ECOLOGICAL EFFECTS OF MERCURY DEPOSITION IN THE ADIRONDACK REGION OF NEW YORK: CRITICAL ISSUES FOR RECOVERY

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National Science Foundation
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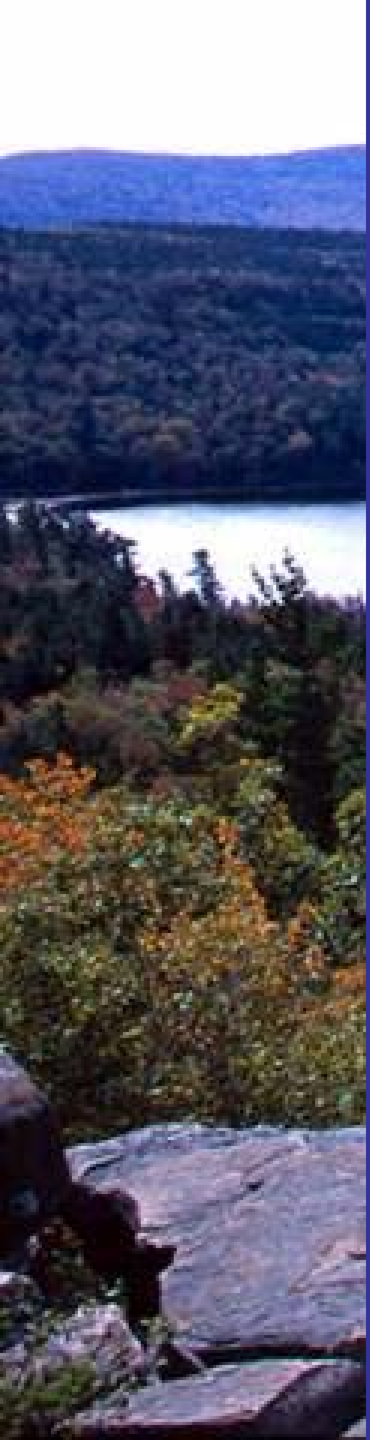
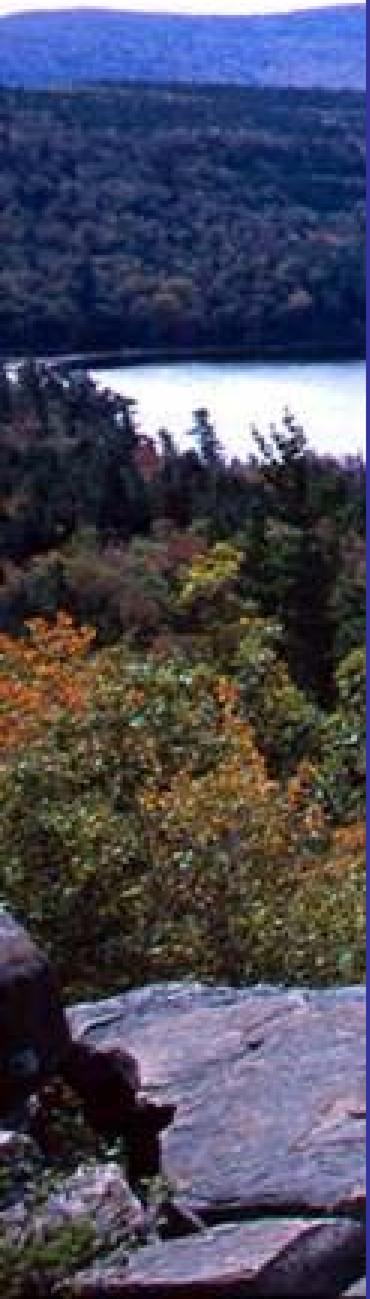


Outline

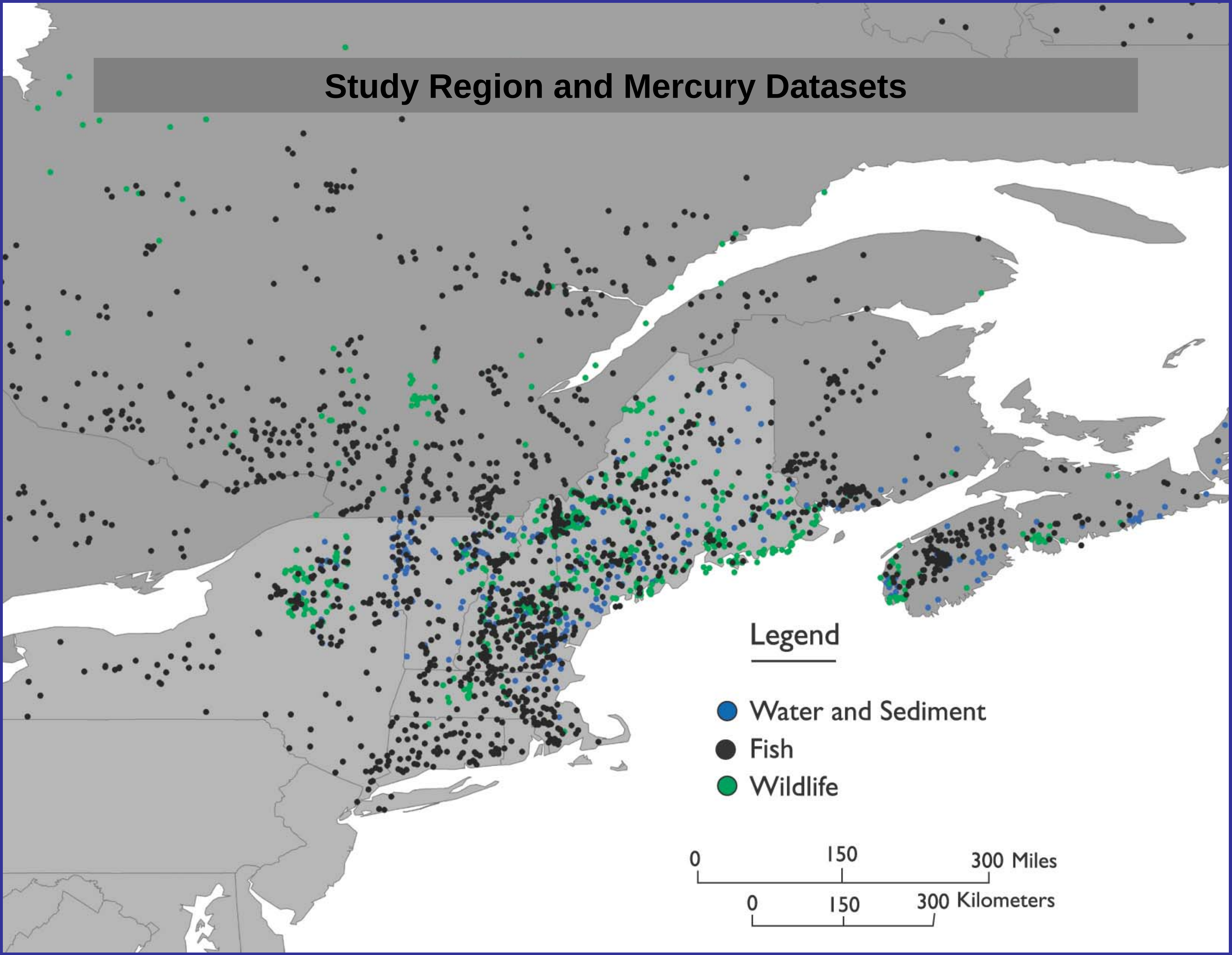
- The State of Mercury Contamination
  - Biological Mercury Hotspots
- What is the Path to Recovery?
  - Watershed Mercury Cycling
  - Recent Trends in Mercury in Water and Fish
- Key Findings and Questions



