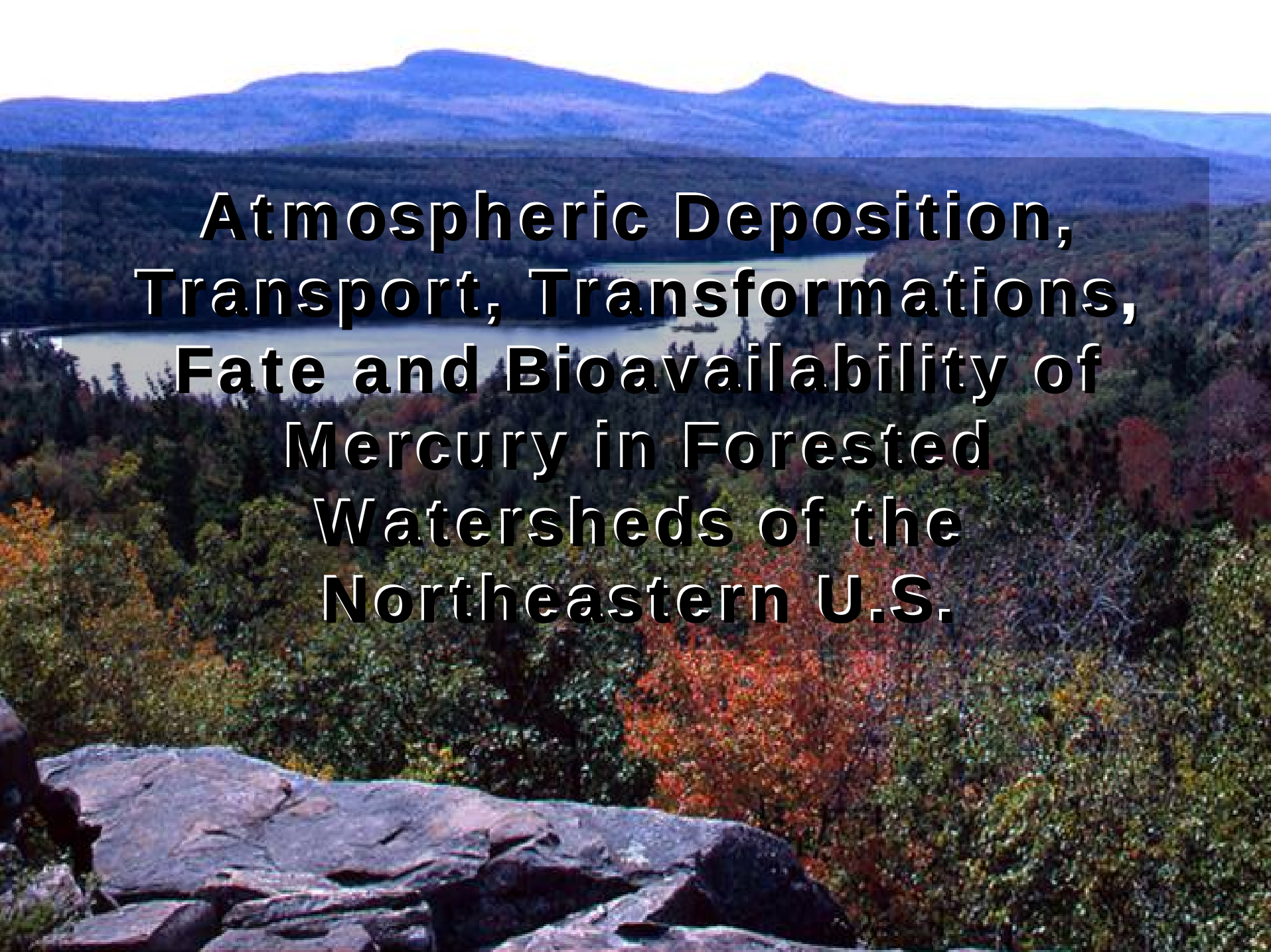
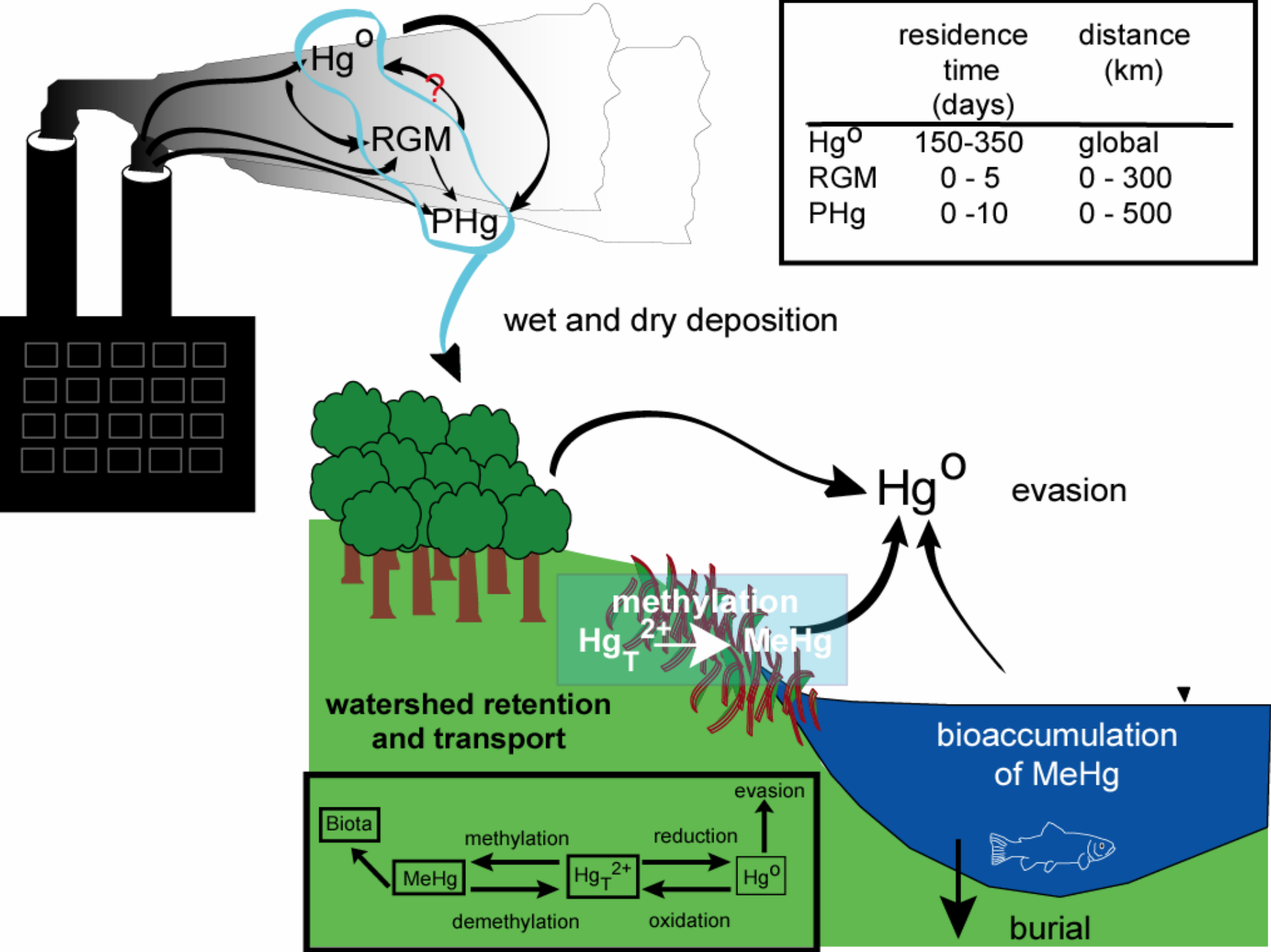

Atmospheric Deposition, Transport, Transformations, Fate and Bioavailability of Mercury in Forested Watersheds of the Northeastern U.S.

Outline

- Upland transformations
- Wetland- surface water dynamics
- Patterns in aquatic biota
- MCM-HD – Model calculations

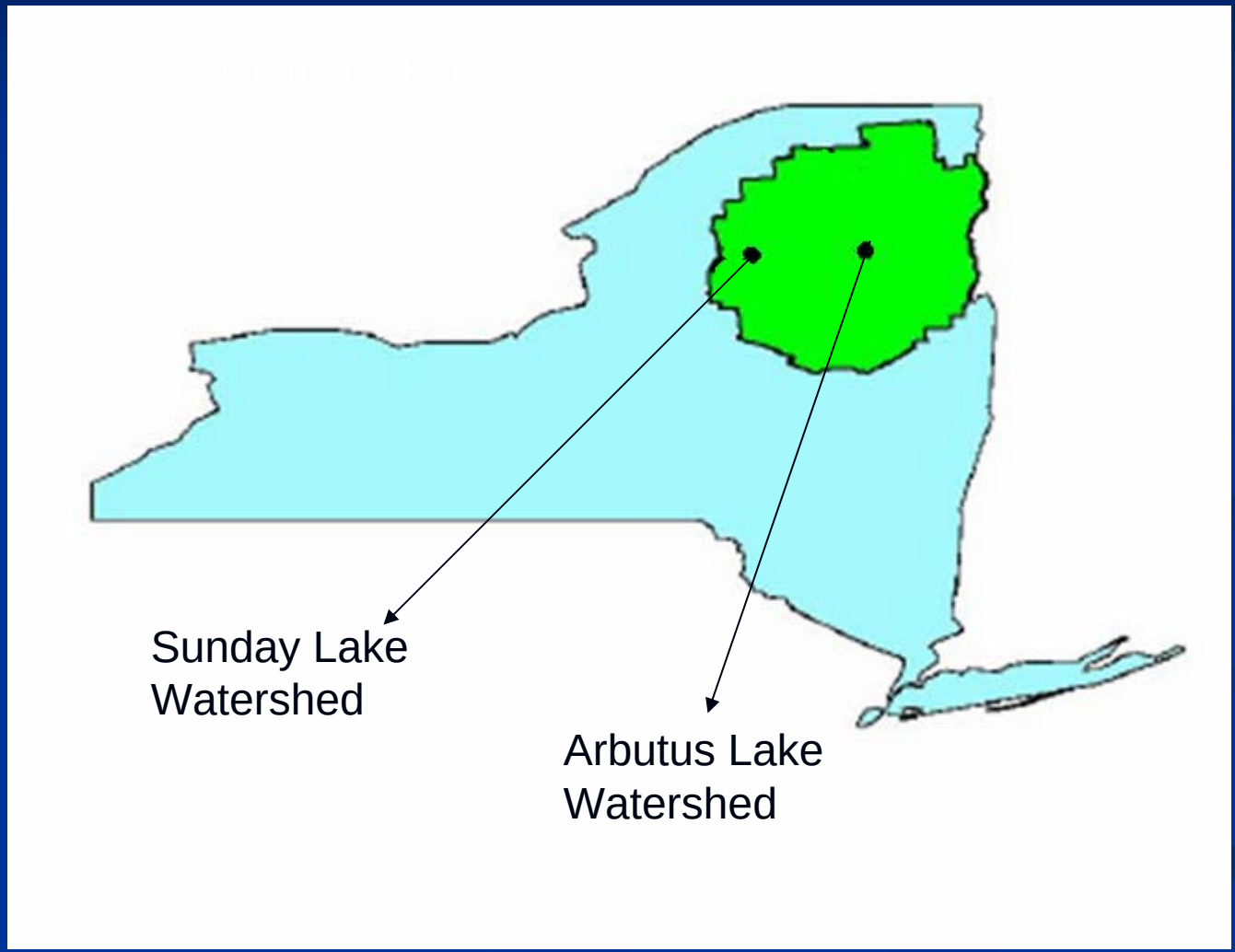
Collaborators

- Ron Munson - Tetra Tech
- Jason Demers - Cornell
- Neil Kamman - VT DEC
- David Evers - Biodiversity Research Institute
- Tom Holsen, Hyun-Deok Choi – Clarkson
- Eric Miller – Ecosystem Research Group
- Brian Branfireum - Toronto

