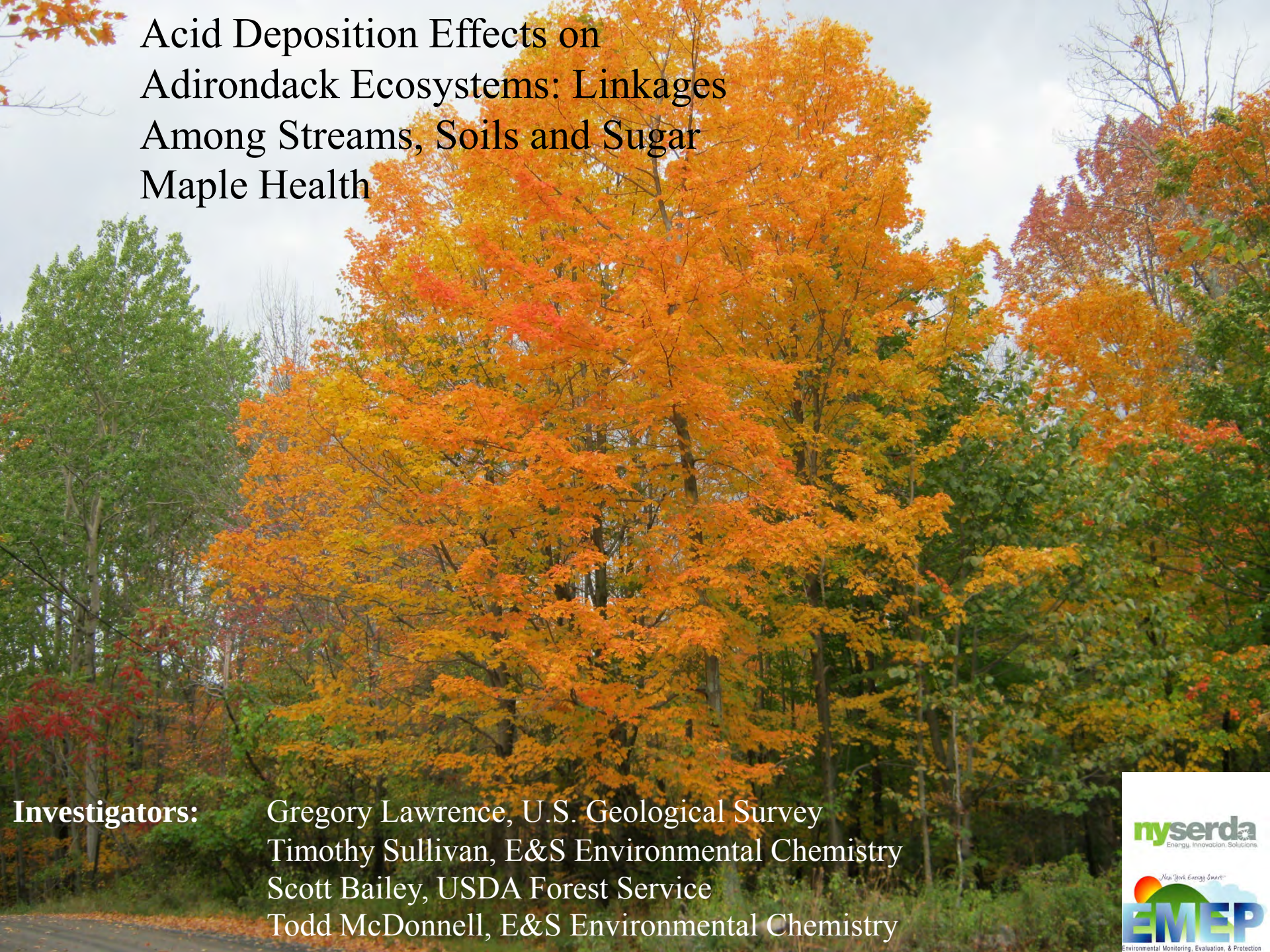
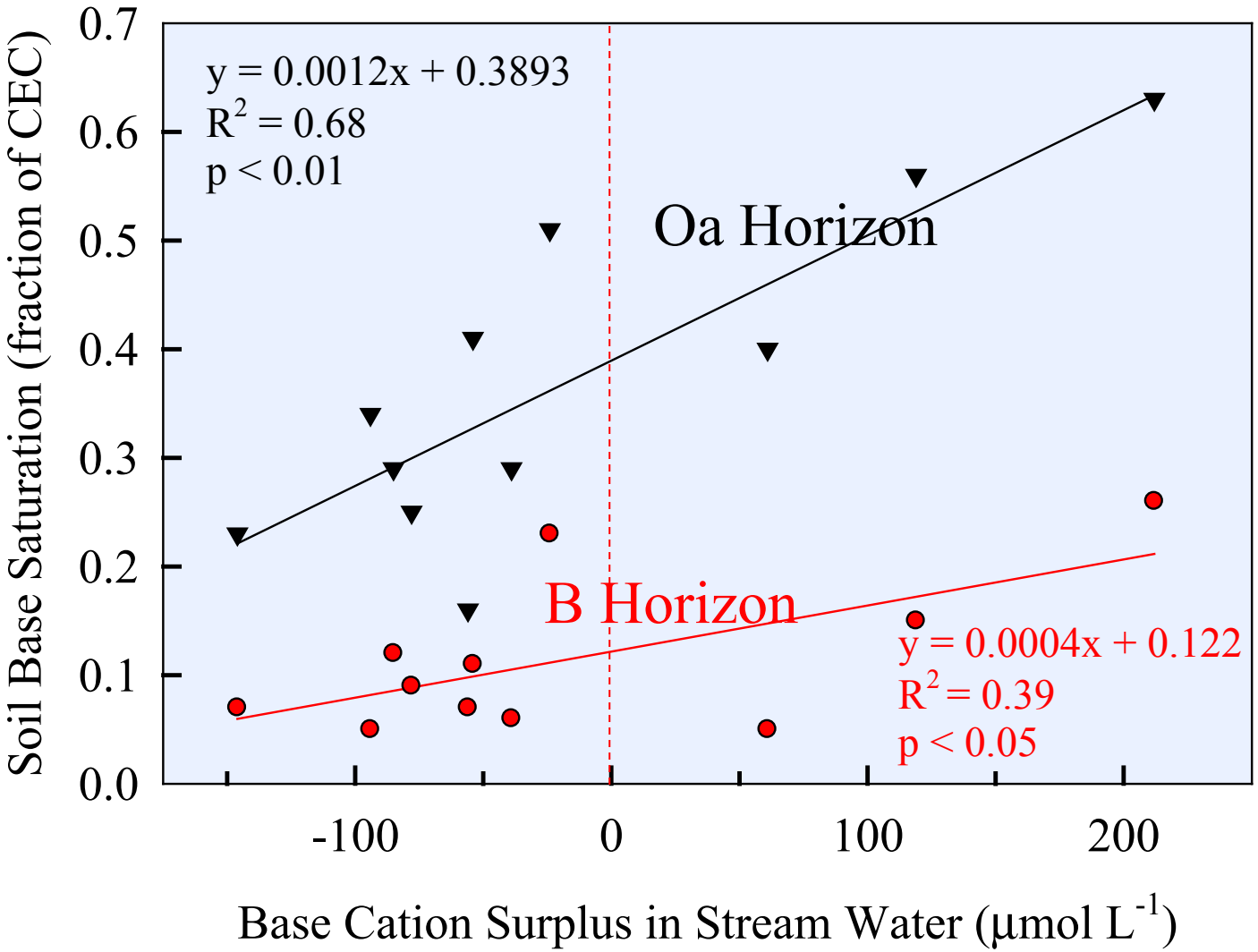
Acid Deposition Effects on Adirondack Ecosystems: Linkages Among Streams, Soils and Sugar Maple Health