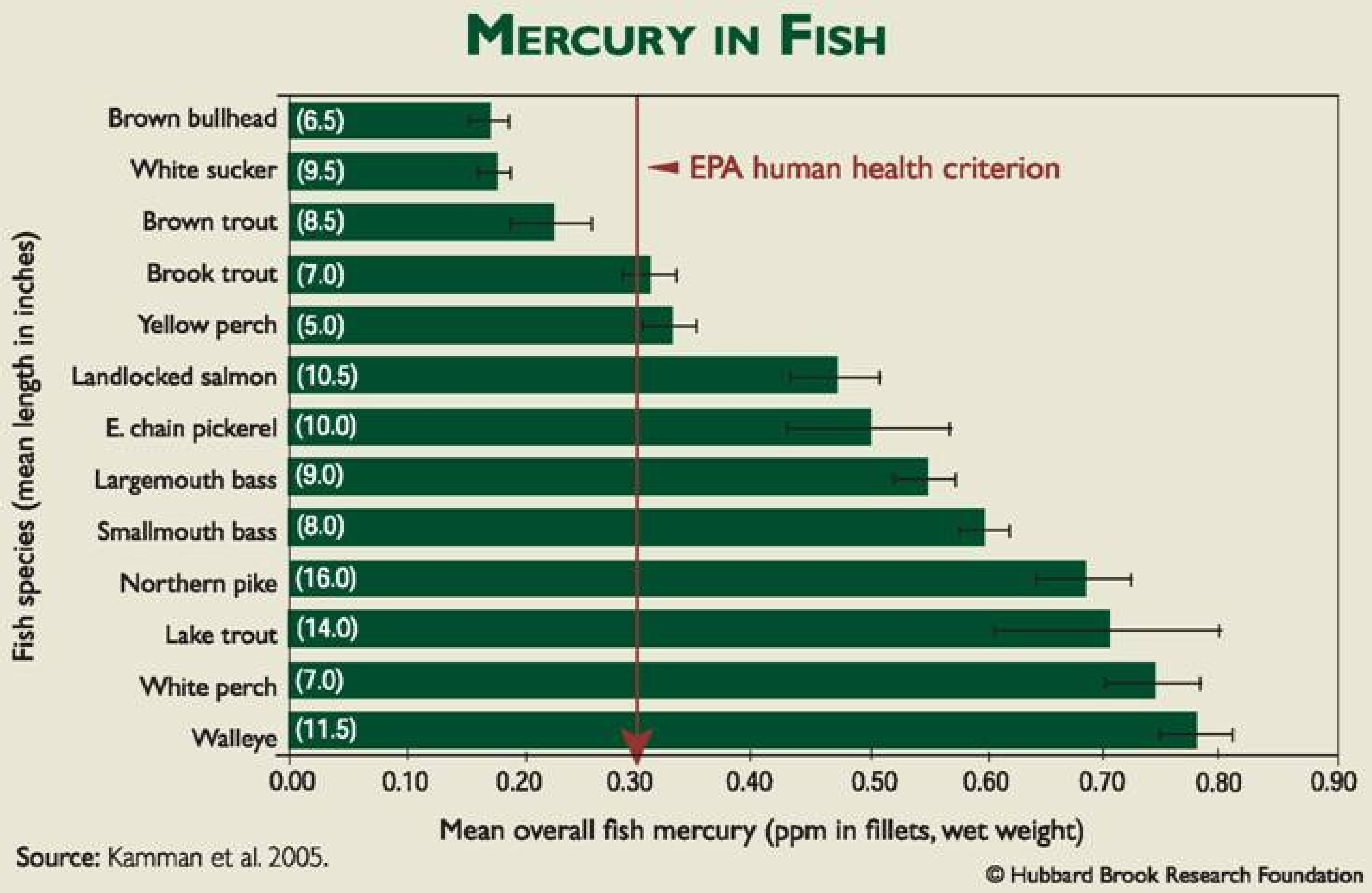
Northeastern Ecosystem Research Cooperative (NERC) - Hg

- 2002 - 2005
- ~70 research scientists
- Data
  - Surface waters - 831 sites
  - Surface sediments - 579 sites
  - Sediment cores - 37 lakes
  - Fish - 15,305 fish tissue
  - Wildlife – 5,600 tissue

Study Region and Mercury Datasets



Evers 2005. *Mercury Connections.*



Mercury in Fish
Brown bullhead
White sucker
Brown trout
Brook trout
Yellow perch
Landlocked salmon
E. chain pickerel
Largemouth bass
Smallmouth bass
Northern pike
Lake trout
White perch
Walleye
(6.5)
(9.5)
(8.5)
(7.0)
(5.0)
(10.5)
(10.0)
(9.0)
(8.0)
(16.0)
(14.0)
(7.0)
(11.5)
EPA human health criterion
Fish species (mean length in inches)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
Mean overall fish mercury (ppm in fillets, wet weight)
Source: Kamman et al. 2005.
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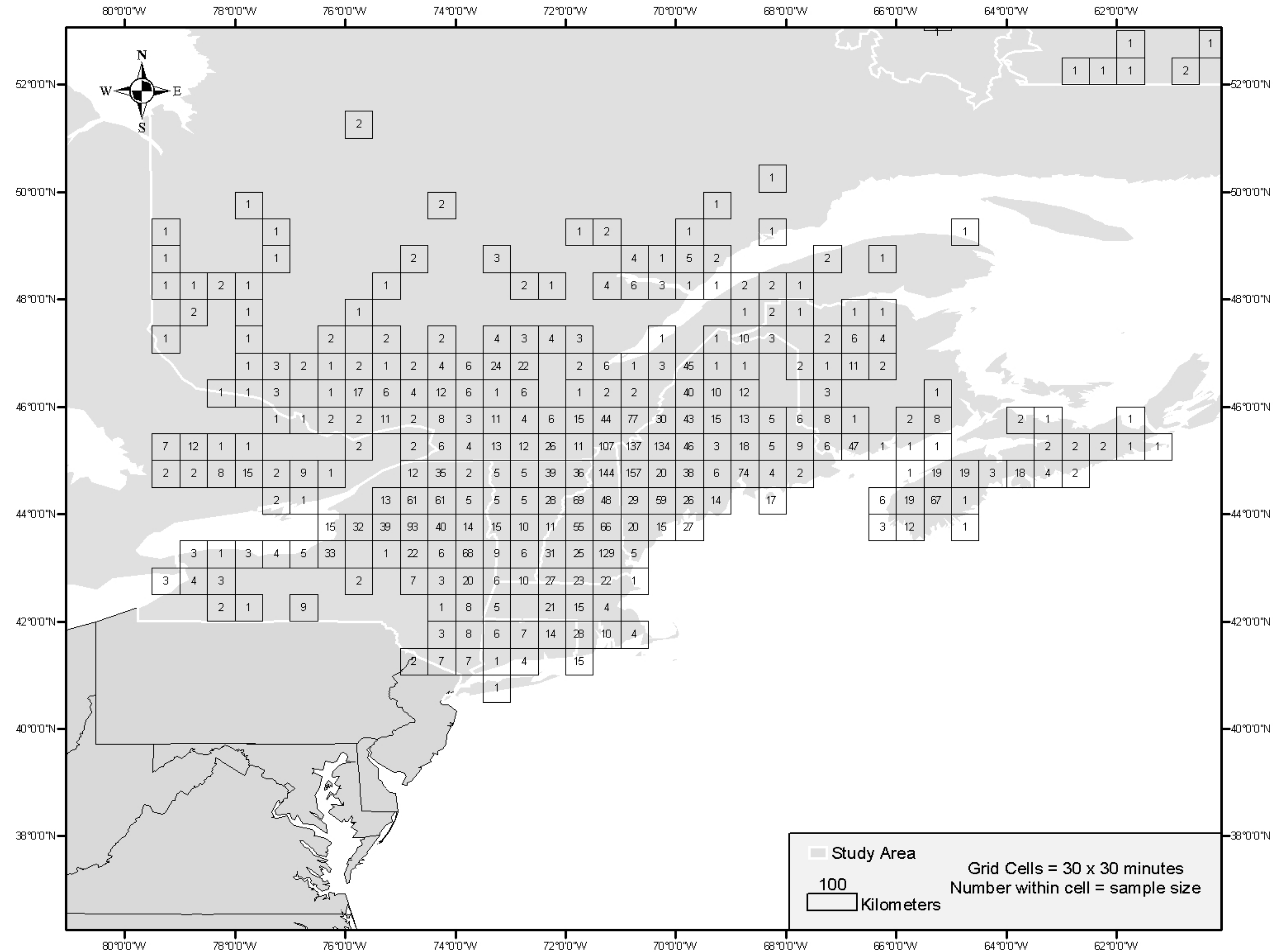
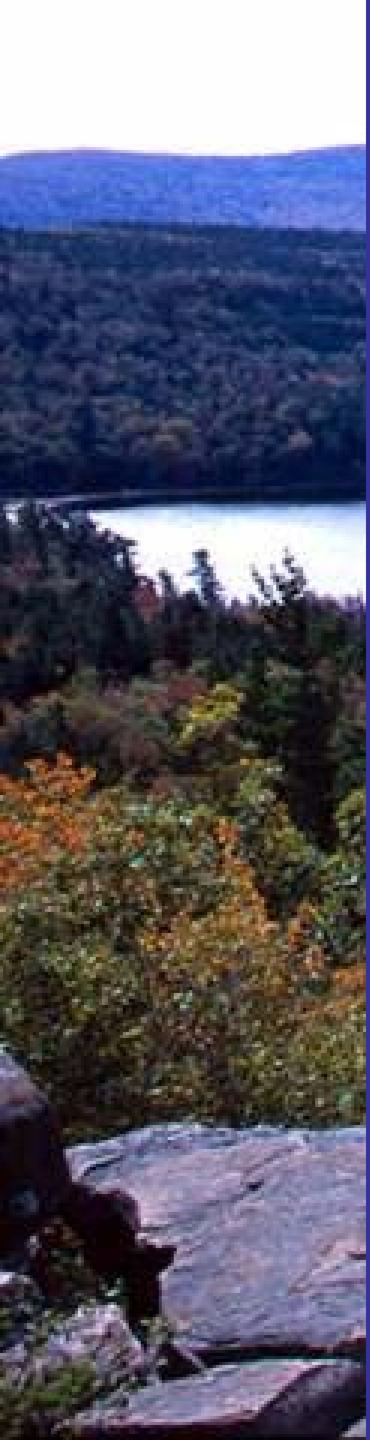