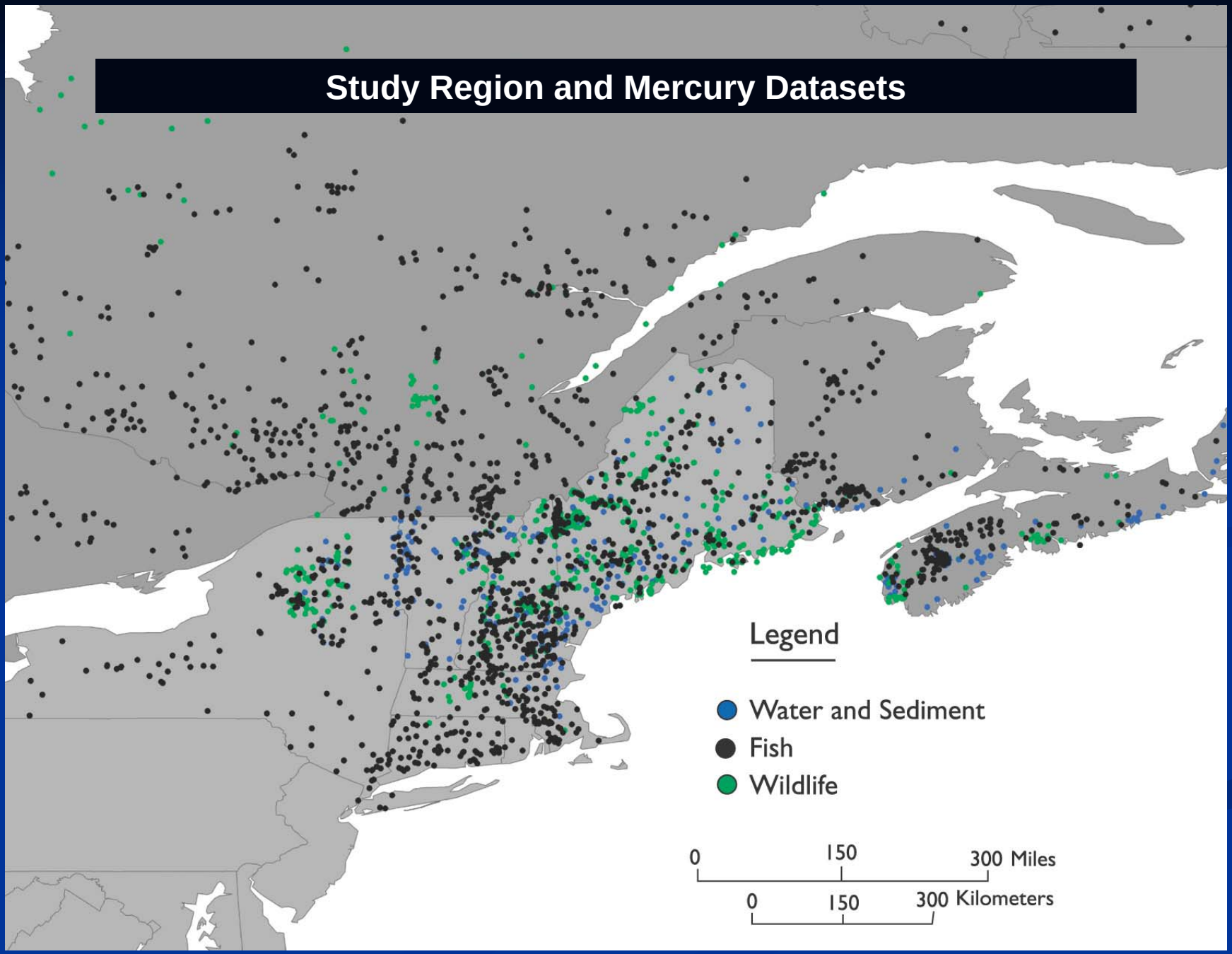


	residence time (days)	distance (km)
Hg^0	150-350	global
RGM	0 - 5	0 - 300
PHg	0 -10	0 - 500

