Outline of Presentation

• Chemical versus biological response

• Aquatic biota
  – Fish
  – Other Biota

• Terrestrial biota with emphasis on sugar maple

• Need for integrated approach
SO$_x$, NH$_x$, NO$_x$

H$_2$SO$_4$, HNO$_3$

Cations
Nutrient Ca$^{2+}$, Mg$^{2+}$
Toxic H$^+$, Al$^{3+}$

Anions
Mobile SO$_4^{2-}$, NO$_3^-$

Biotic Impacts
Nutrient Depletion
Toxicity
Major Components
Related to Sulfur and Nitrogen Emissions and Ecosystem Effects

- Emissions
- Deposition
- Water Chemistry
- Aquatic Biota
- Soil Chemistry
- Terrestrial Biota

Relative Response Time:
- Days
- Decades
- Centuries

Color Legend:
- Fast
- Slow
From Adirondack Lake Survey Corporation

LAKES WITH AND WITHOUT FISH

Lakes with fish

Lakes without fish
Other Aquatic Biota
Example of Brooktrout Lake in the Adirondack Mountains
(from Clifford Siegfried)
Species Richness

**ZOOPLANDKTON TAXA - BROOKTROUT LAKE**
Forest Ecosystems
Red Spruce Decline (higher elevations)
Sugar Maple Decline

residuum/colluvium
nutrient poor

seep

bedrock

bedrock

glacial till

glacial outwash

nutrient rich
Upper B-horizon

Mortality (% dead basal area)

Mg saturation%

2% Threshold

0.5% Threshold

Ca saturation%

less severe defoliation

severe defoliation
Atmospheric Deposition Major Driver:  

But Other Factors Matter  

- Other components of air pollutants including ozone  
- Geology (location and substrate)  
- Introduction of exotic species  
- Herbivory (Deer, Moose, Insects)  
- Land use change including forest management  
- Climatic effects  
- Not only is the biota affected, but the biota can have a marked impact on the chemistry especially N cycling and nitrate in surface waters
Exotic Pests and Pathogens as Agents of Species Change

Established pests:
- Gypsy moth
- Hemlock woolly adelgid
- Beech scale

New pests & pathogens:
- Emerald ash borer
- Asian longhorned beetle
- Sudden oak death

Control of Nitrate in Catskill Streams

Variance in soil C:N is primarily explained by species composition, especially sugar maple and red oak.

Ca Rich Site (S14)

Litter
Low C:N

Litter
High Ca

High Mineralization & Nitrification

NO₃⁻

Uptake

Ca²⁺

Leaching

weathering

Stream

High Ca²⁺
High NO₃⁻

Ca-rich parent material

Ca Poorer Site (S15)

Litter
Low Ca

Litter
High C:N

Low Mineralization & Nitrification

NO₃⁻

Leaching

weathering

Stream

Low Ca²⁺
Low NO₃⁻

Ca-poorer parent material

SO$_x$ NH$_x$, NO$_x$

H$_2$SO$_4$ HNO$_3$

Ozone
Geology
Climate Change
Land Use
Herbivory
Exotics

Cations
Nutrient Ca$^{2+}$, Mg$^{2+}$
Toxic H$^+$, Al$^{3+}$

Anions
Mobile SO$_4^{2-}$ NO$_3^-$

Biotic Impacts
Nutrient Depletion
Toxicity