80°0'0"W
78°0'0"W
76°0'0"W
74°0'0"W
72°0'0"W
70°0'0"W
68°0'0"W
66°0'0"W
64°0'0"W
62°0'0"W
52°0'0"N
50°0'0"N
48°0'0"N
46°0'0"N
44°0'0"N
42°0'0"N
40°0'0"N
38°0'0"N
N
S
W
E
Study Area
100
Kilometers
Grid Cells = 30 x 30 minutes
Number within cell = sample size



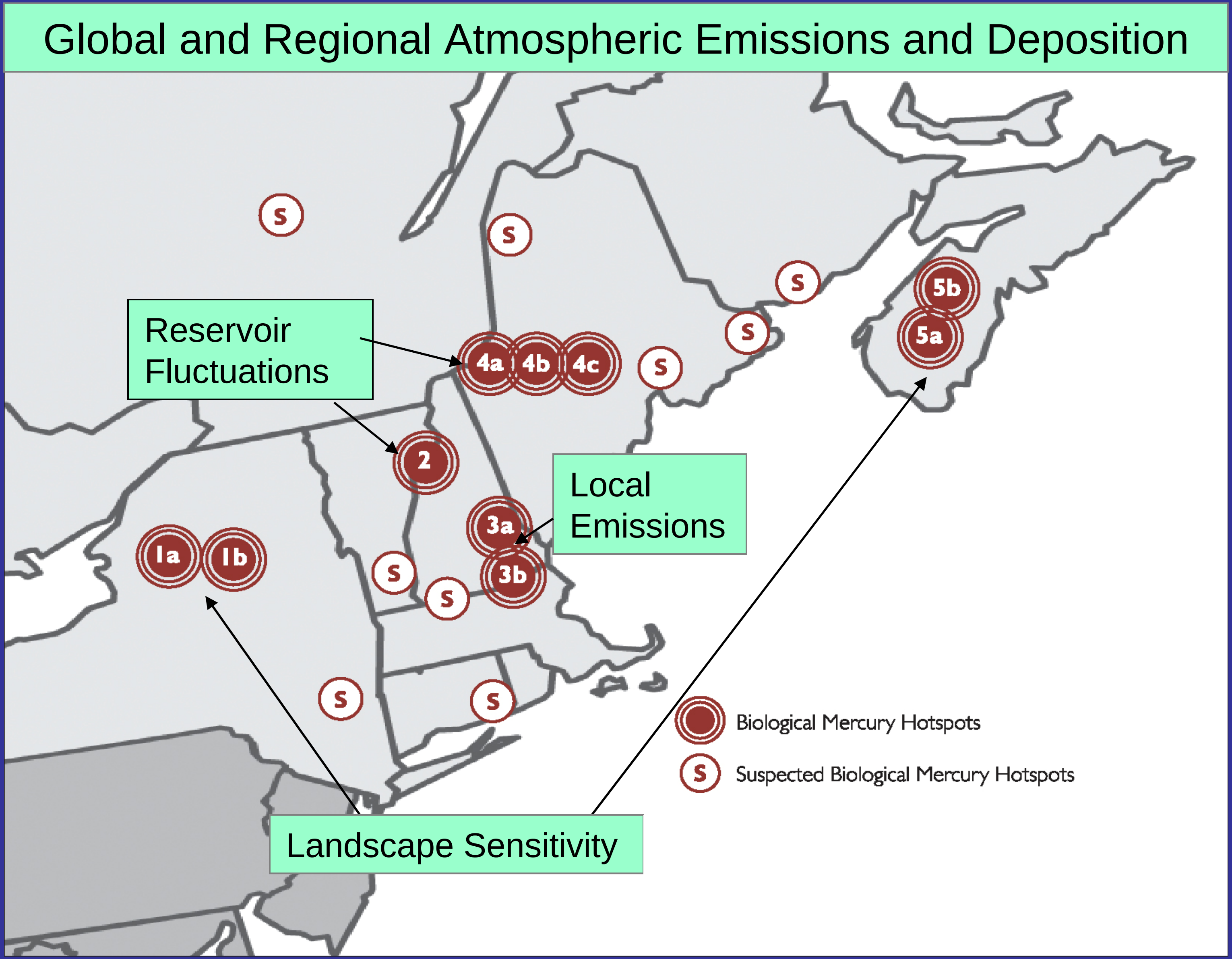
Methods

1. Based on 7,311 observations

2. Human health analysis:
   - Indicator = yellow perch
   - Threshold = 0.3 ppm (EPA level)

3. Ecological health analysis
   - Indicator = Common loon blood
   - Threshold = 3.0 ppm

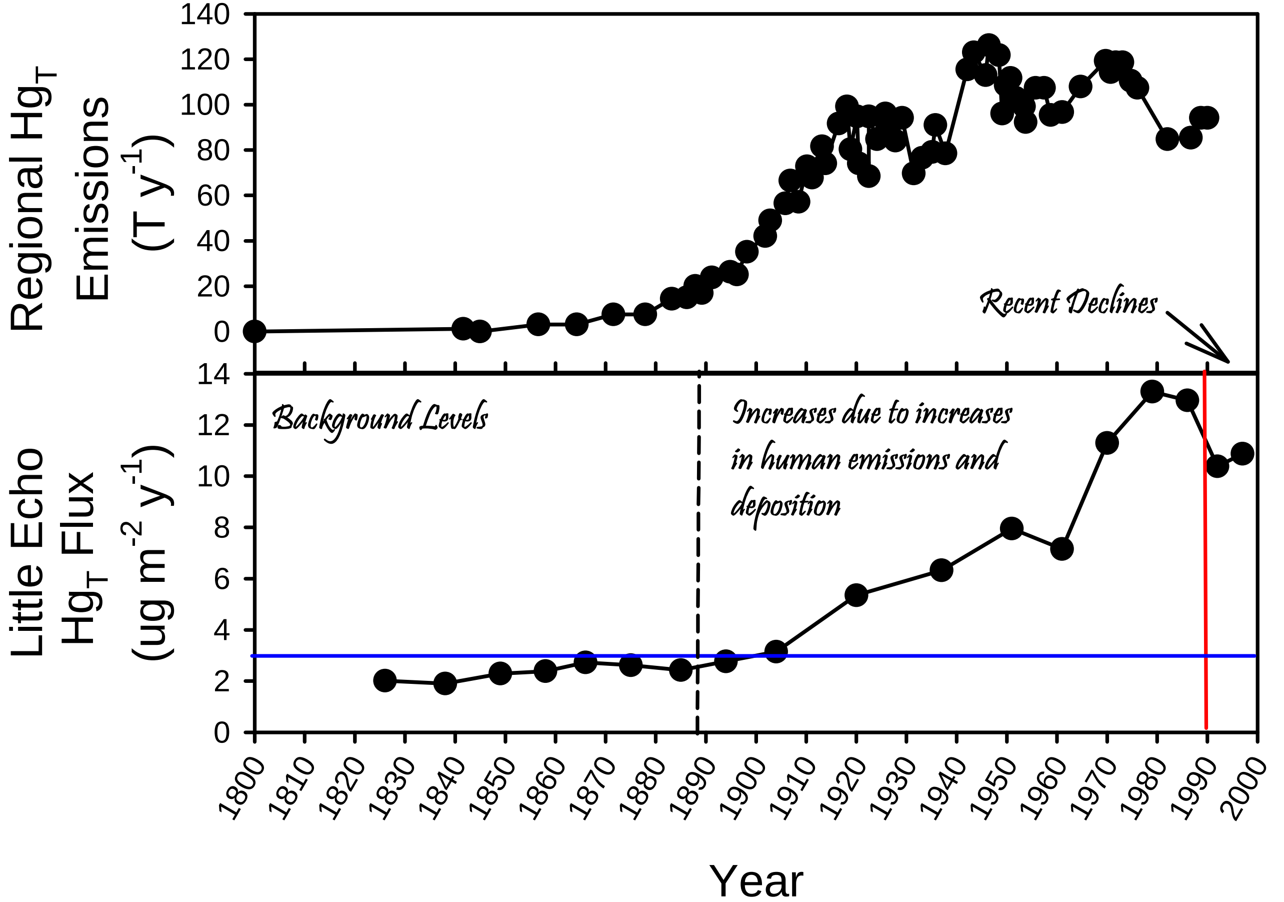
Biological Mercury Hotspots



Biological Hotspots Can Be Caused by Moderate Mercury Deposition to Sensitive Watersheds

Sensitive Watersheds:

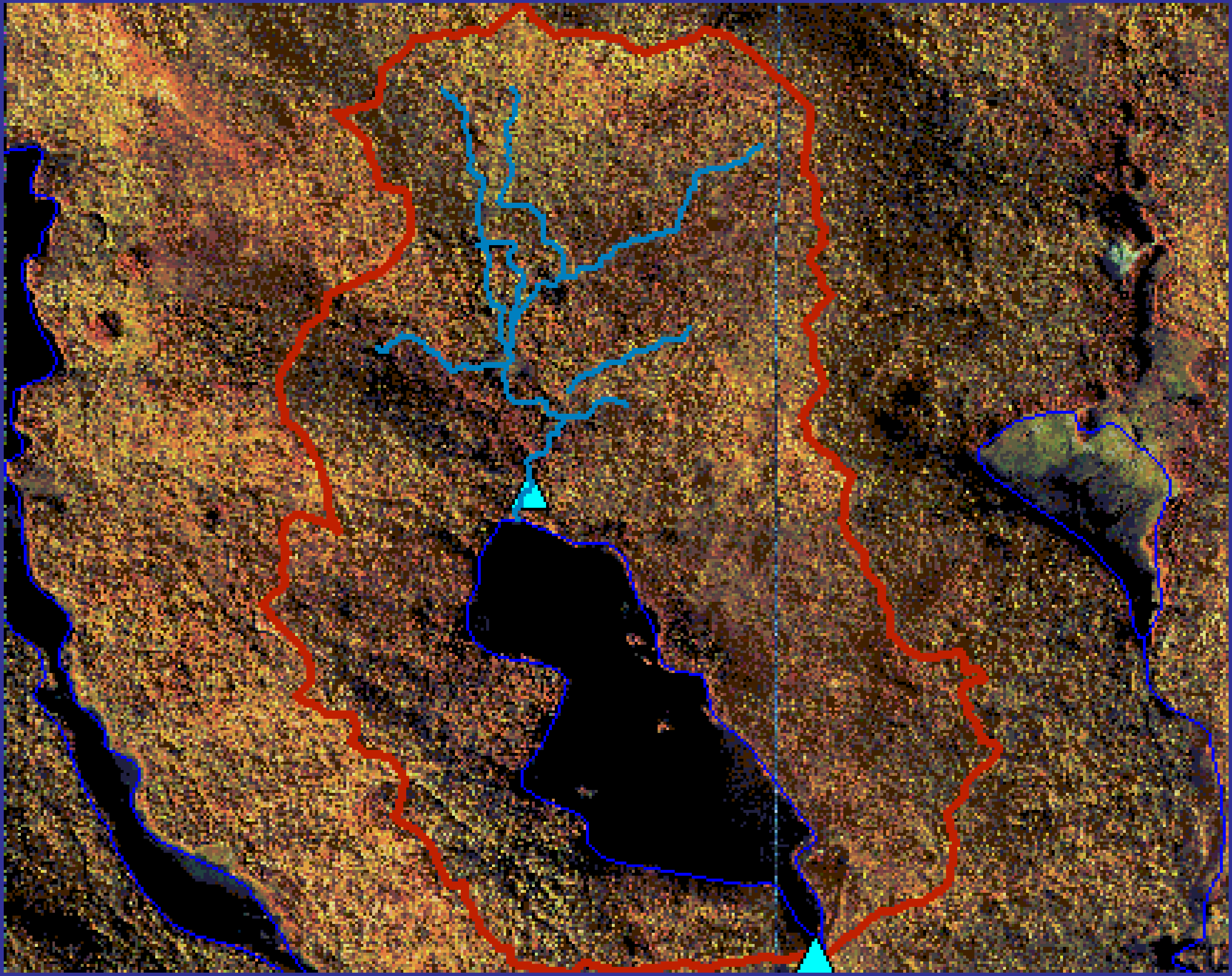
1. Abundant forest cover and wetlands
2. Shallow groundwater flow paths
3. Low nutrient inputs
4. Impacted by acid rain