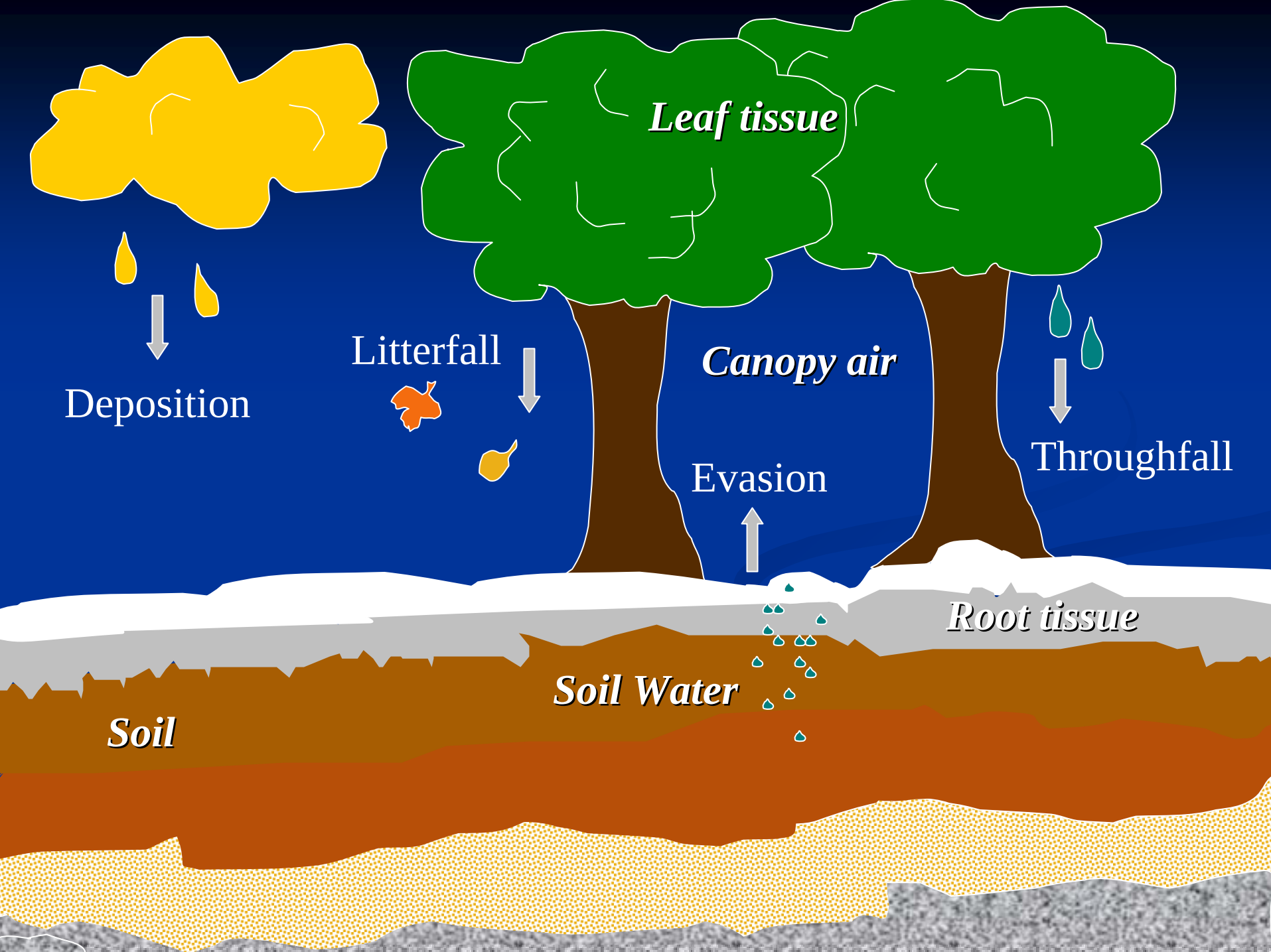
Site Description

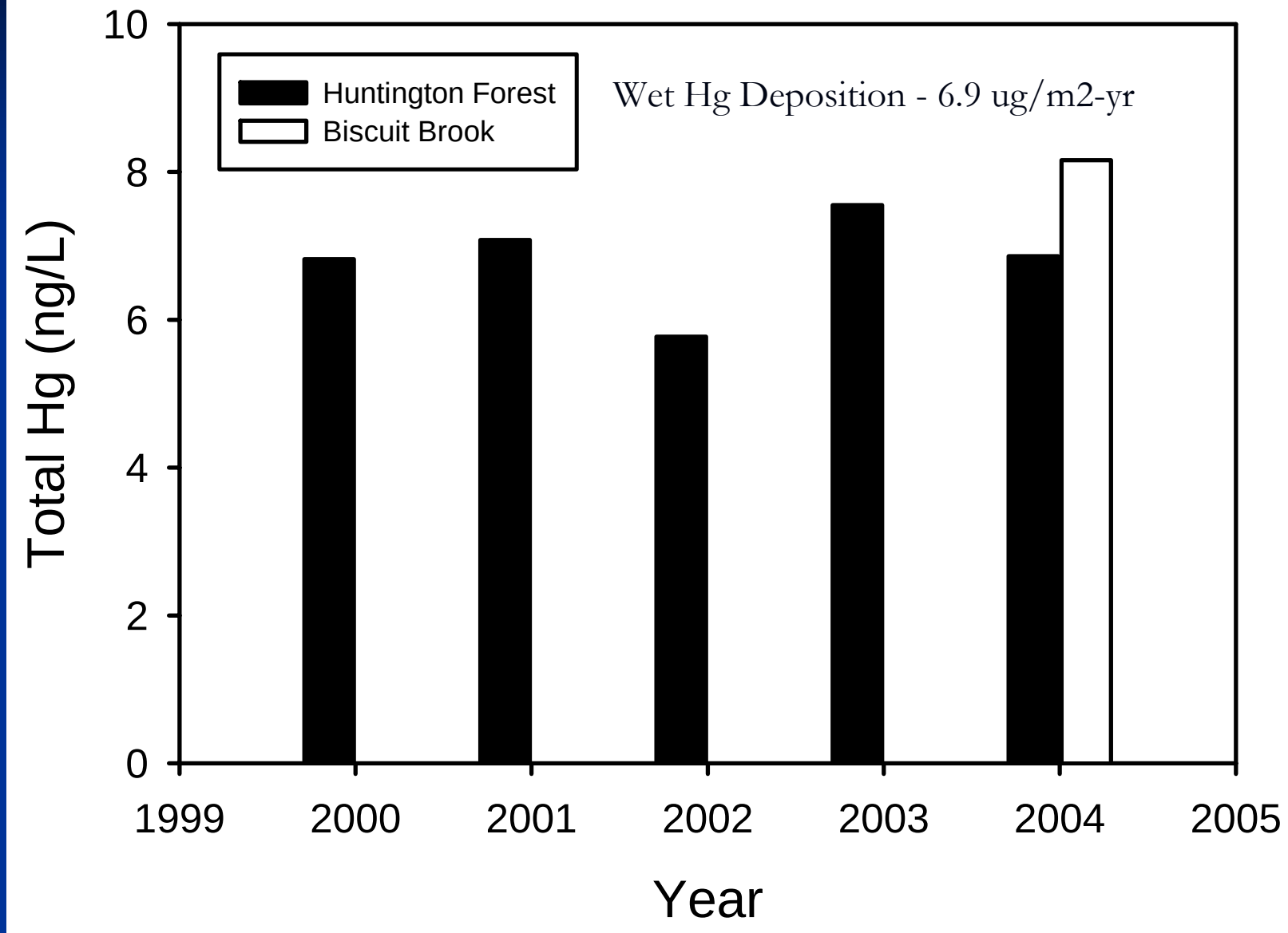


Study Region and Mercury Datasets

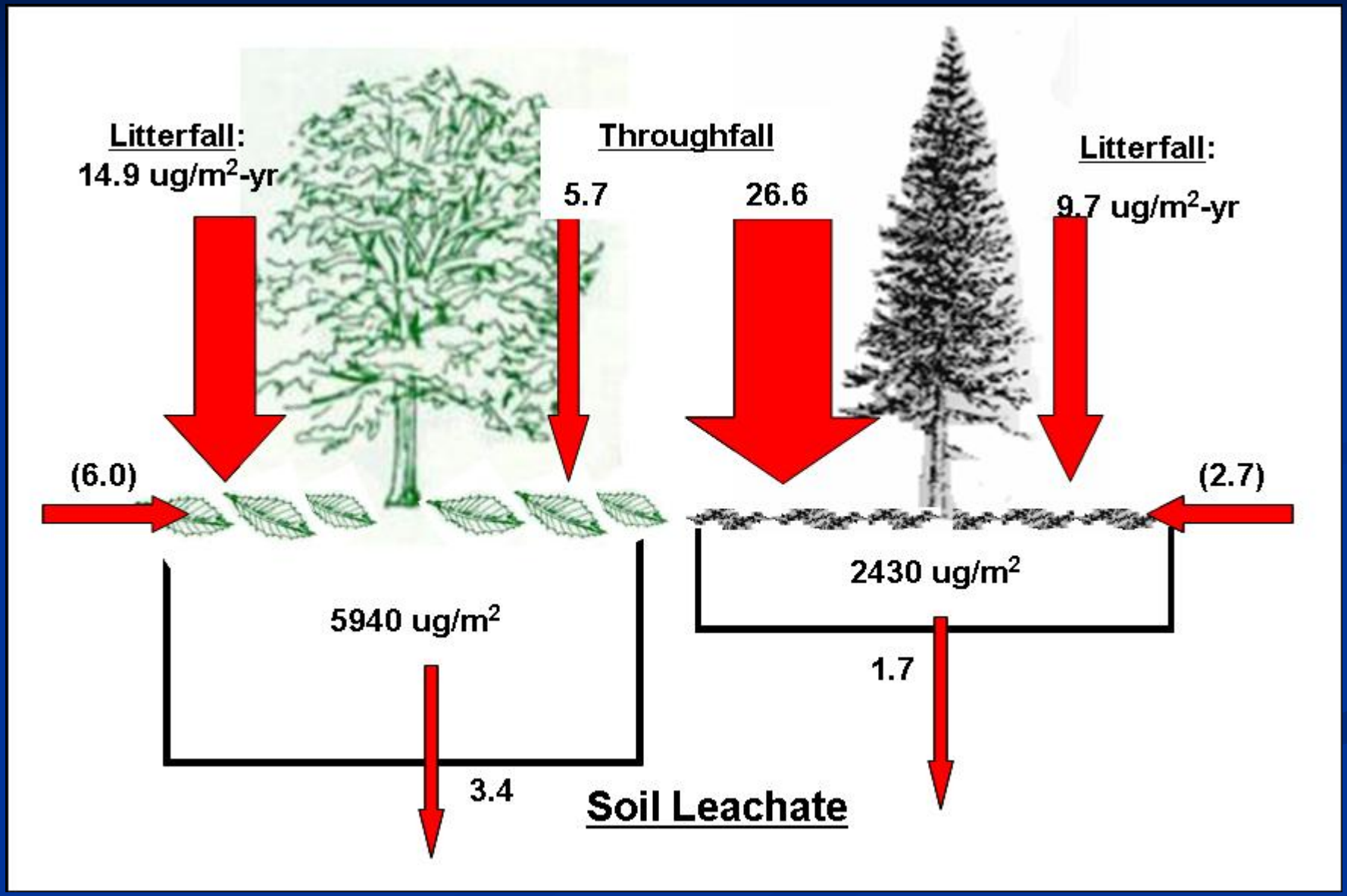


Evers 2005. ***Mercury Connections.***

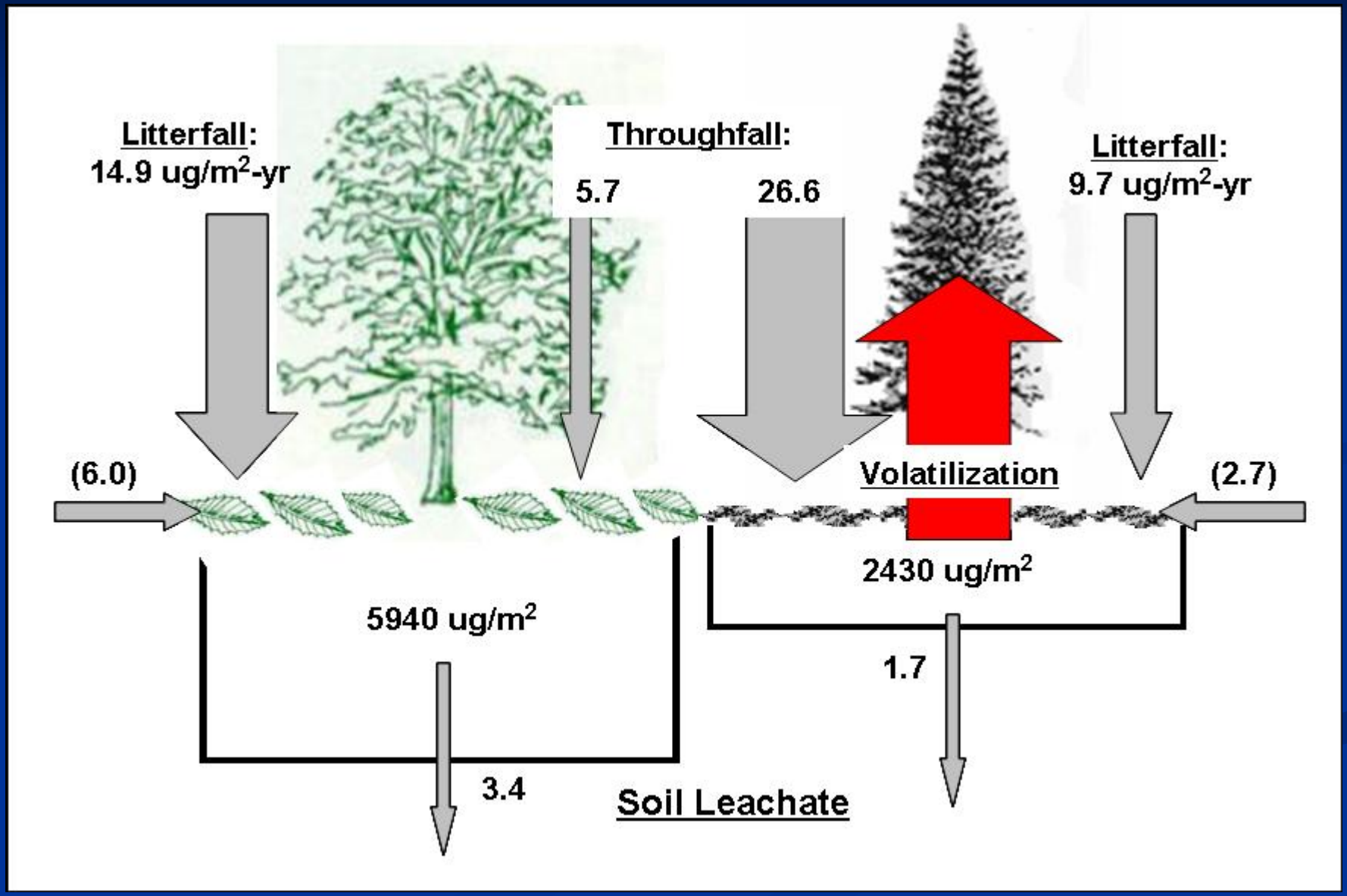

Leaf tissue
Deposition
Litterfall
Canopy air
Throughfall
Evasion
Root tissue
Soil Water
Soil


Huntington Forest
Biscuit Brook
Wet Hg Deposition - 6.9 ug/m2-yr
Total Hg (ng/L)
0
2
4
6
8
10
1999
2000
2001
2002
2003
2004
2005
Year

