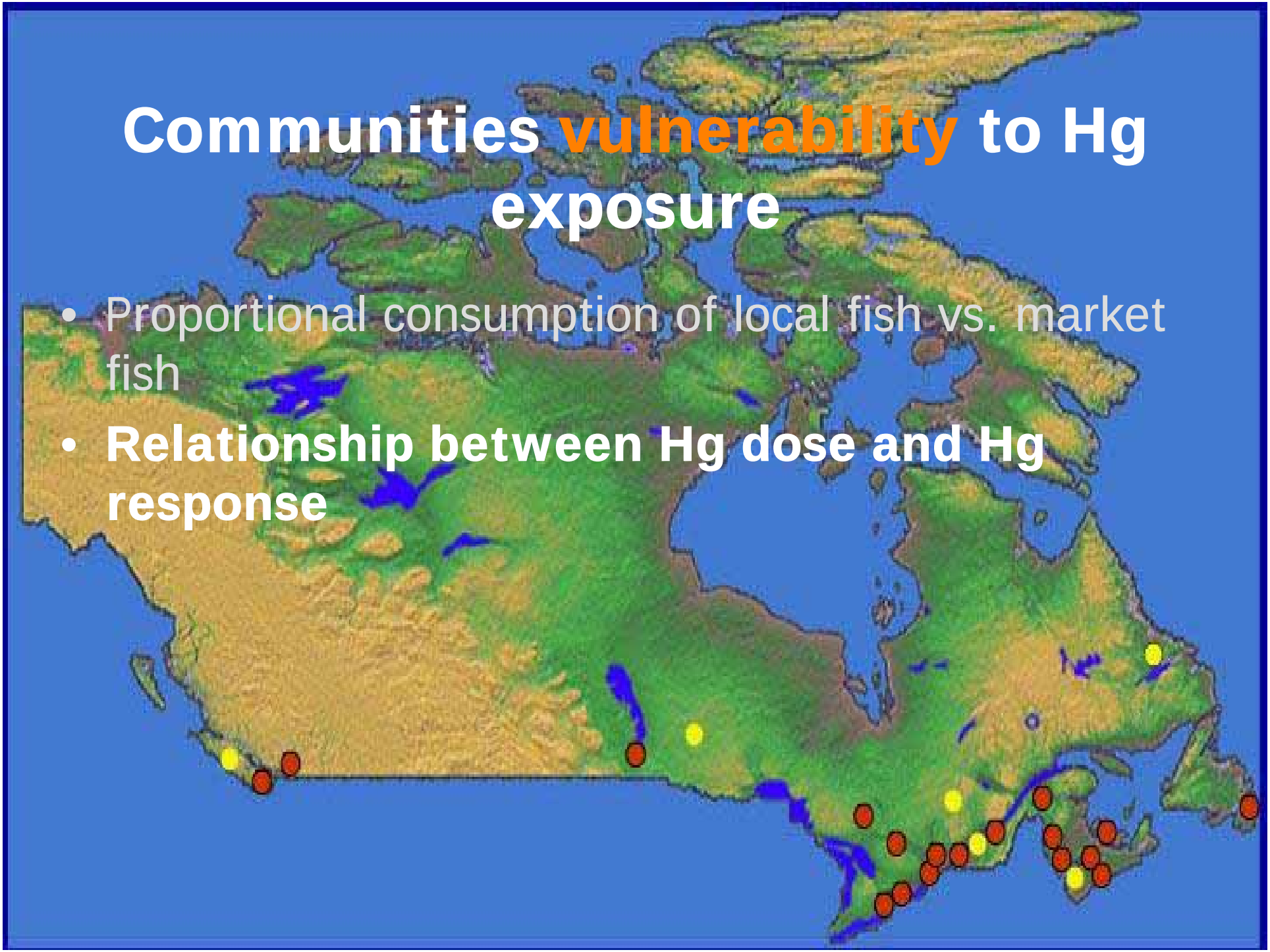
Hg in market fish…

- MeHg in canned pale tuna*: 0.02 to 0.16 ppm
- MeHg in canned white tuna*: 0.15 to 0.7 ppm
- MeHg in fresh tuna**: 0.2 to 1.3 ppm
- MeHg in fresh swordfish**: 0.7 to 3.7 ppm
- MeHg in fresh mackerel**: 0.1 to 1.7 ppm
- MeHg in fresh shark**: 0.05 to 4.5 ppm