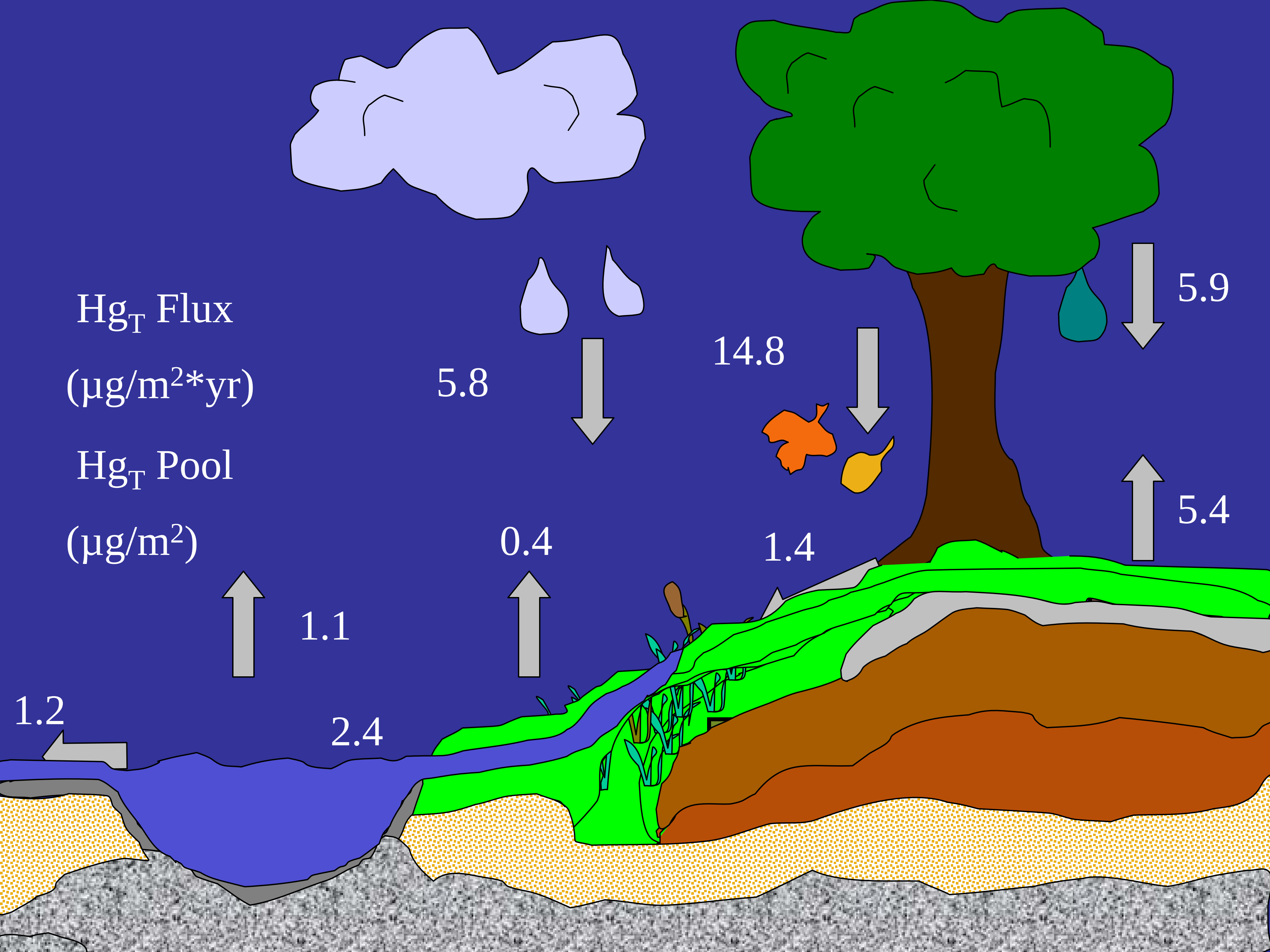


Number	**39**
Background	**~ 3 ug/m^2-yr**
Increases start	**~ 1880 - 1900**
Peak	**~ 1970 - 1990**
Peak/Background	**~ 5.6 (2.4 - 13.8)**
% Reduction from peak	**~ 30 (0 - 71)%**