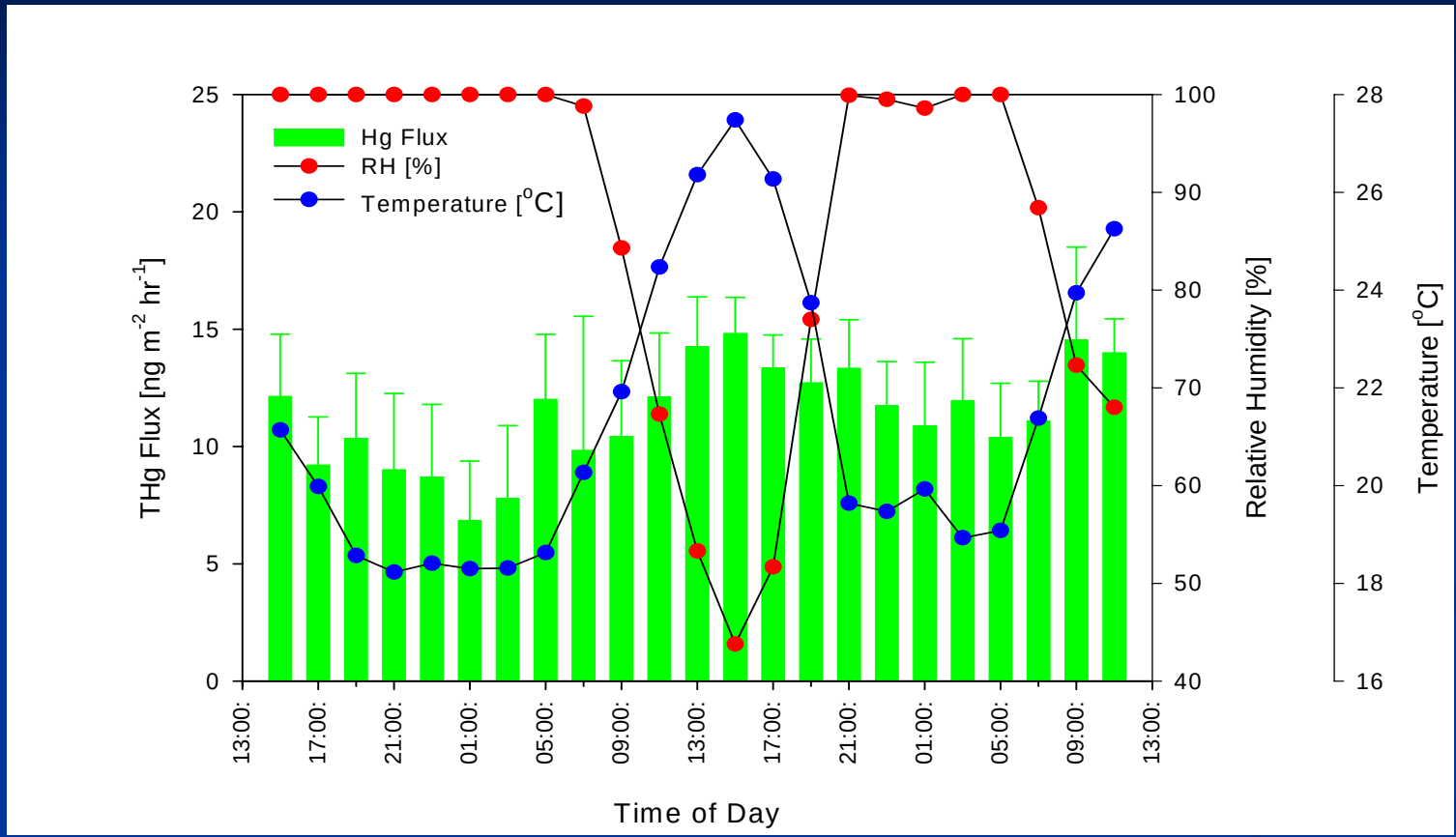
Forest Ecosystem Hg Mass Balance

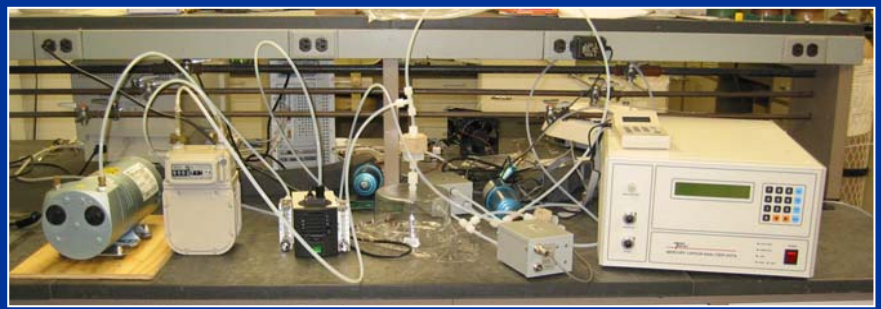


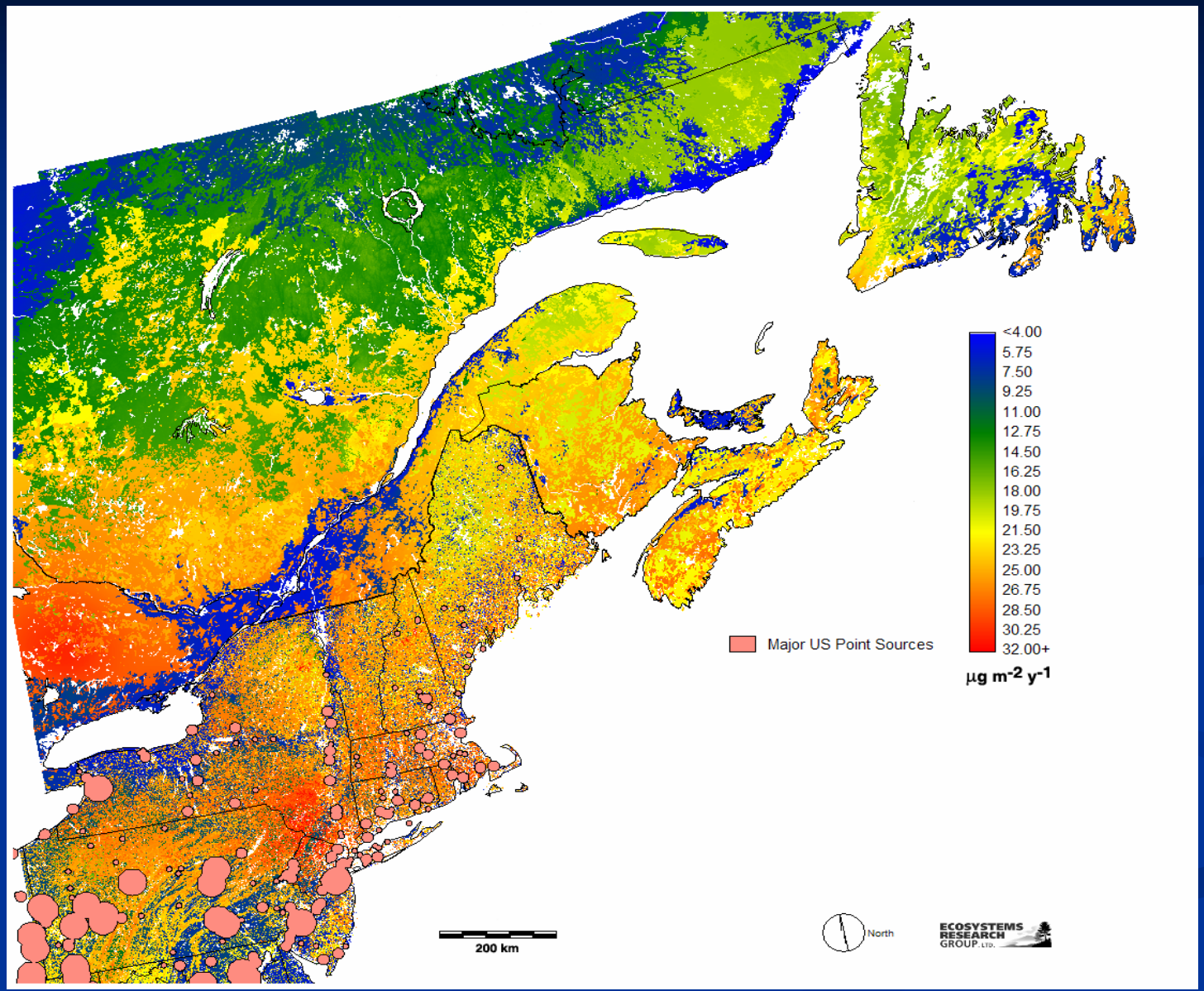
Forest Ecosystem Hg Mass Balance

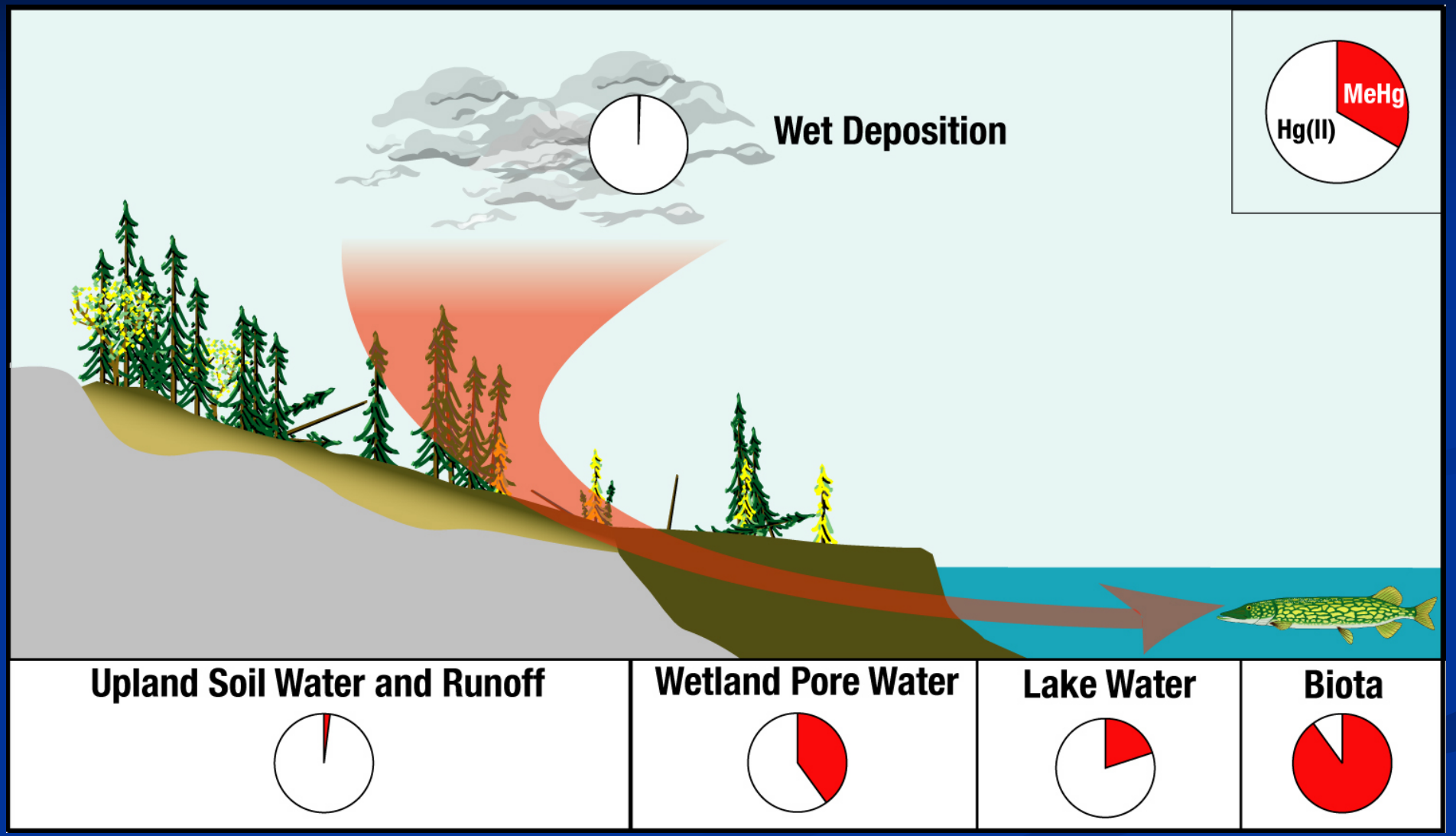


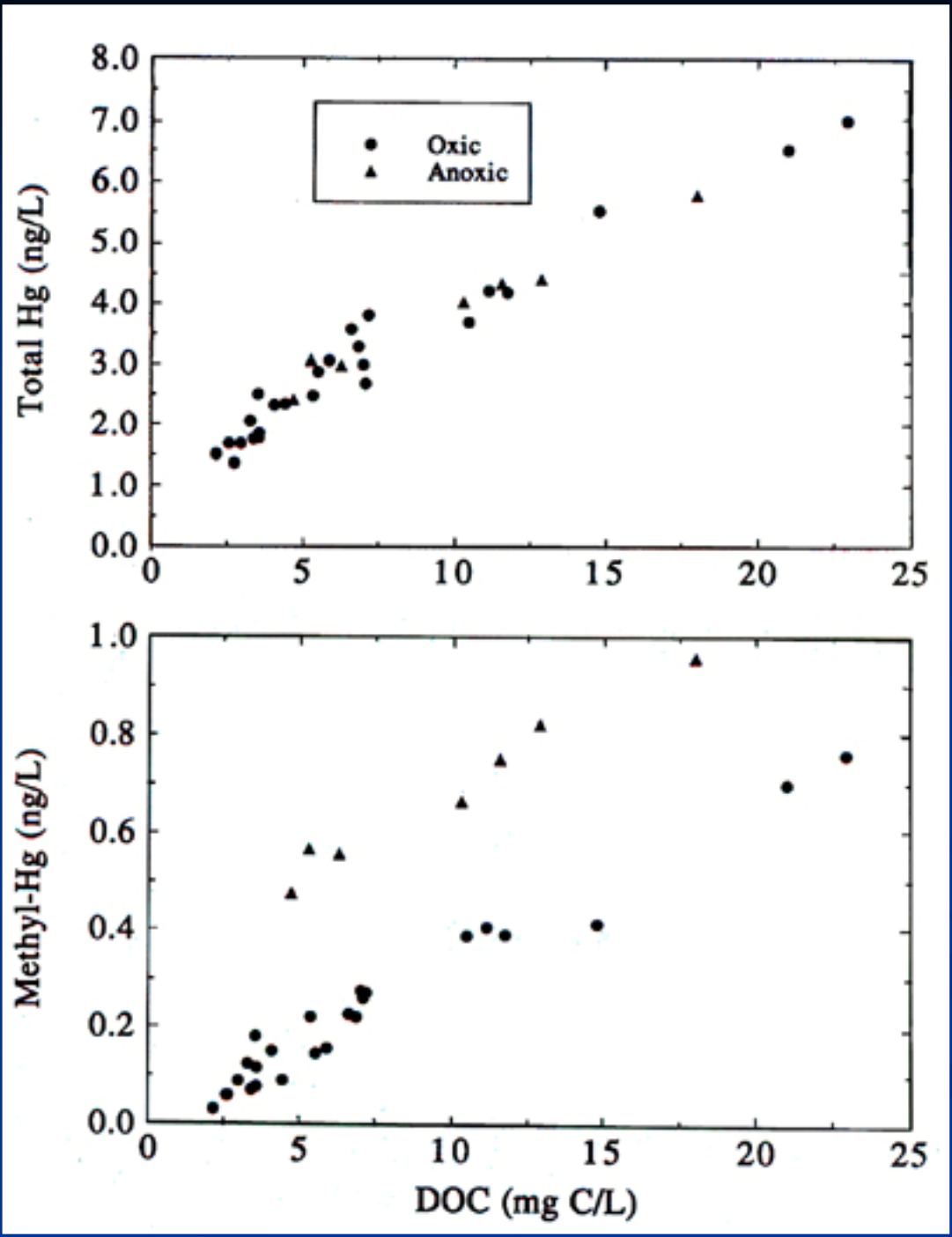
Mercury Flux from Soil Surface