(* COMERN 2003; **FDA 2002)

Communities vulnerability to Hg exposure

- Proportional consumption of local fish vs. market fish
- **Relationship between Hg dose and Hg response**



Region	Number fish meals local (3 months)	Number fish meals all sources (3 months)	Calculated mean Hg level in fish diet (ppm)	Calculated daily exposure (ugHg/day/kg bodyweight)	Modeled Hg levels in hair using calculated exposure (ppm)	Measured Hg levels in hair (ppm) (first 3 cms)
St. Lawrence	7,3	16,6	0,09	0,033	0,6	0,8 (SD 0,97)
Abitibi	8,1	16,9	0,27	0,100	1,6	0,8 (SD 1,47)
Labrador	46,9	46,9	0,25	0,243	4,1	0,4 (SD 0,39)


COMING BACK ON THE
THREE CASE STUDIES...
Sheshashi
Innu Nation
Abitibi-Témis.
Sports fishers
Lake StPierre
Sports & comm. fishers

Mercury in « polluted » lake St Pierre

SENSITIVITY

-  Industrial inputs of Hg and other pollutants
-  Downwind atm. inputs of Hg and other pollutants
-  Surrounding wetlands as active Hg methylation sites

VULNERABILITY

-  Frequent consumption of local fish
-  Fast growing fish

Mercury in « pristine » subsistence fishing lakes of Labrador

VULNERABILITY

-  Heavy consumption of local fish
-  Low dose-response to Hg of the Innu community

SENSITIVITY

-  Slow growing fish
-  Small Fishing intensity
-  Atmospheric Hg reactivity at high latitudes
-  Small inputs of Hg from watershed