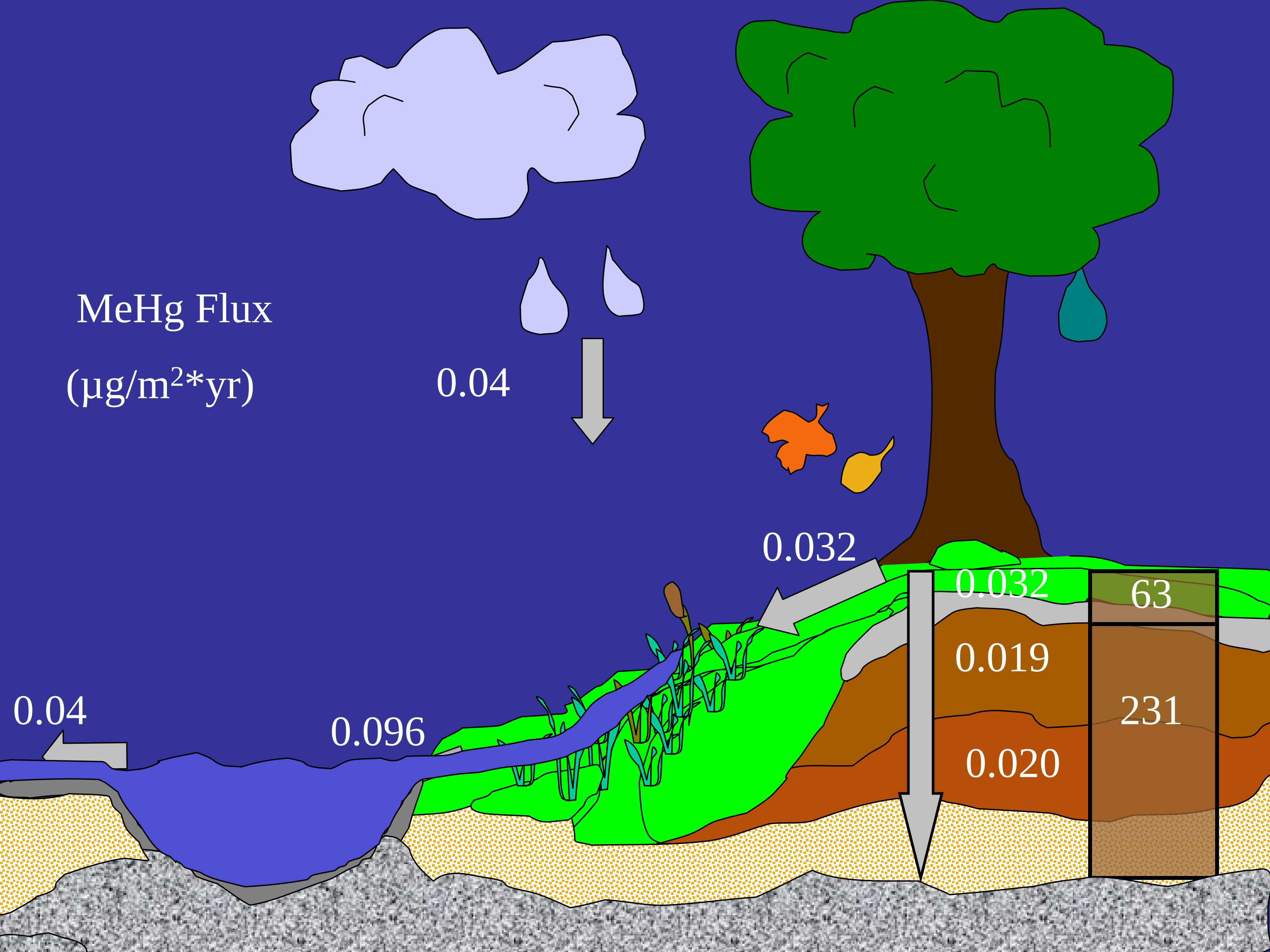
Arbutus Lake – 48.2 ha

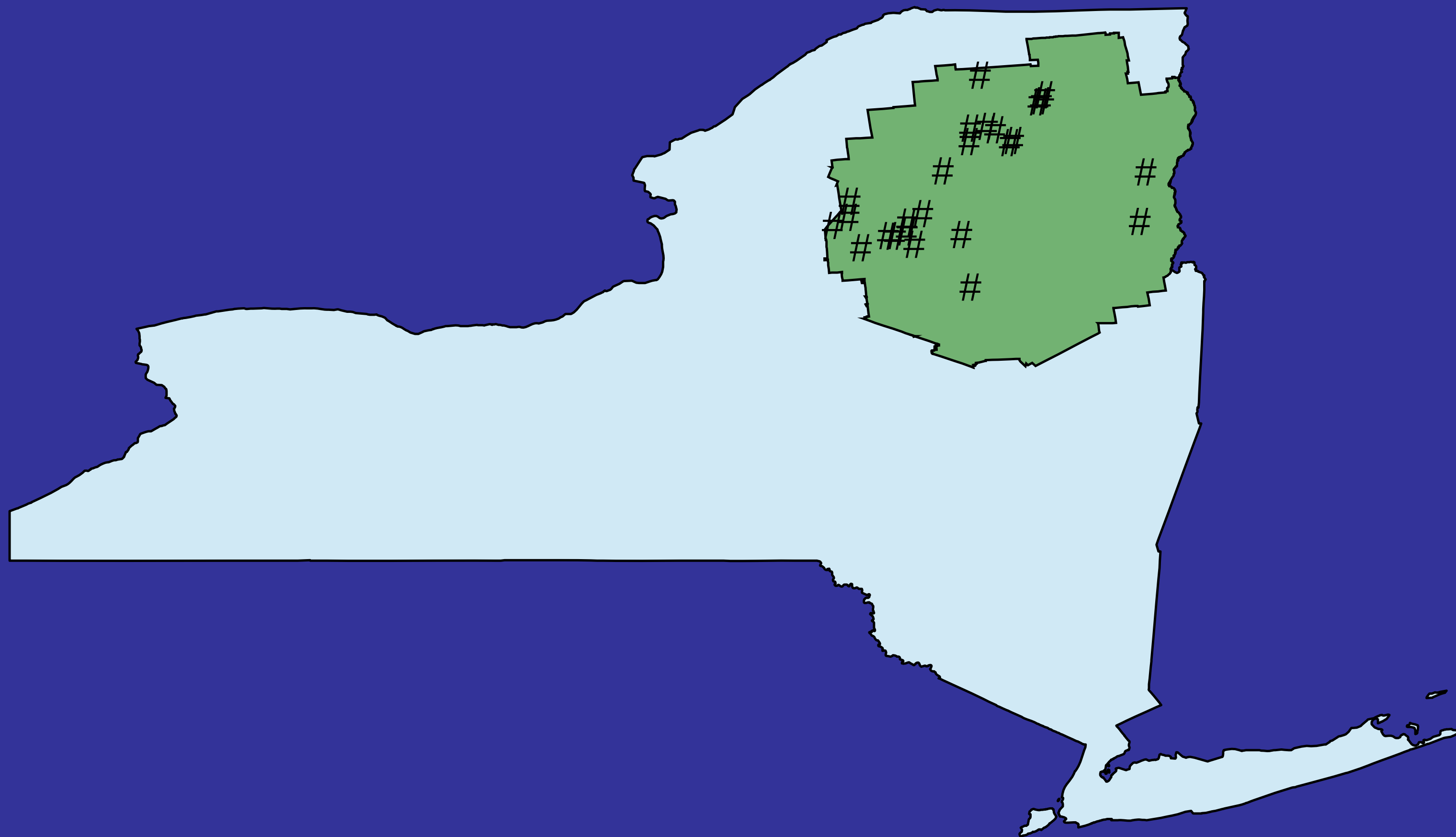
Arbutus Lake Watershed-352 ha

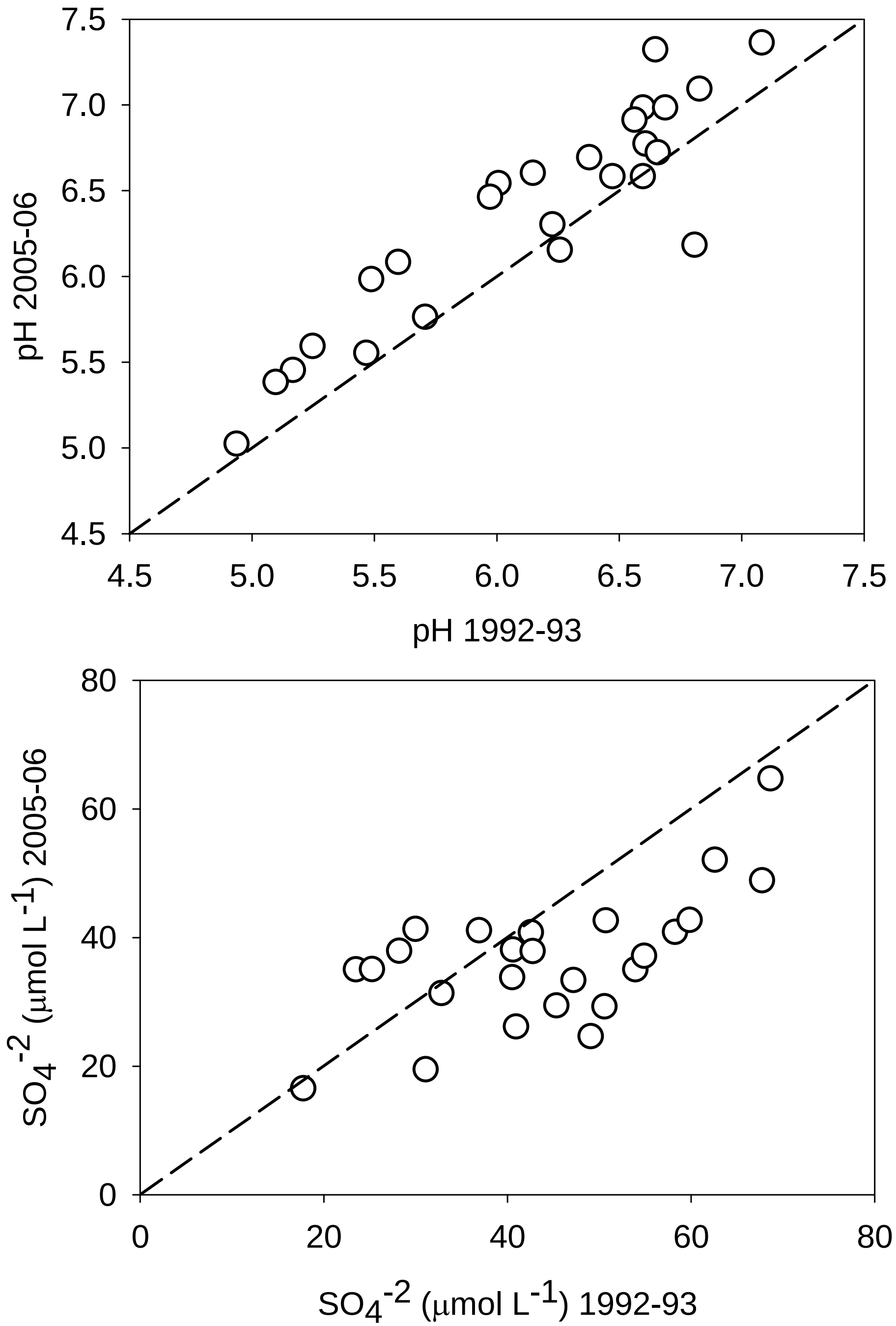


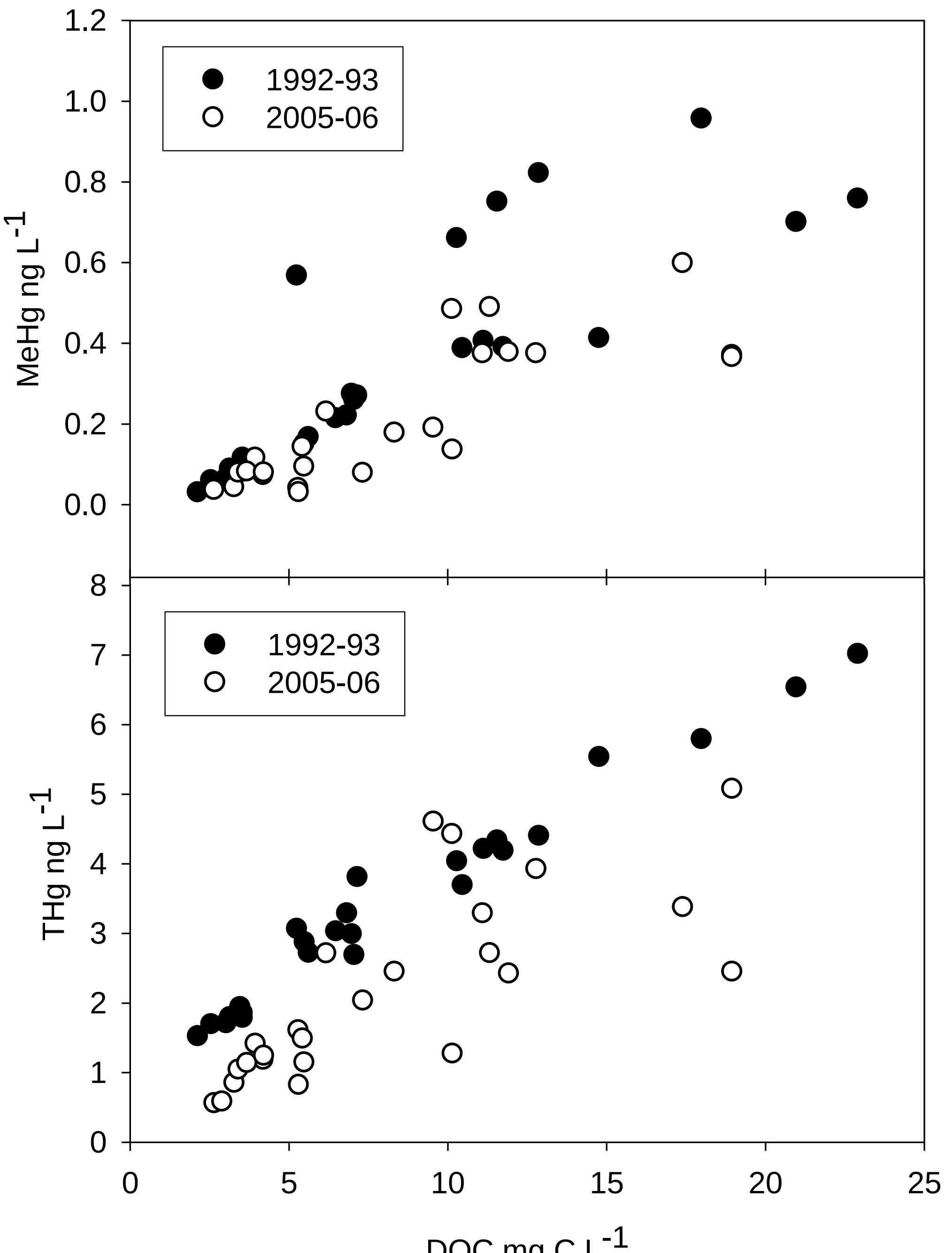