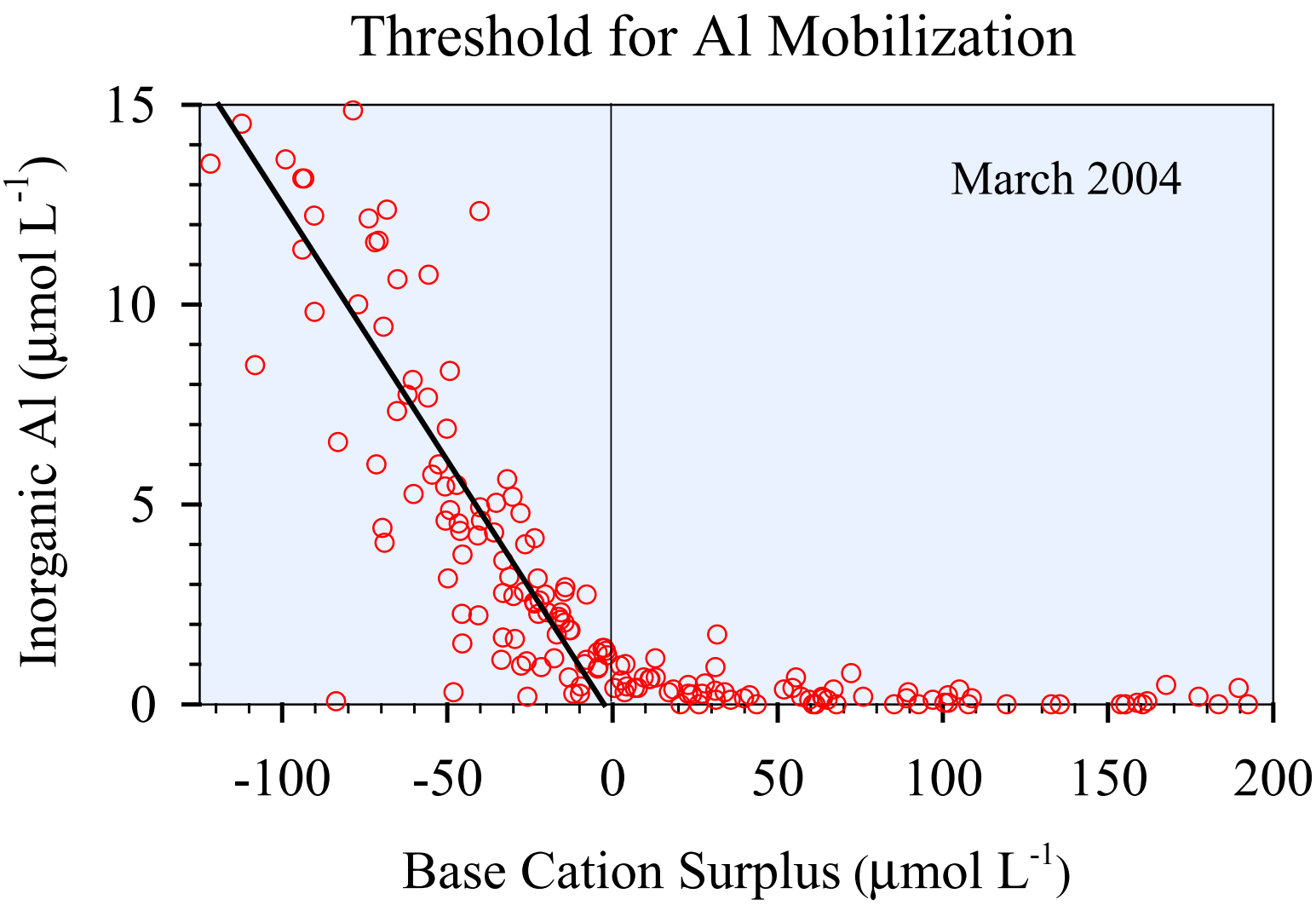
Investigators: Gregory Lawrence, U.S. Geological Survey
Timothy Sullivan, E&S Environmental Chemistry
Scott Bailey, USDA Forest Service
Todd McDonnell, E&S Environmental Chemistry