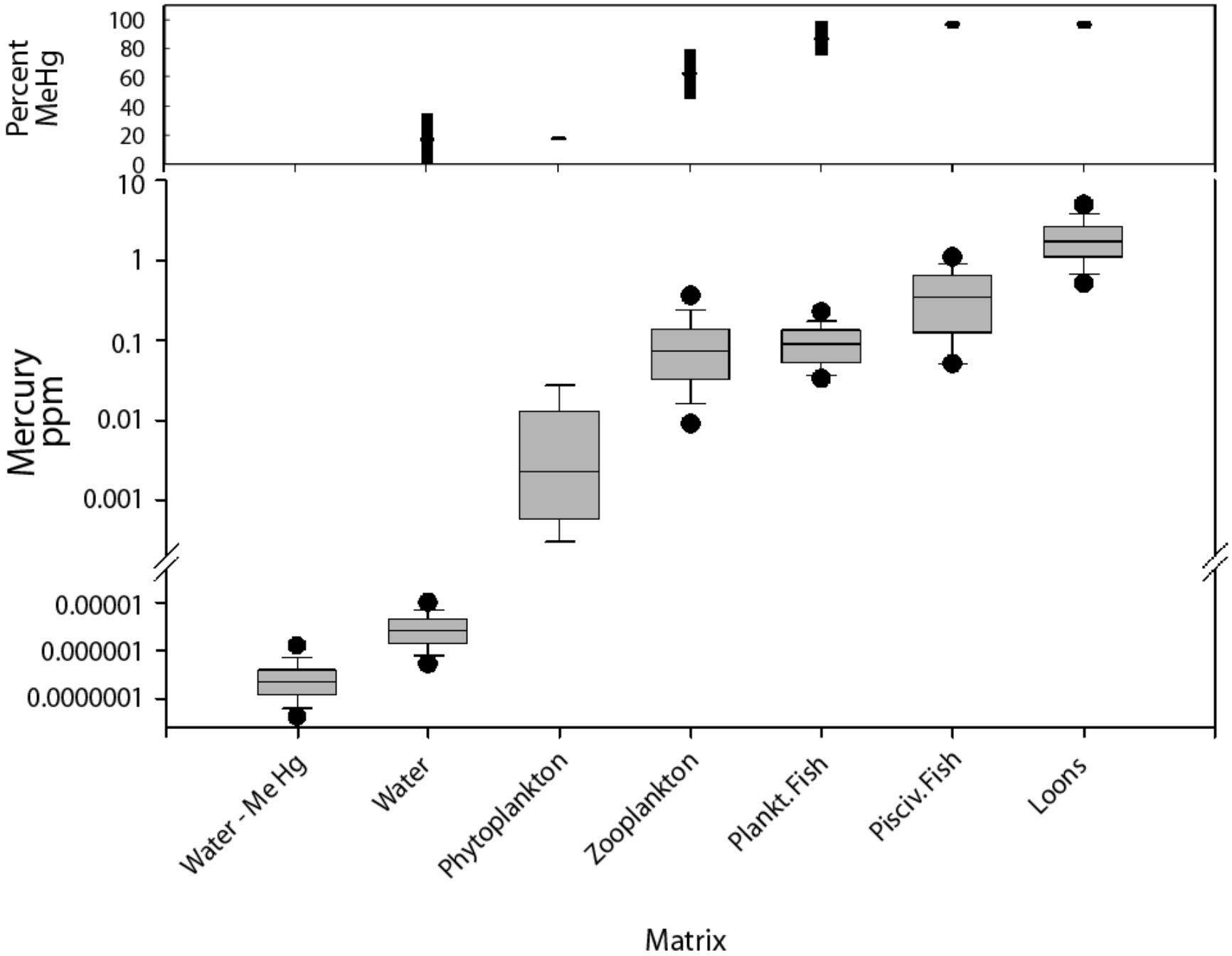




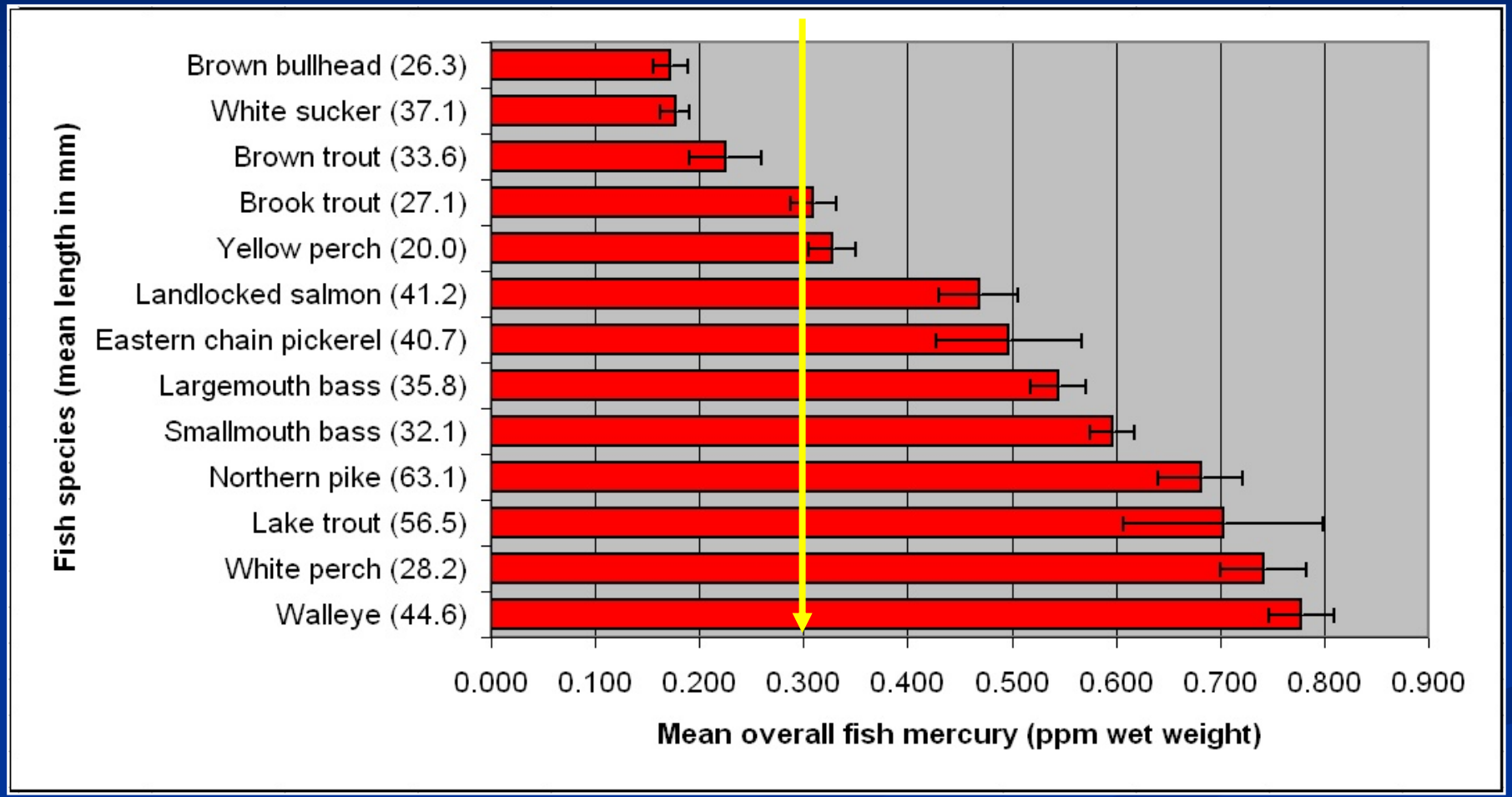

<4.00
5.75
7.50
9.25
11.00
12.75
14.50
16.25
18.00
19.75
21.50
23.25
25.00
26.75
28.50
30.25
32.00+
µg m-2 y-1
Major US Point Sources
200 km
North
ECOSYSTEMS RESEARCH GROUP LTD.

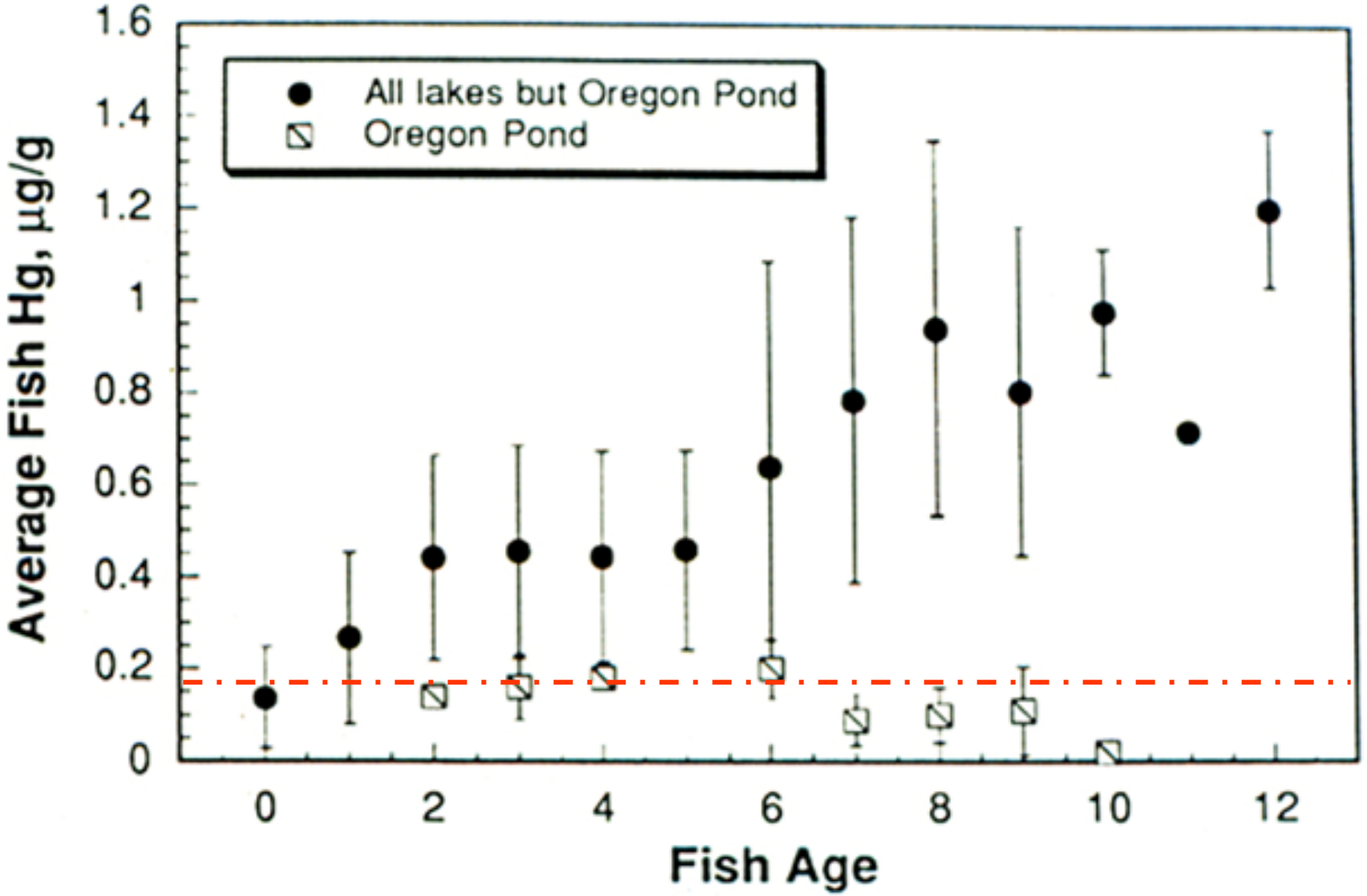