Hg_T Flux
(µg/m^2*yr)
Hg_T Pool
(µg/m^2)
5.8
14.8
5.9
0.4
1.4
5.4
1.1
1.2
2.4

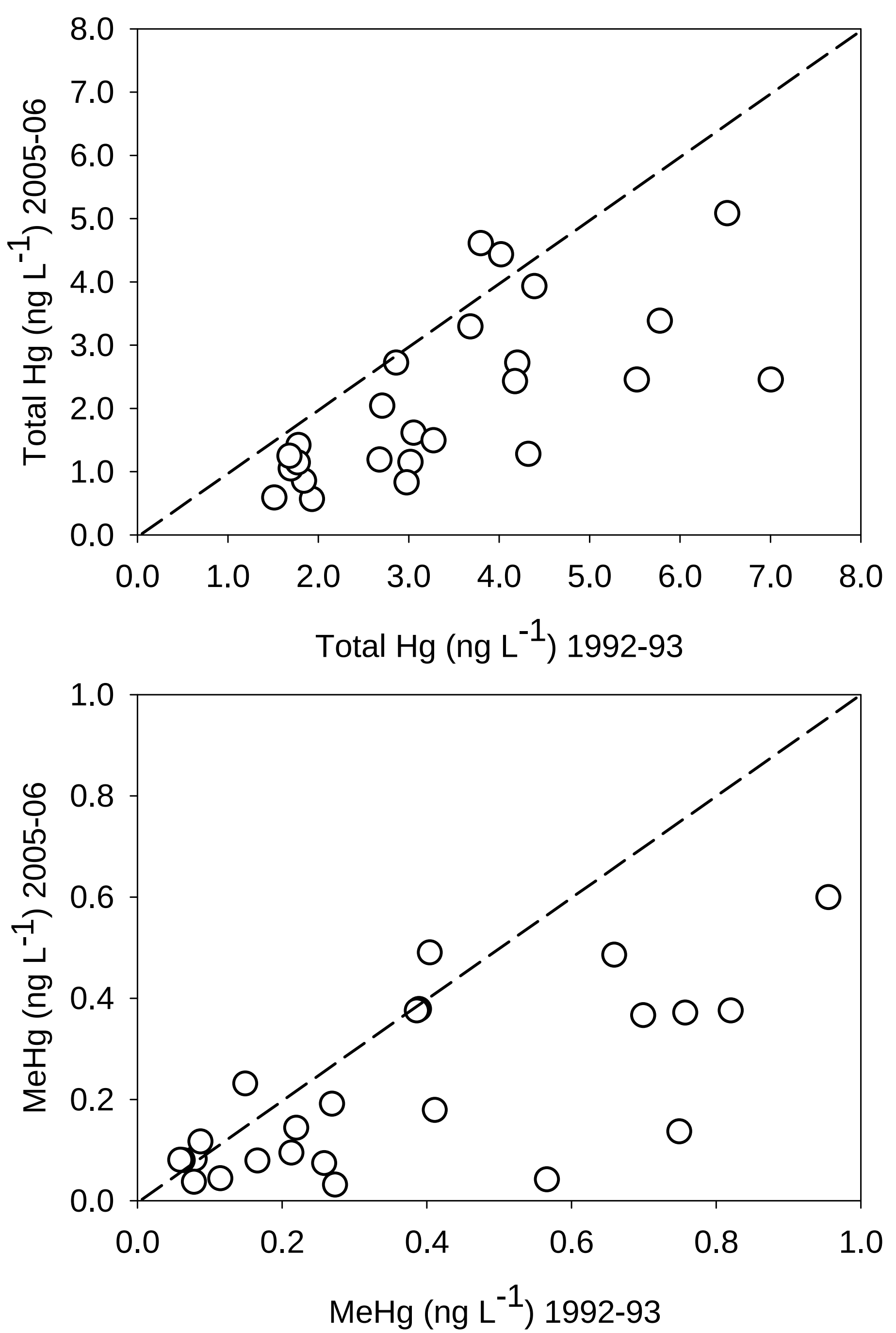

MeHg Flux
(µg/m2*yr)
0.04
0.032
0.032
63
0.019
231
0.020
0.04
0.096