Mercury in « pristine » sports fishing lakes of the Canadian Shield

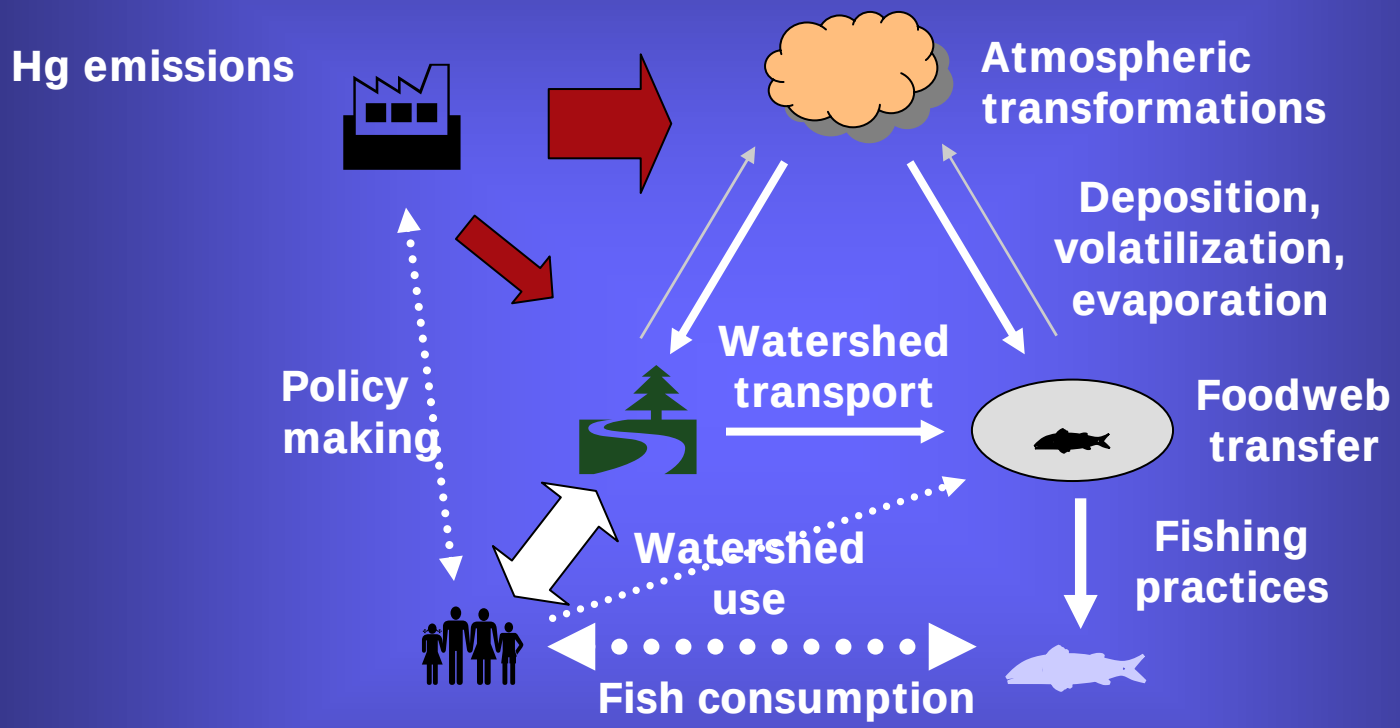
SENSITIVITY

-  Low inputs of Hg from watersheds
-  Unfavorable methylation conditions
-  Moderate fishing intensity
-  Slow growing fish

VULNERABILITY

-  Moderate local “trophy” fish consumption

The sensitivity of ecosystems to Hg loadings



The vulnerability of communities to Hg exposure


How is this achieved?
Involvement of communities
Sharing of knowledge

Outcome

Empowerment of the communities on how to safely enjoy their fish meals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Collaborative Mercury Research Network
www.unites.uqam.ca/comern

Labrador	118 participants			
	Fish meals	SD	minimum	maximum
fish meals/year				
Salmon	29.1	57.5	1	336
Lake Trout	40.7	117.0	1	1008
Arctic Char	44.7	102.6	1	536
Northern Pike	12.6	28.3	1	120
meals/spring	(total for three-months)			
Salmon	3.2	11.9	0	84
Lake Trout	11.9	34.7	0	252
Arctic Char	9.9	41.0	0	252
Northern Pike	3.8	12.4	0	60
Smelt	7.9	15.9	0	84
Brook Trout	10.0	21.8	0	168

Mean Hg levels in first 3cm of hair (ppm)			
mean	std	minimum	maximum
0.39	0.39	0.2	2.47

Lake St. Pierre	130 participants			
	Fish meals	SD	minimum	maximum
fish meals/year				
Yellow Perch	15,3	22,7	0	163
Walleye	13,0	16,4	0	112
Northern Pike	1,1	4,2	0	39
meals/spring	(total for three-months)			
Yellow Perch	3,7	9,3	0	76
Walleye	3,1	6,2	0	39
Northern Pike	0,5	3,5	0	39

Mean Hg levels in first 3cm of hair (ppm)			
mean	std	minimum	maximum
0.83	0,97	0,04	5,23

Abitibi	146 participants			
	Fish meals	SD	minimum	maximum
fish meals/year				
Walleye	18,1	21,8	0	96
Northern Pike	5,1	10,0	0	48
meals/spring	(total for three-months)			
Walleye	6,6	12,0	0	70
Northern Pike	1,5	3,1	0	12

Mean Hg levels in first 3cm of hair (ppm)			
mean	std	minimum	maximum
0,78	1,47	0,01	13,47