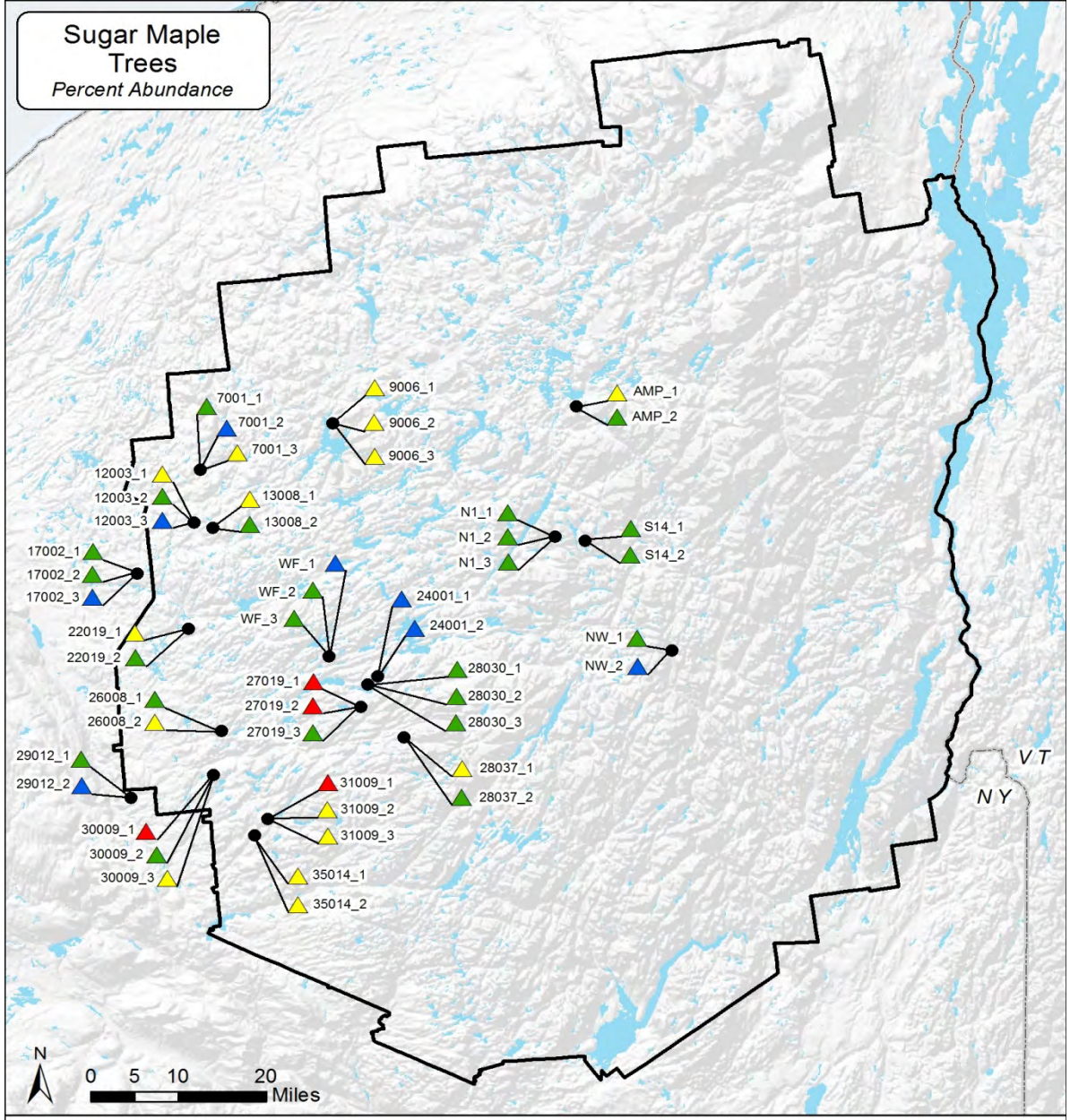

Soil-Stream Water
Linkages


y = 0.0012x + 0.3893
R2 = 0.68
p < 0.01
Oa Horizon
B Horizon
y = 0.0004x + 0.122
R2 = 0.39
p < 0.05
Soil Base Saturation (fraction of CEC)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
-100
0
100
200
Base Cation Surplus in Stream Water (µmol L-1)

Two Fundamental Problems:

1. Accelerated loss of calcium
2. Mobilization of inorganic aluminum

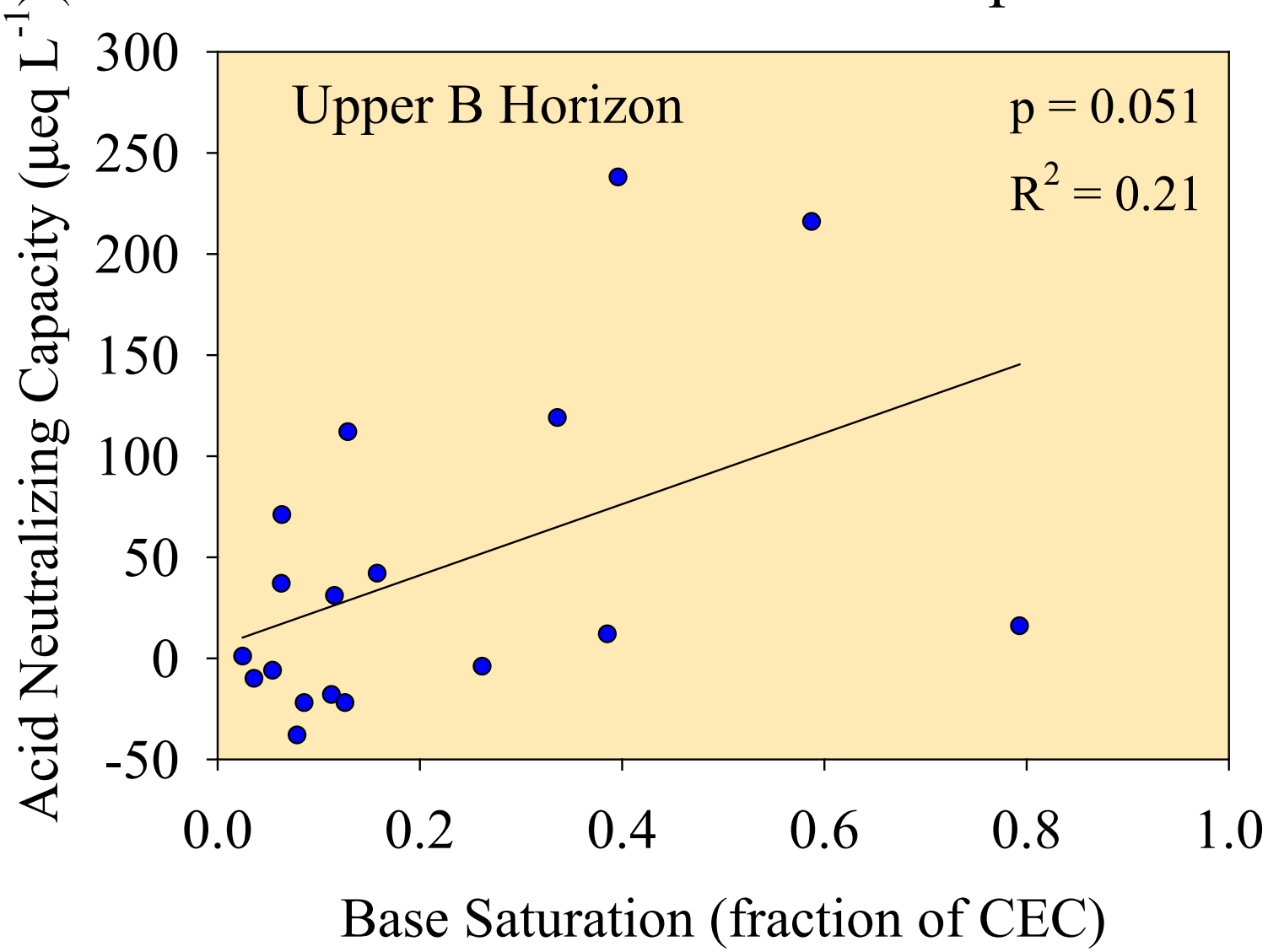

Threshold for Al Mobilization
March 2004
Inorganic Al (µmol L-1)
15
10
5
0
-100
-50
0
50
100
150
200
Base Cation Surplus (µmol L-1)

