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

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Site Description

Sunday Lake Watershed

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

Litterfall: 14.9 ug/m²-yr

Throughfall:
5.7
26.6

Litterfall: 9.7 ug/m²-yr

(6.0)

5940 ug/m²

3.4

Soil Leachate

2430 ug/m²

1.7

(2.7)
Forest Ecosystem Hg Mass Balance

Litterfall: 14.9 ug/m²-yr

Throughfall: 5.7

26.6

Litterfall: 9.7 ug/m²-yr

Volatilization

2430 ug/m²

1.7

Soil Leachate

5940 ug/m²

(6.0)

(2.7)
Mercury Flux from Soil Surface

![Graph showing Mercury Flux, Relative Humidity, and Temperature over a 24-hour period.](image)

- **Hg Flux** [ng m^{-2} hr^{-1}]
- **RH [%]**
- **Temperature [°C]**

**Time of Day**

- 13:00
- 17:00
- 21:00
- 01:00
- 05:00
- 09:00
- 13:00
- 17:00
- 21:00

**Related Images**

- Image 1: Equipment setup for Mercury Flux measurement.
- Image 2: Close-up of the measurement device.
- Image 3: Soil surface setup for the experiment.
The graph illustrates the average fish mercury concentration (µg/g) plotted against fish age (years). Two categories are shown:

- **Black circles**: All lakes except Oregon Pond.
- **White squares**: Oregon Pond.

The y-axis represents the average fish mercury concentration, ranging from 0 to 1.6 µg/g, while the x-axis represents fish age, ranging from 0 to 12 years. The data points show a consistent increase in mercury concentration with age for both categories, with Oregon Pond having slightly higher values than all other lakes except for the youngest age group.
A: Where TP exceeds 30 ppb, fish fillets do not exceed 0.3 ppm meHg
B: For pH, 75% of lakes with pH < 6.1 s.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 μ 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
Mercury Cycling Model for Headwater Drainage Lakes (MCM-HD)

**Canopy Interactions**
- Precipitation
- Particle Capture
- Throughfall

**Atmospheric Deposition**

**Soil Hydrologic Processes**
- Rain
- ET

**Soil Chemical Processes**
- Organic Complexation
- Sorption
- Reduction
- Methylation
- Demethylation
- Volatilization
- Hg (II)
- Hg (O)
- CH₃-Hg

**Wetland Hg Processes**
- Reduction
- Demethylation
- Volatilization

**Wetland Water Quality/Hydrology**
Sunday Lake Inlet Calibration: Total Hg

[Graph showing the trend of Total Hg (ng/l) over time from Sep/1/99 to Sep/1/02. The graph compares simulated and observed data with a line graph and scatter plot.]
Sunday Lake Inlet Calibration: Methyl Hg

![Graph showing Methyl Hg concentrations from Sep/1/99 to Sep/1/02. The graph compares simulated and observed values. The x-axis represents dates, and the y-axis represents Methyl Hg concentrations in ng/l.]
Sunday Lake: Simulated Response of Fish Hg to 15% and 50% Decreases in Atmospheric Hg Deposition

Yellow Perch Hg (ug/g) vs Simulation Year

- Red line: Mercury Deposition at Current Level
- Blue dashed line: Mercury Deposition Reduced 50%
- Black dotted line: Mercury Deposition Reduced 15%
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