Building exemplary science

Breakthrough on the fractionation of Hg isotopes

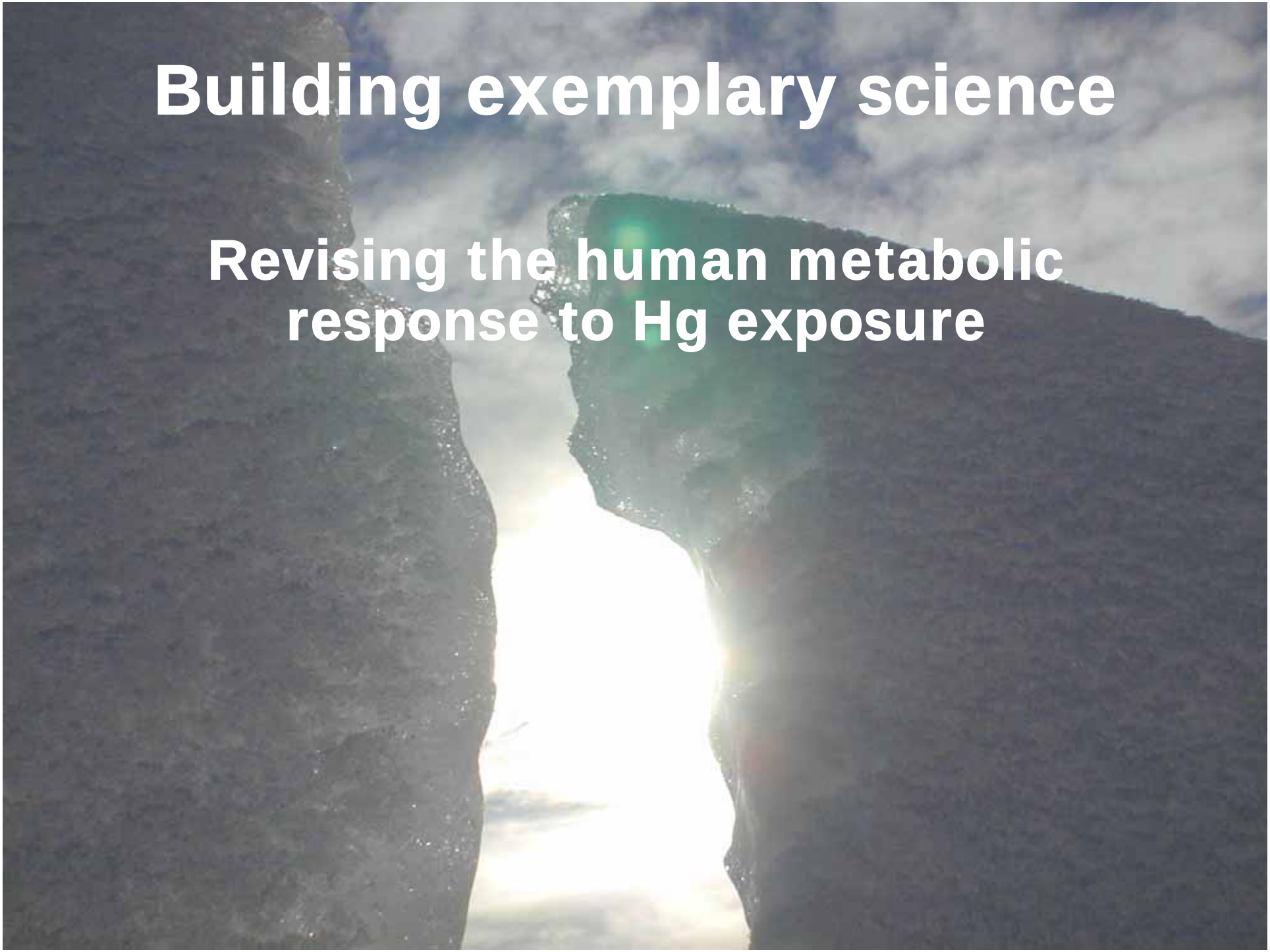
Breakthrough on reactivity of newly deposited atmospheric Hg

Perfecting our understanding of Hg/organic matter interactions

Perfecting our understanding methylation processes

Developing usable models

Developing integration tools


Building exemplary science
Revising the human metabolic response to Hg exposure