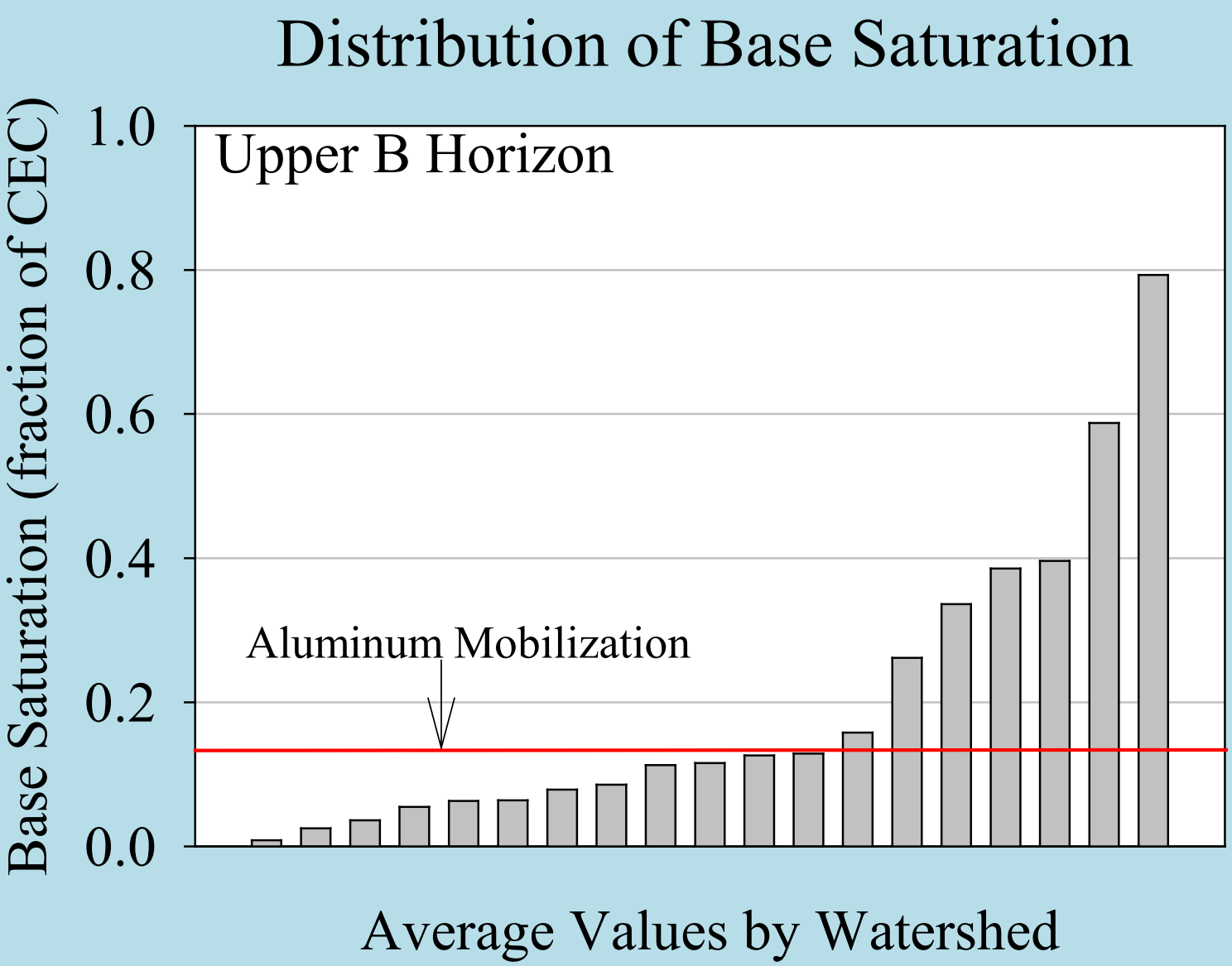

Sugar Maple Trees
Percent Abundance
7001_1
7001_2
7001_3
9006_1
9006_2
9006_3
AMP_1
AMP_2
12003_1
12003_2
12003_3
13008_1
13008_2
N1_1
N1_2
N1_3
S14_1
S14_2
17002_1
17002_2
17002_3
WF_1
WF_2
WF_3
24001_1
24001_2
22019_1
22019_2
NW_1
NW_2
27019_1
27019_2
27019_3
28030_1
28030_2
28030_3
26008_1
26008_2
29012_1
29012_2
28037_1
28037_2
31009_1
31009_2
31009_3
30009_1
30009_2
30009_3
35014_1
35014_2
VT
NY
N
0 5 10 20
Miles
Sugar Maple - Trees
0 - 25%
25 - 50%
50 - 75%
75 - 100%
State Boundary
Adirondack Park Boundary
NHD Waterbody
E&S
Environmental Chemistry, Inc.