Wet Deposition
MeHg
Hg(II)
Upland Soil Water and Runoff
Wetland Pore Water
Lake Water
Biota

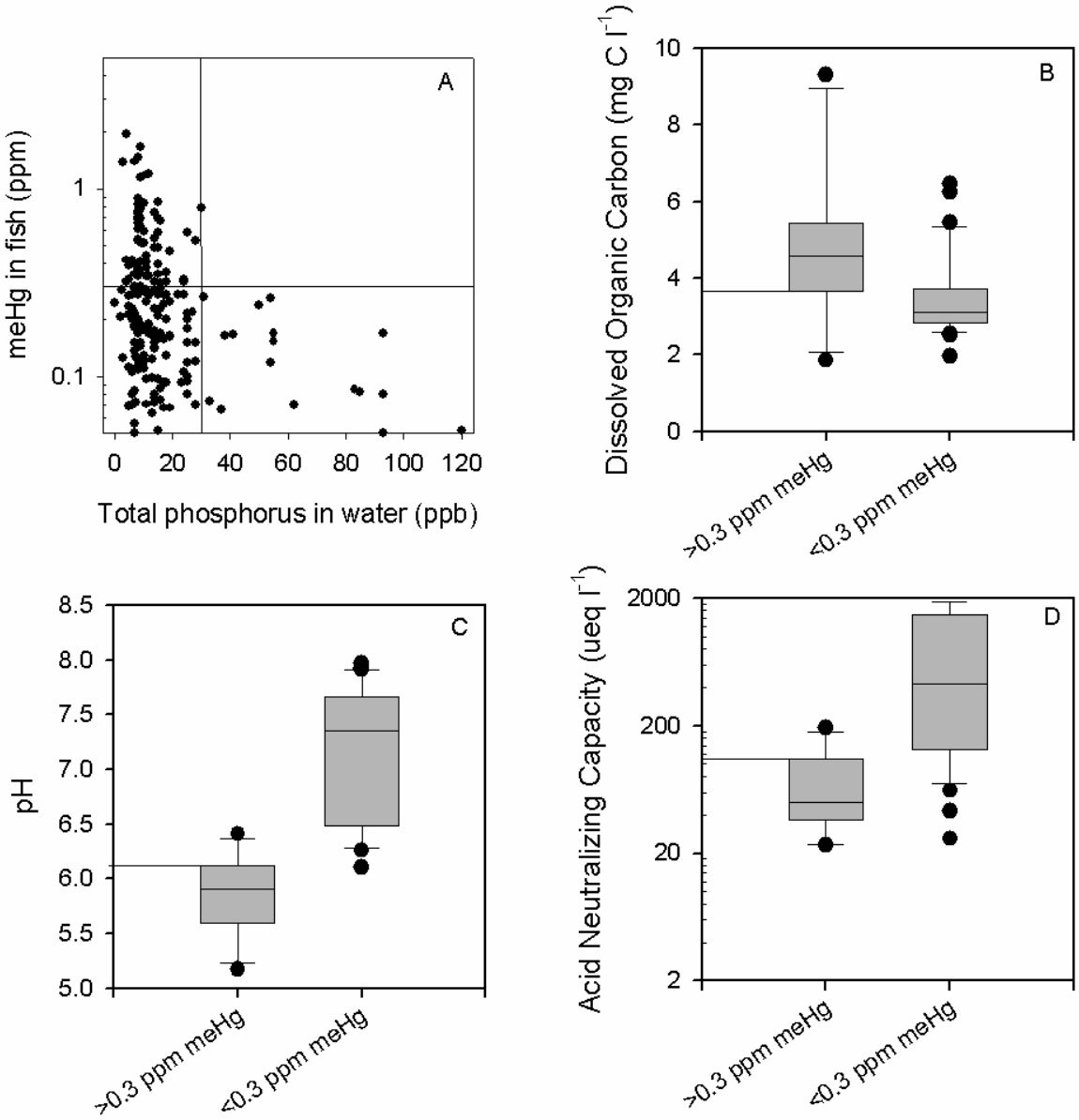

Oxic
Anoxic
Total Hg (ng/L)
Methyl-Hg (ng/L)
DOC (mg C/L)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
0.2
0.4
0.6
0.8
0
5
10
15
20
25