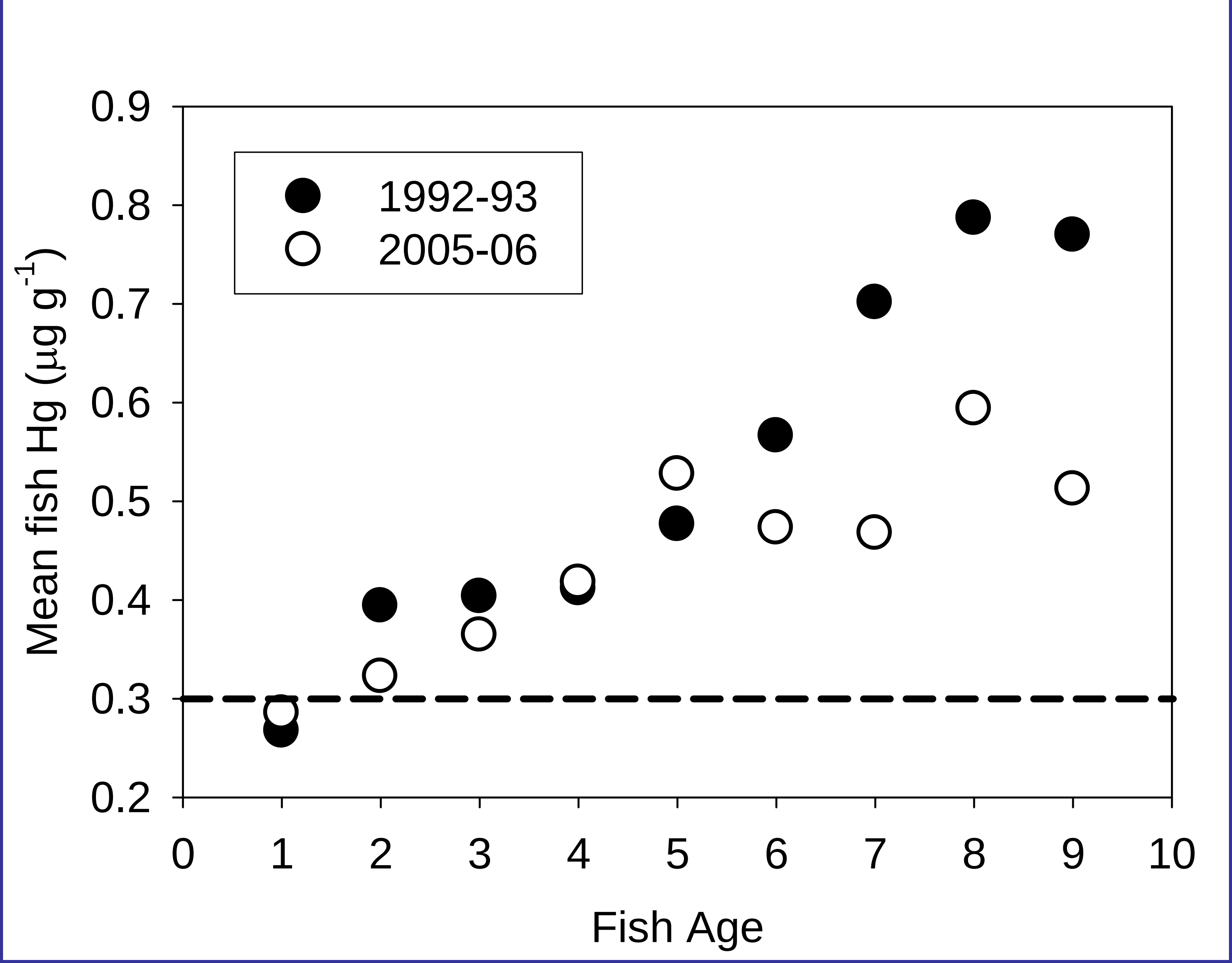



pH 2005-06
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.5
5.0
5.5
6.0
6.5
7.0
7.5
pH 1992-93
SO_4^{-2} (μmol L^{-1}) 2005-06
80
60
40
20
0
0
20
40
60
80
SO_4^{-2} (μmol L^{-1}) 1992-93