Measurements

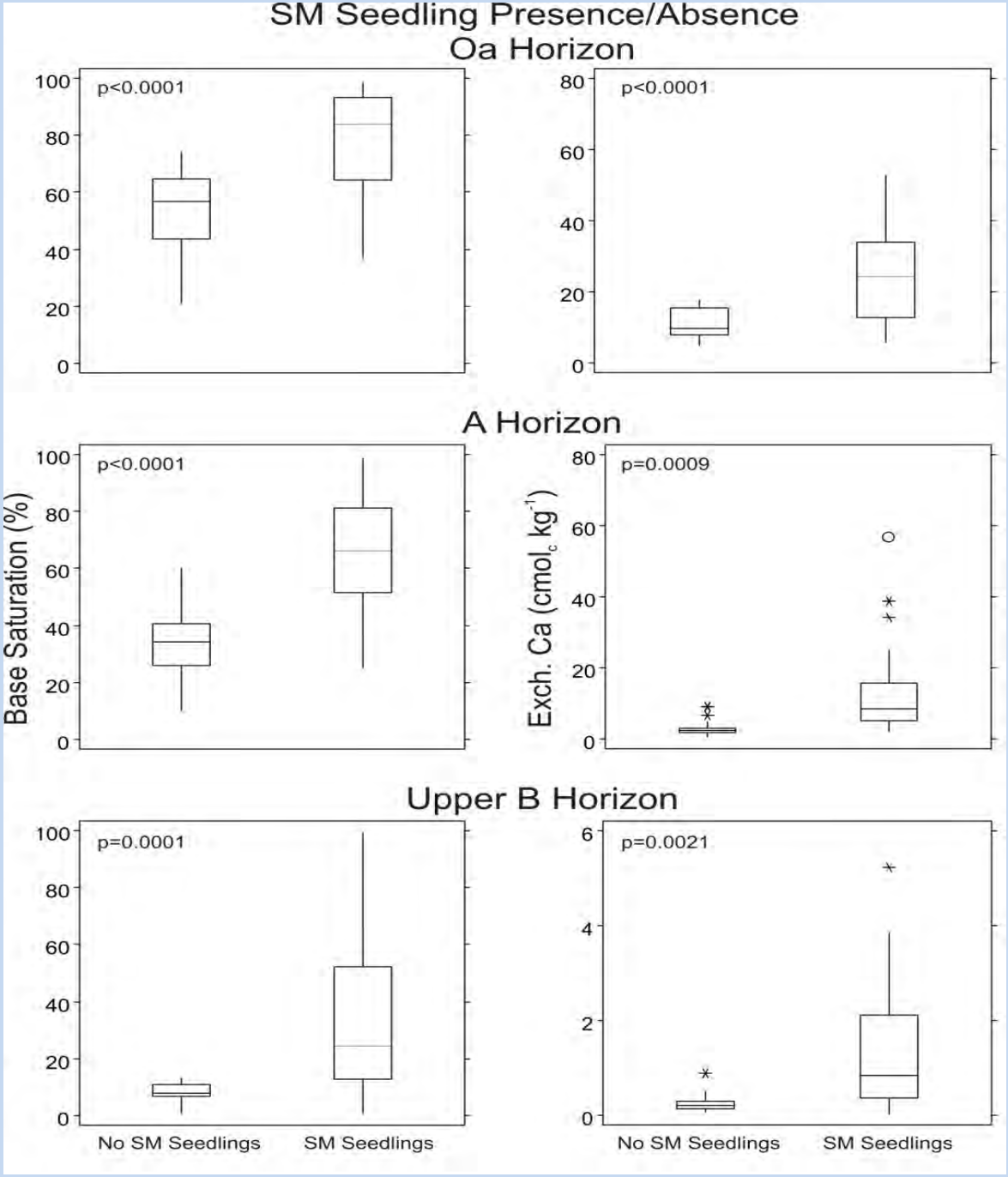
- Tree species composition—overstory and understory.
- Canopy condition.
- Growth history.
- Soil chemistry
- Stream chemistry

Soil-Stream Relationships

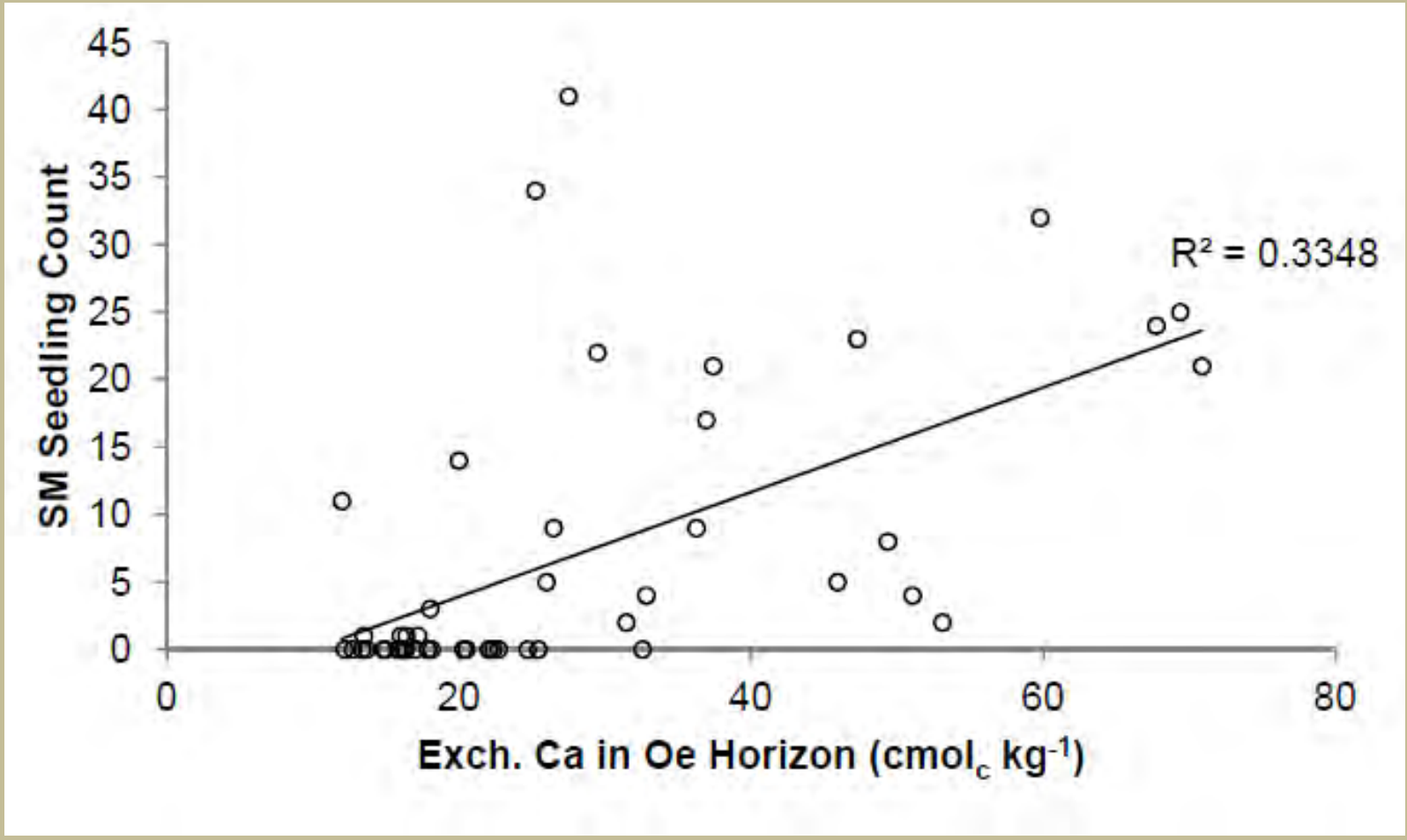



Distribution of Base Saturation
Upper B Horizon
Base Saturation (fraction of CEC)
1.0
0.8
0.6
0.4
0.2
0.0
Aluminum Mobilization
Average Values by Watershed