Percent MeHg
100
80
60
40
20
0
Mercury ppm
10
1
0.1
0.01
0.001
0.00001
0.000001
0.0000001
Water - Me Hg
Water
Phytoplankton
Zooplankton
Plankt. Fish
Pisciv. Fish
Loons
Matrix

Mercury in Fish by Species



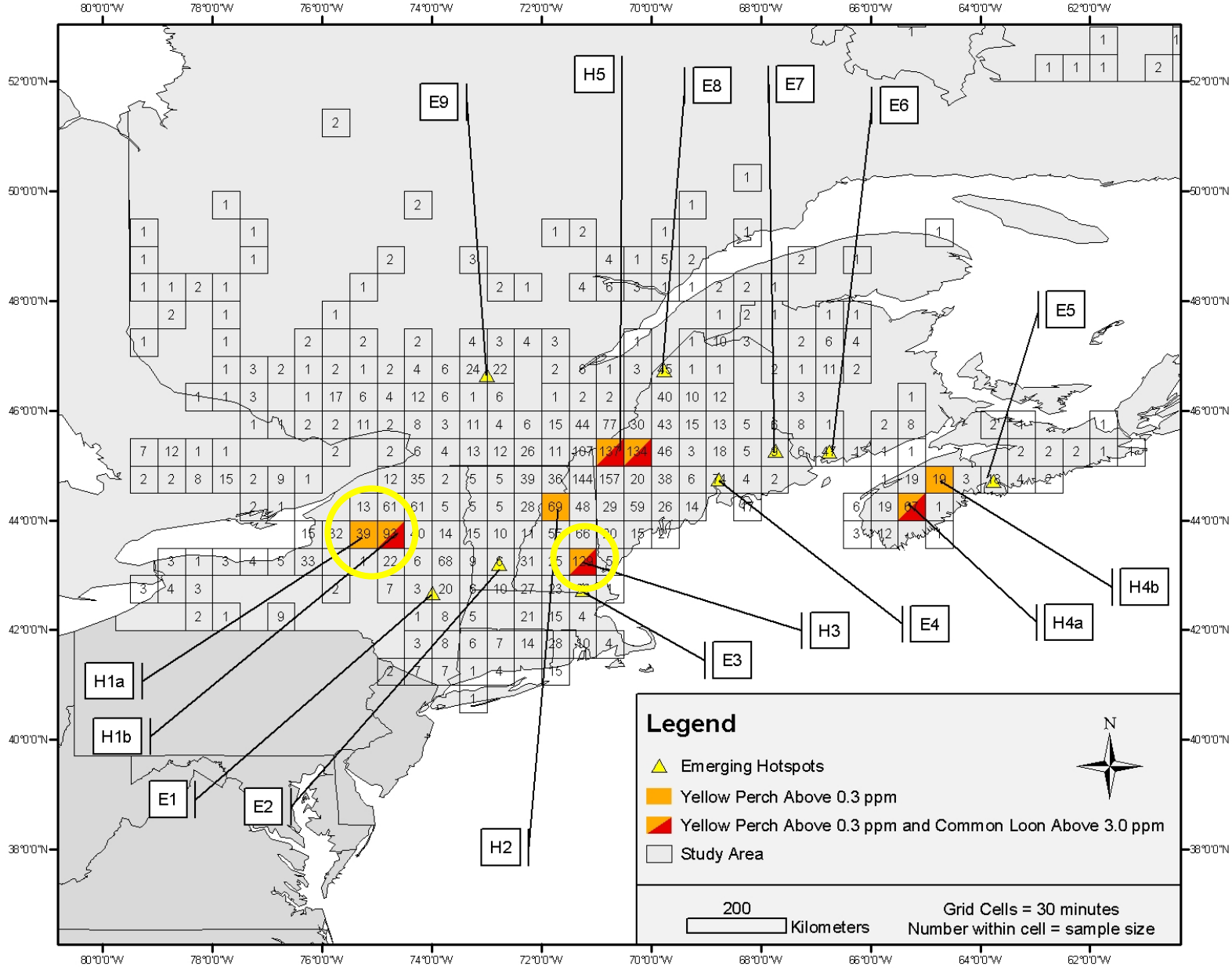

All lakes but Oregon Pond
Oregon Pond
Average Fish Hg, µg/g
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
Fish Age



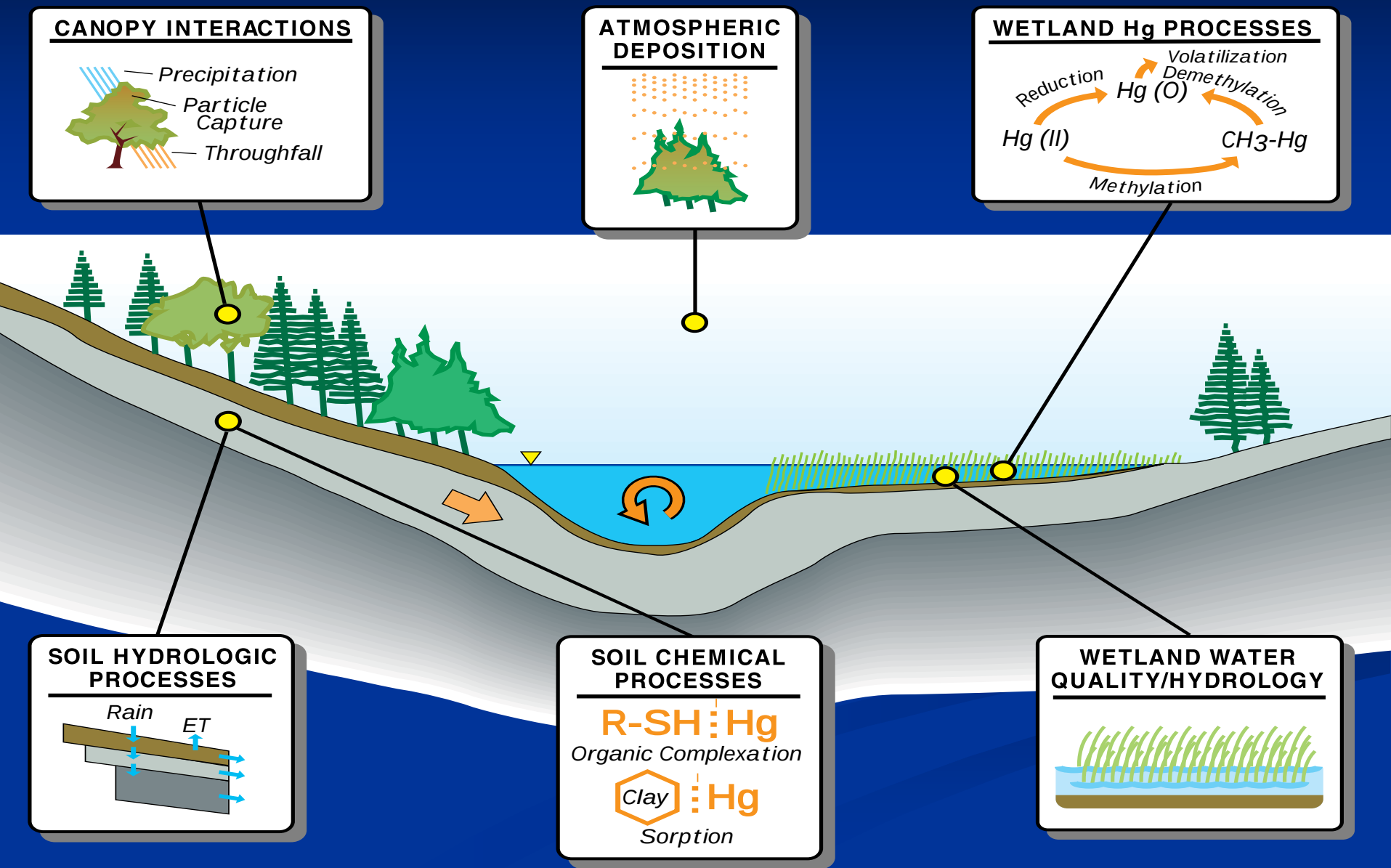
A: Where TP exceeds 30 ppb, fish fillets do not exceed 0.3 ppm meHg
B: For pH, 75% of lakes with pH< 6.1s.u. have fish >0.3 ppb meHg
C: For DOC, 75% of lakes w/ DOC > 3.8 mg C l^{-1} have fish >0.3 ppb meHg
D: For ANC, 75% of lakes w/ ANC< 108 *u* eq. l^{-1}have fish >0.3 ppb meHg

Lake-watersheds vary in their sensitivity to mercury inputs based on:

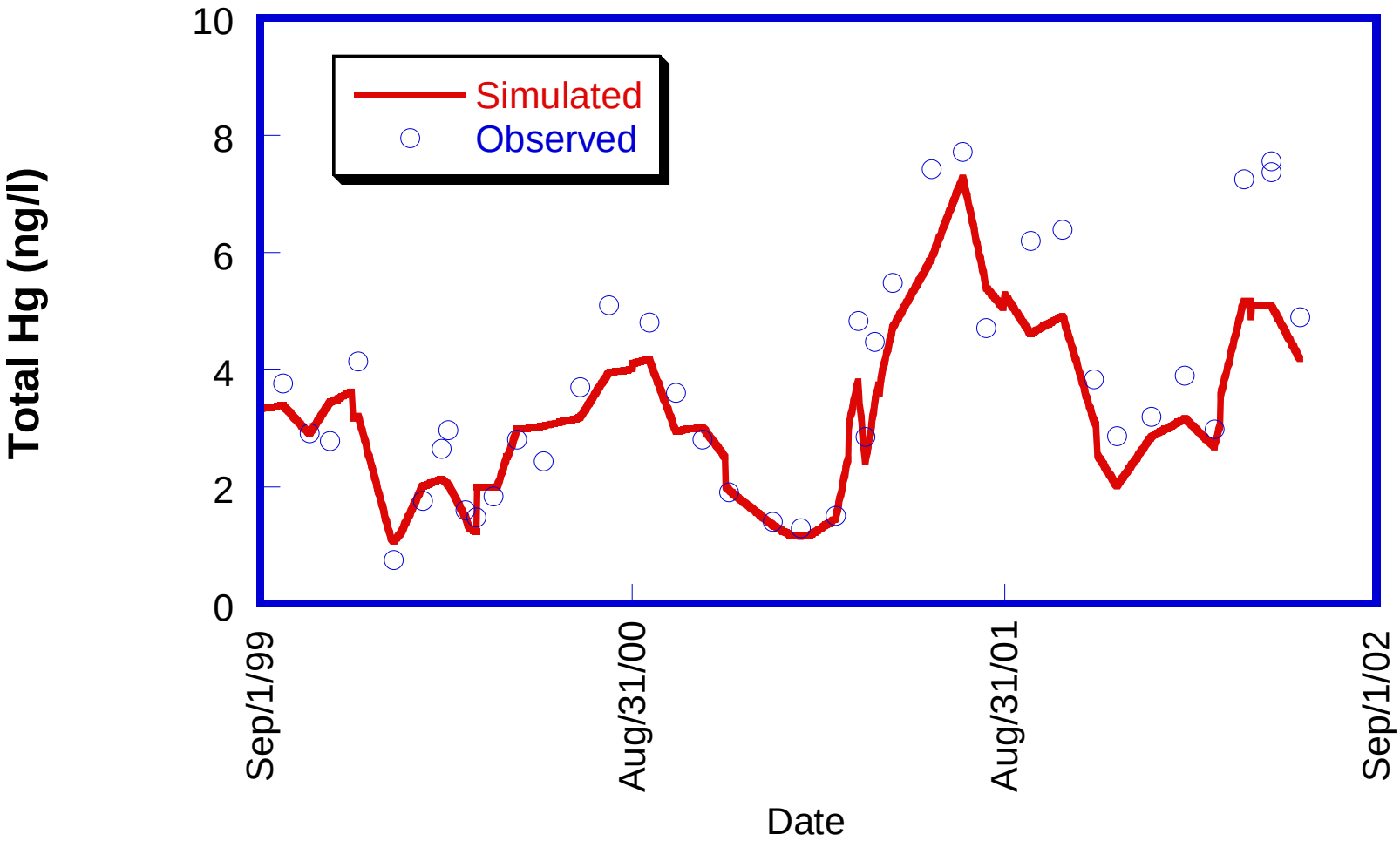
1. Land Cover (e.g., forest, wetlands)
2. Hydrologic flowpaths
3. Aquatic productivity