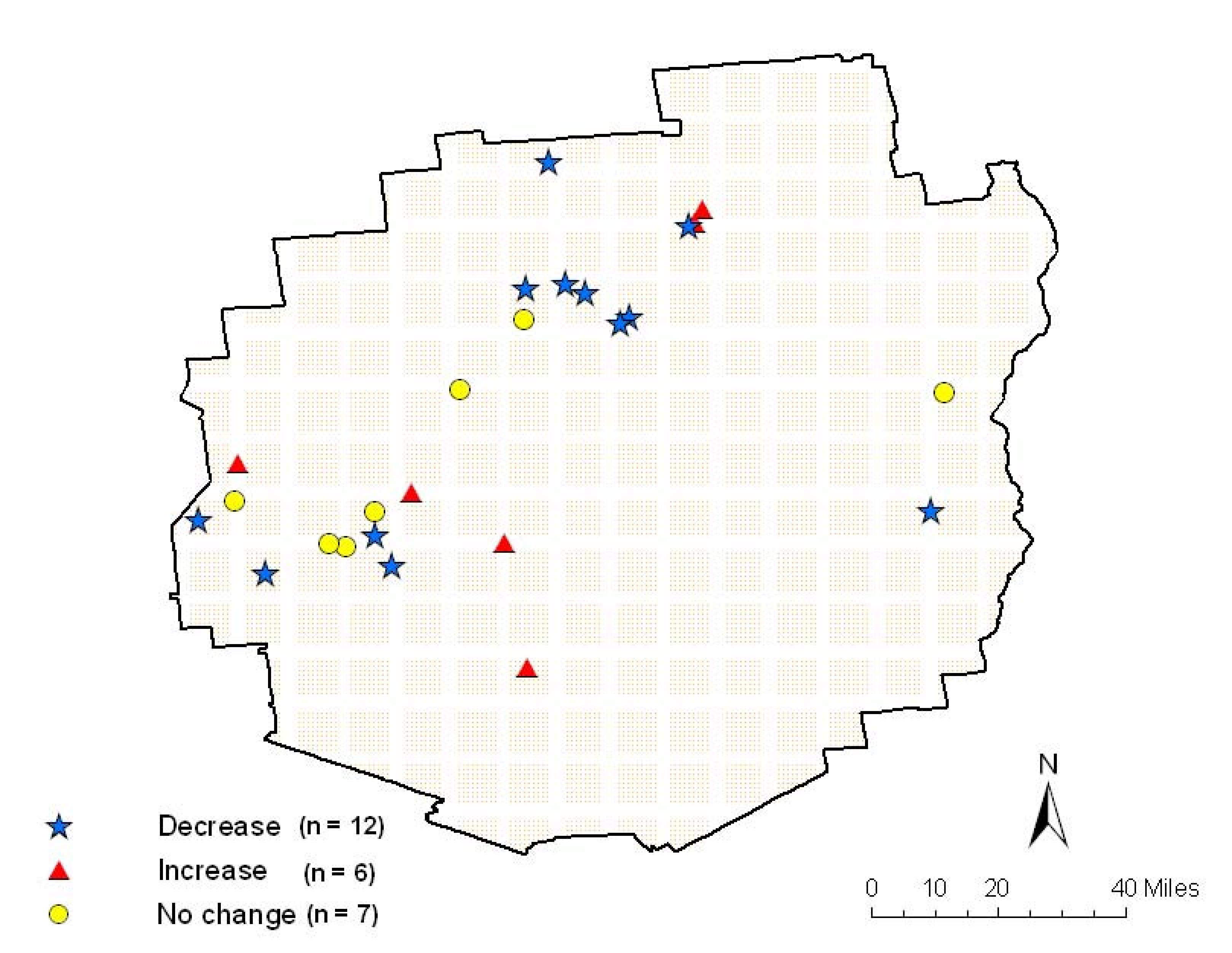


1.2
1.0
0.8
0.6
0.4
0.2
0.0
MeHg ng L-1
1992-93
2005-06
8
7
6
5
4
3
2
1
0
THg ng L-1
1992-93
2005-06
0
5
10
15
20
25
DOC mg C L-1


Total Hg (ng L-1) 2005-06
Total Hg (ng L-1) 1992-93
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
MeHg (ng L-1) 2005-06
MeHg (ng L-1) 1992-93
0.0
0.2
0.4
0.6
0.8
1.0

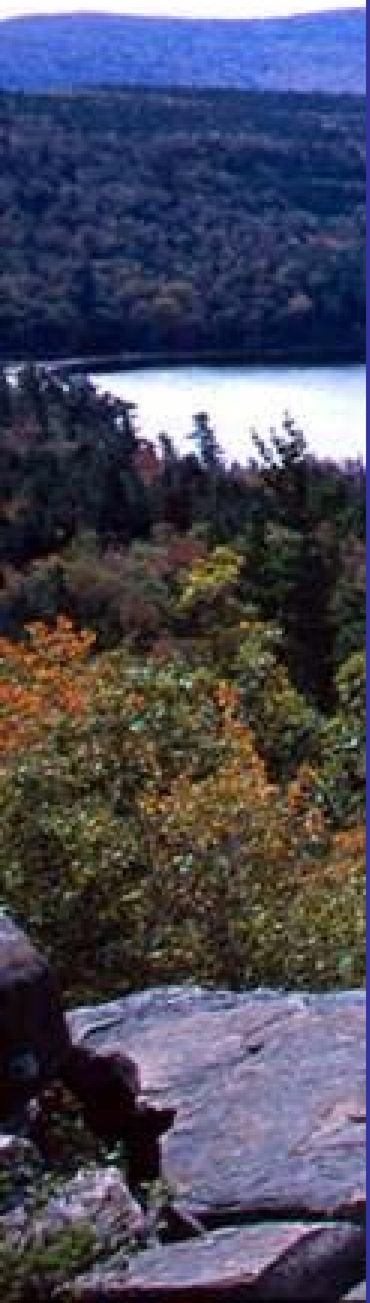


Mean fish Hg (μg g-1)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0 1 2 3 4 5 6 7 8 9 10
Fish Age
1992-93
2005-06


N
Decrease (n = 12)
Increase (n = 6)
No change (n = 7)
0 10 20 40 Miles

Key Messages

- Comprehensive analysis of air, sediment, water, fish and wildlife show that Hg contamination is pervasive.
- Five biological Hg hotspots and nine additional areas of concern are identified in the Northeast that pose ecological and human health risk
- Mercury inputs to forest ecosystems largely occur by litterfall. Soil and lake sediments are a sink for Hg inputs. Wetlands are the major source of methyl Hg.
- There have been recent decreases in Hg loading, generally decreases in water column Hg and some decreases in fish Hg.
- Environmental monitoring programs are needed to fully document the extent and changes in Hg pollution.



Critical Questions

- What is the fate of atmospherically deposited Hg, particularly from litter and in soil?
- Do Hg concentrations in fish decrease in response to decreases in Hg loading and what factors affect this response (e.g., sulfate load, changes in DOC, watershed characteristics)?
- What levels of emission controls will be adequate to reduce Hg exposure to acceptable levels?