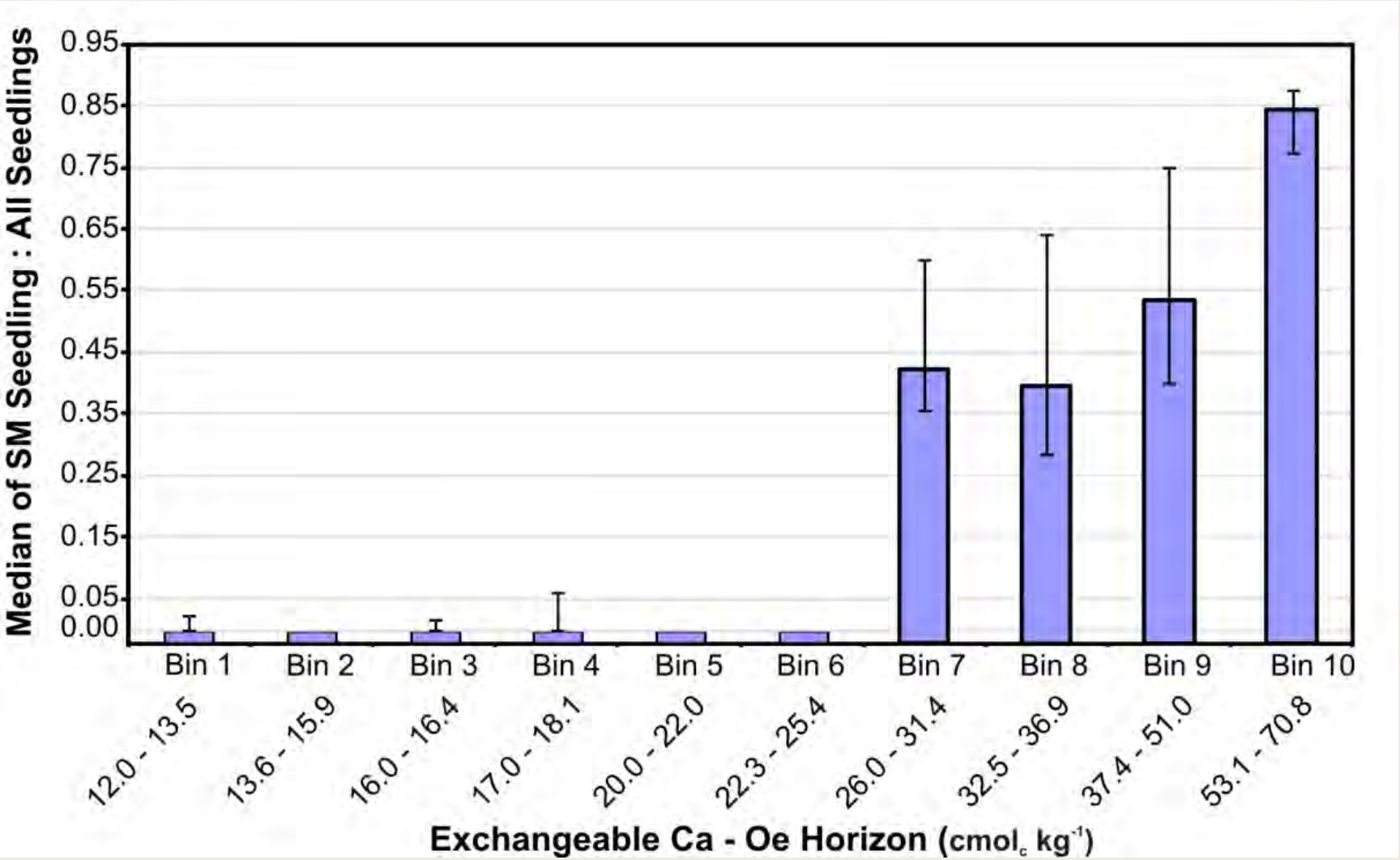

NHSWGA

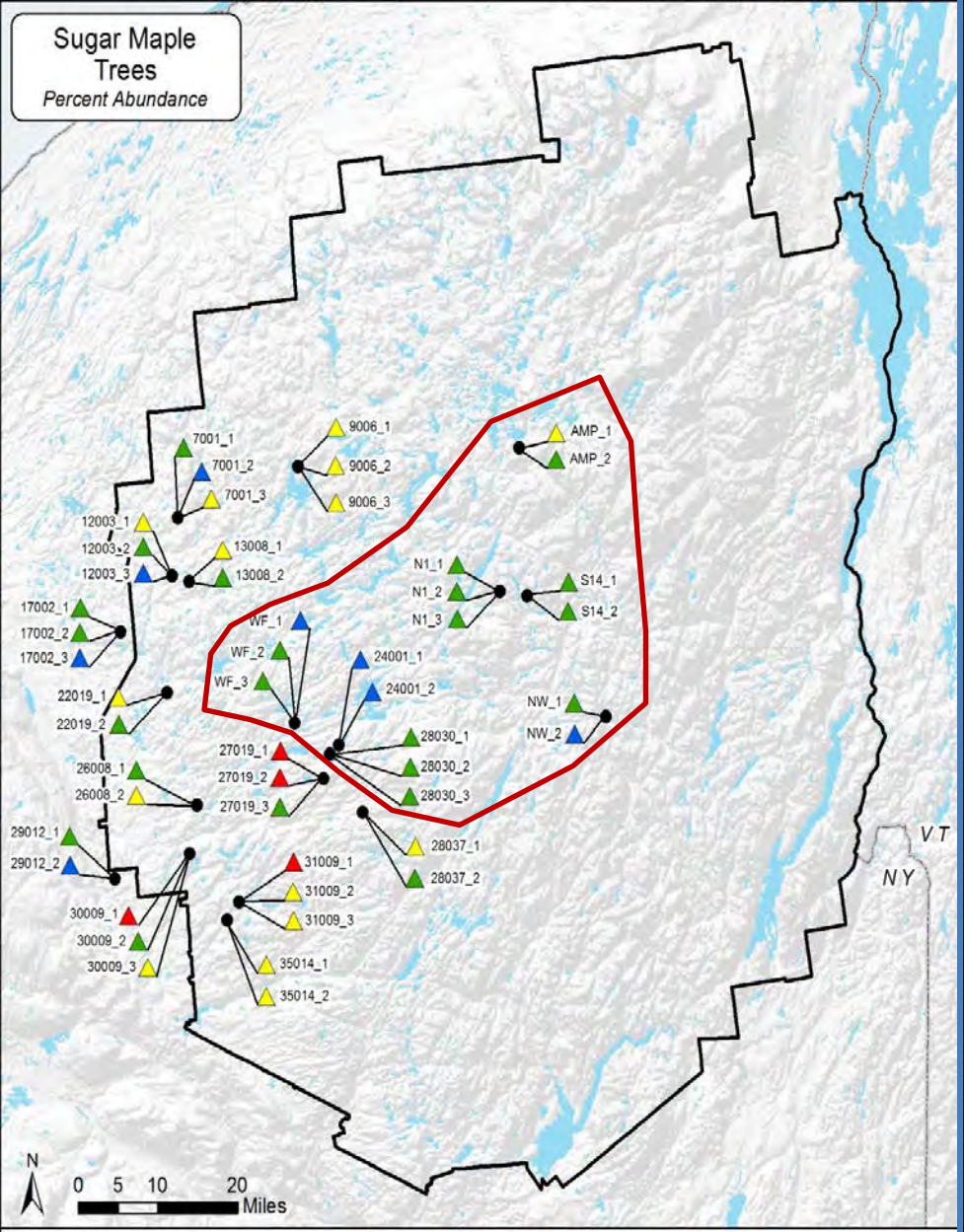

SM Seedling Presence/Absence
Oa Horizon
p<0.0001
p<0.0001
A Horizon
Base Saturation (%)
p<0.0001
Exch. Ca (cmol$_c$ kg^{-1})
p=0.0009
Upper B Horizon
p=0.0001
p=0.0021
No SM Seedlings
SM Seedlings
No SM Seedlings
SM Seedlings