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
E9
H5
E8
E7
E6
E5
H4b
H4a
E4
H3
E3
H1a
H1b
E1
E2
H2
Legend
Emerging Hotspots
Yellow Perch Above 0.3 ppm
Yellow Perch Above 0.3 ppm and Common Loon Above 3.0 ppm
Study Area
N
200
Kilometers
Grid Cells = 30 minutes
Number within cell = sample size

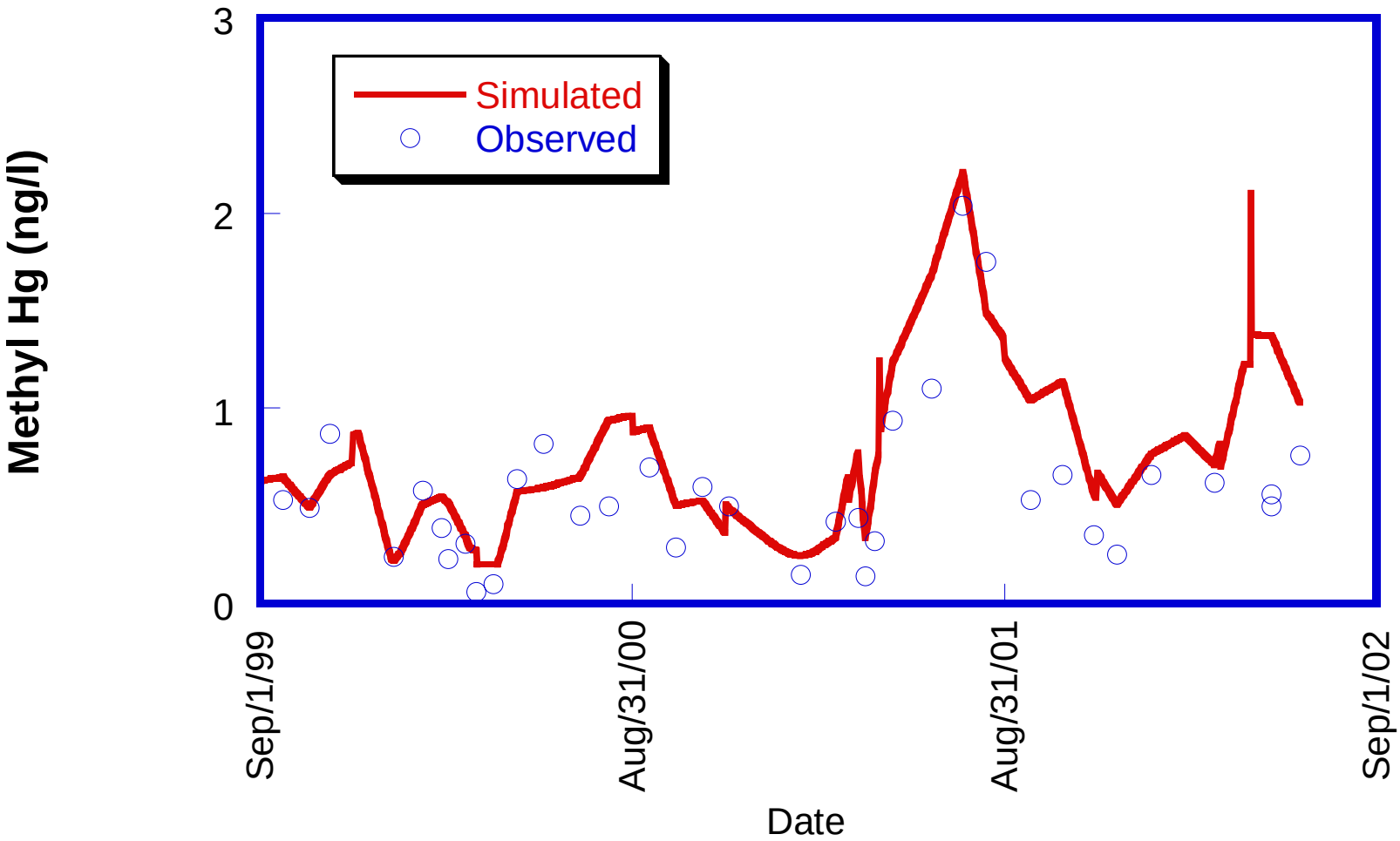
Mercury Cycling Model for Headwater Drainage Lakes (MCM-HD)



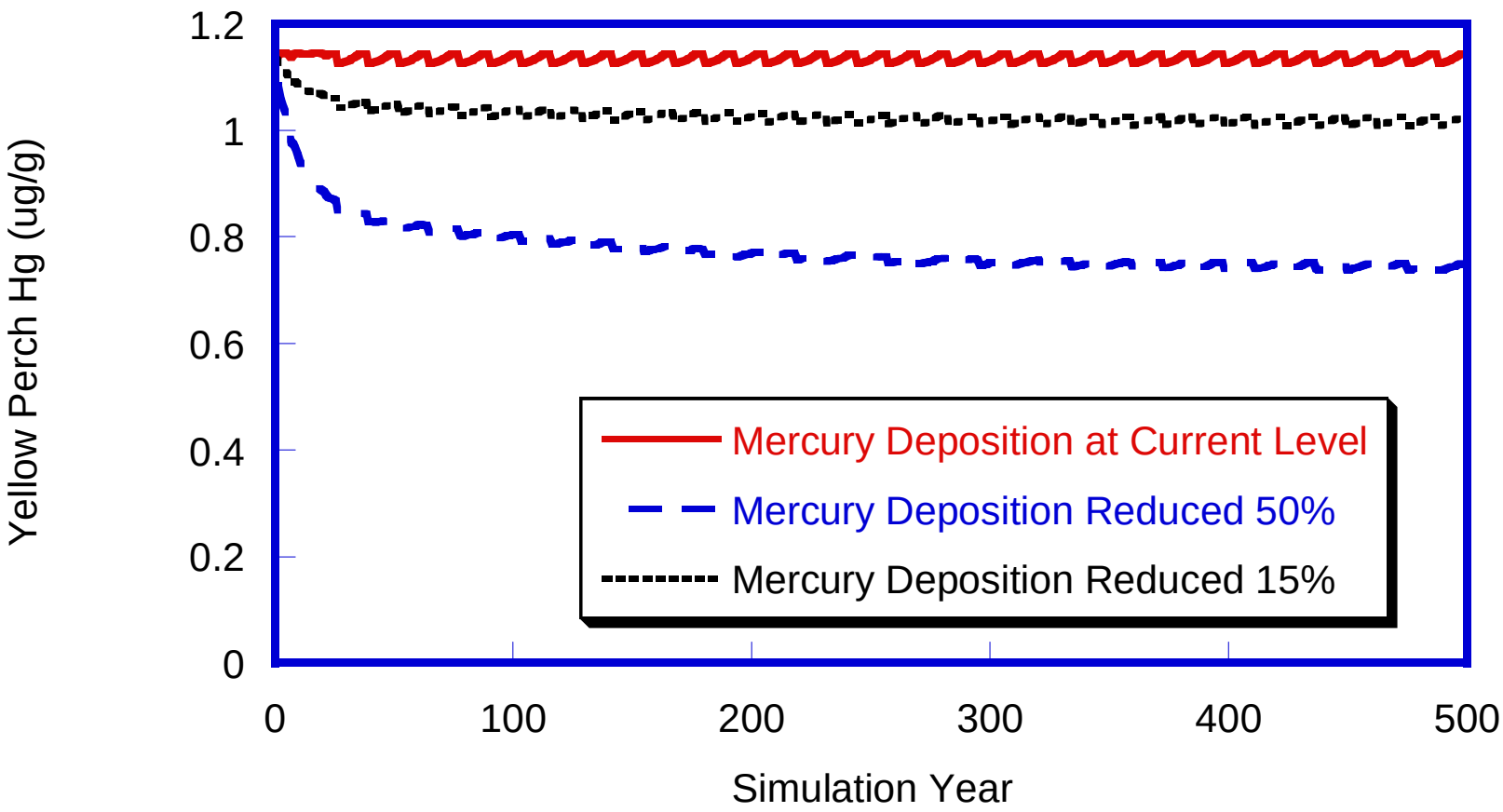
Sunday Lake Inlet Calibration: Total Hg



Sunday Lake Inlet Calibration: Methyl Hg



Sunday Lake: Simulated Response of Fish Hg to 15% and 50% Decreases in Atmospheric Hg Deposition



Conclusions

- The forest canopy enhances Hg deposition
- Hg inputs are retained in soil, re-emitted to the atmosphere or lost with drainage
- Wetlands enhance the supply and transport of MeHg
- Marked bioaccumulation of MeHg occurs in the aquatic food chain
- The western Adirondacks is a Hg “hotspot”

Research Needs

- Dry deposition (total deposition)
- Fate of soil Hg
- Soil re-emissions
- Response of fish Hg to changes in Hg inputs and acid rain