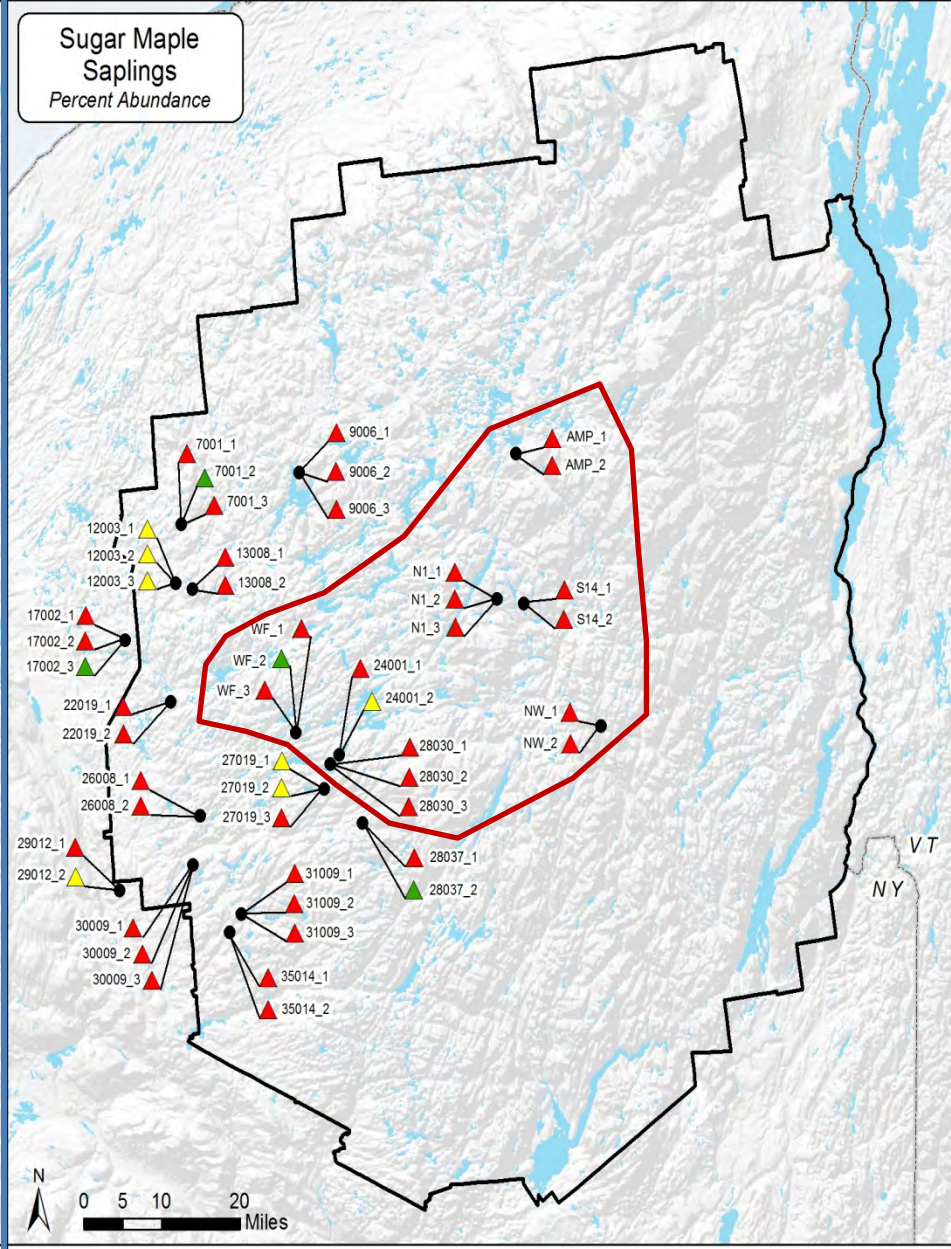
Seedling abundance related to soil calcium



Relative Abundance of Sugar Maple Seedlings







Sugar Maple - Trees

- 0 - 25%
- 25 - 50%
- 50 - 75%
- 75 - 100%

State Boundary
Adirondack Park Boundary
NHD Waterbody

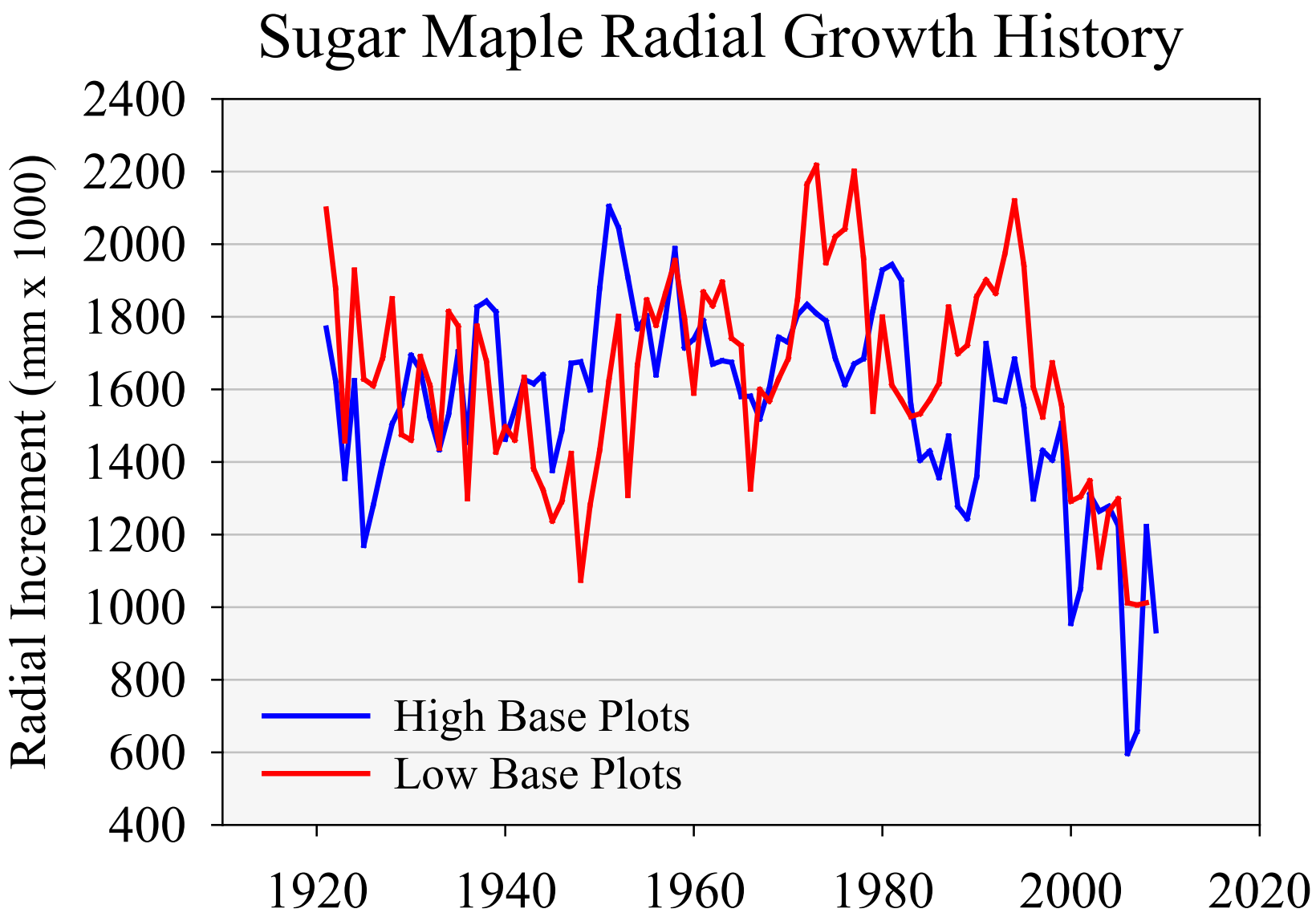
E&S Environmental Chemistry, Inc.

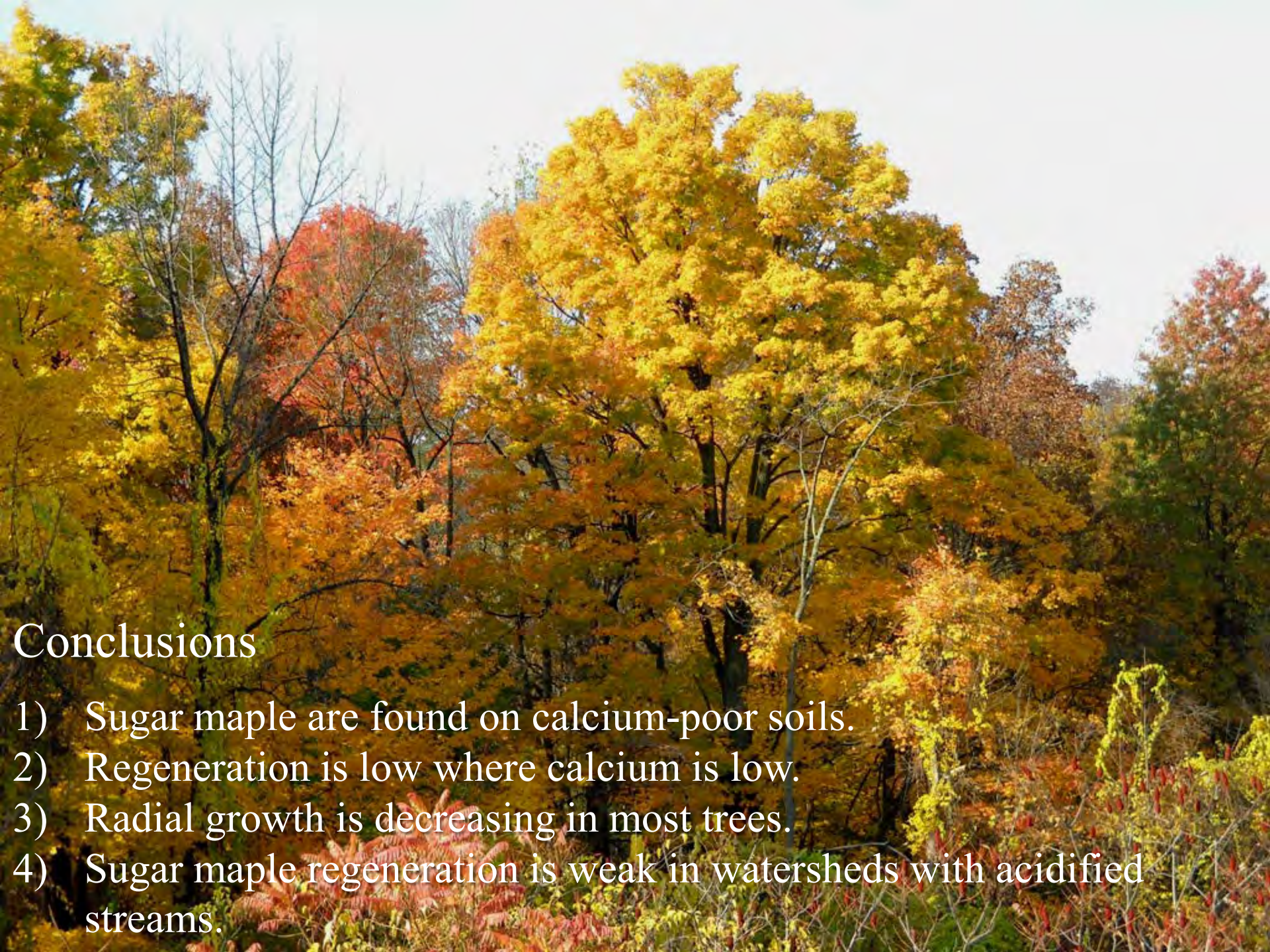
Sugar Maple - Saplings

- 0 - 25%
- 25 - 50%
- 50 - 75%
- 75 - 100%

State Boundary
Adirondack Park Boundary
NHD Waterbody

E&S Environmental Chemistry, Inc.


Sugar Maple Radial Growth History
Radial Increment (mm x 1000)
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
1920
1940
1960
1980
2000
2020
High Base Plots
Low Base Plots



Conclusions

1) Sugar maple are found on calcium-poor soils.
2) Regeneration is low where calcium is low.
3) Radial growth is decreasing in most trees.
4) Sugar maple regeneration is weak in watersheds with acidified streams.