Legacy effects of acidic deposition on soils limit reversal of stream acidification from declining atmospheric N deposition

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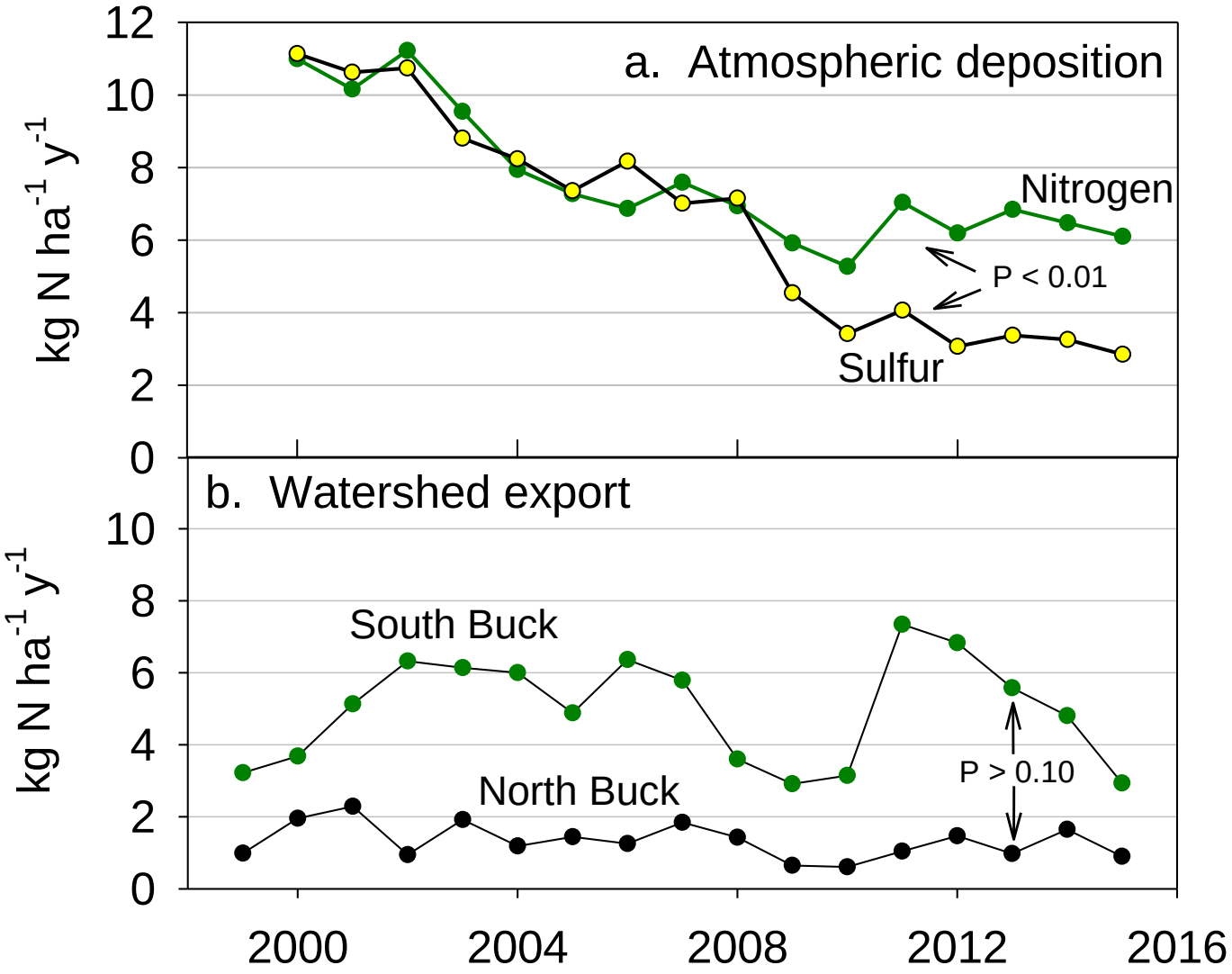
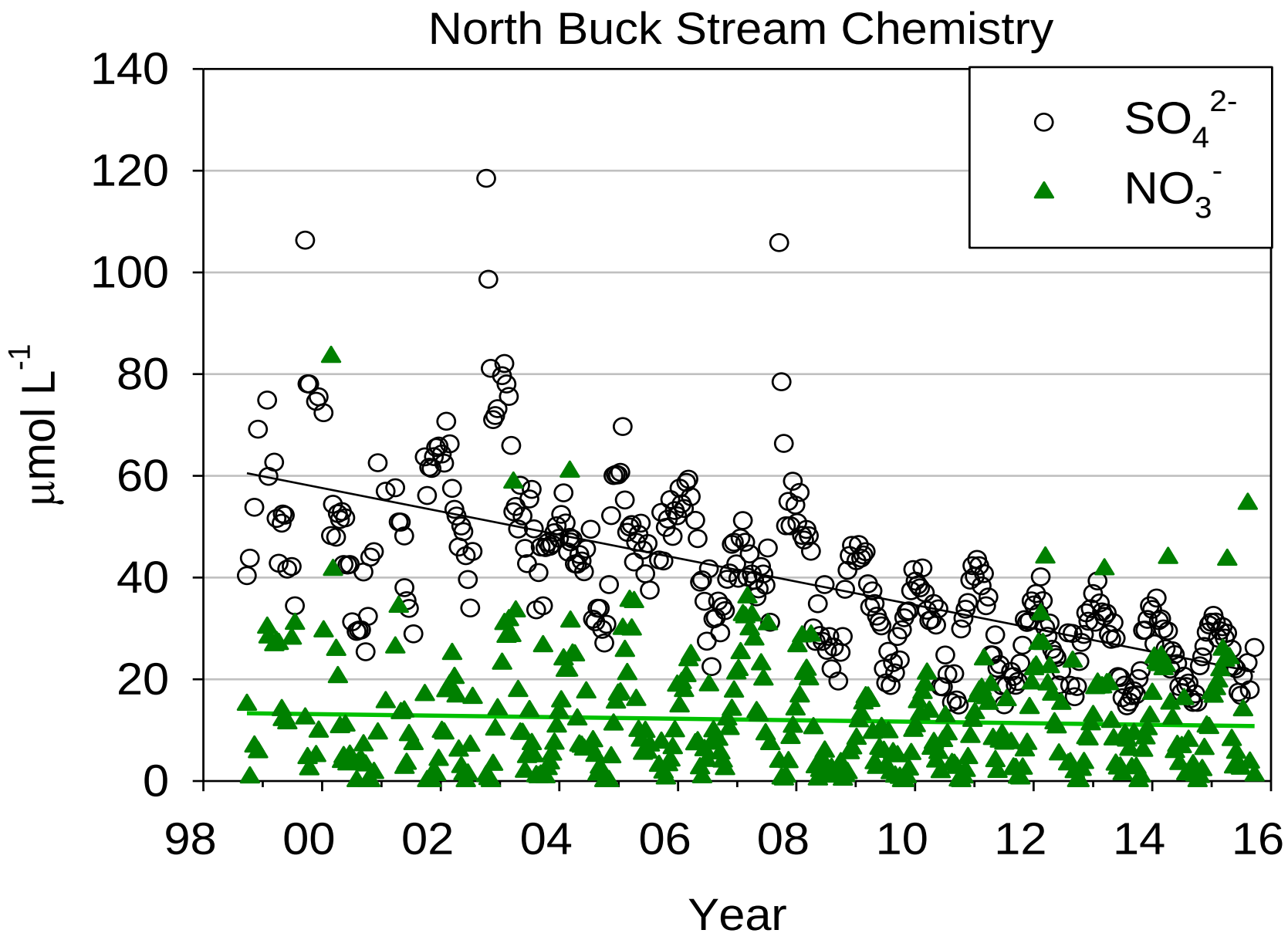
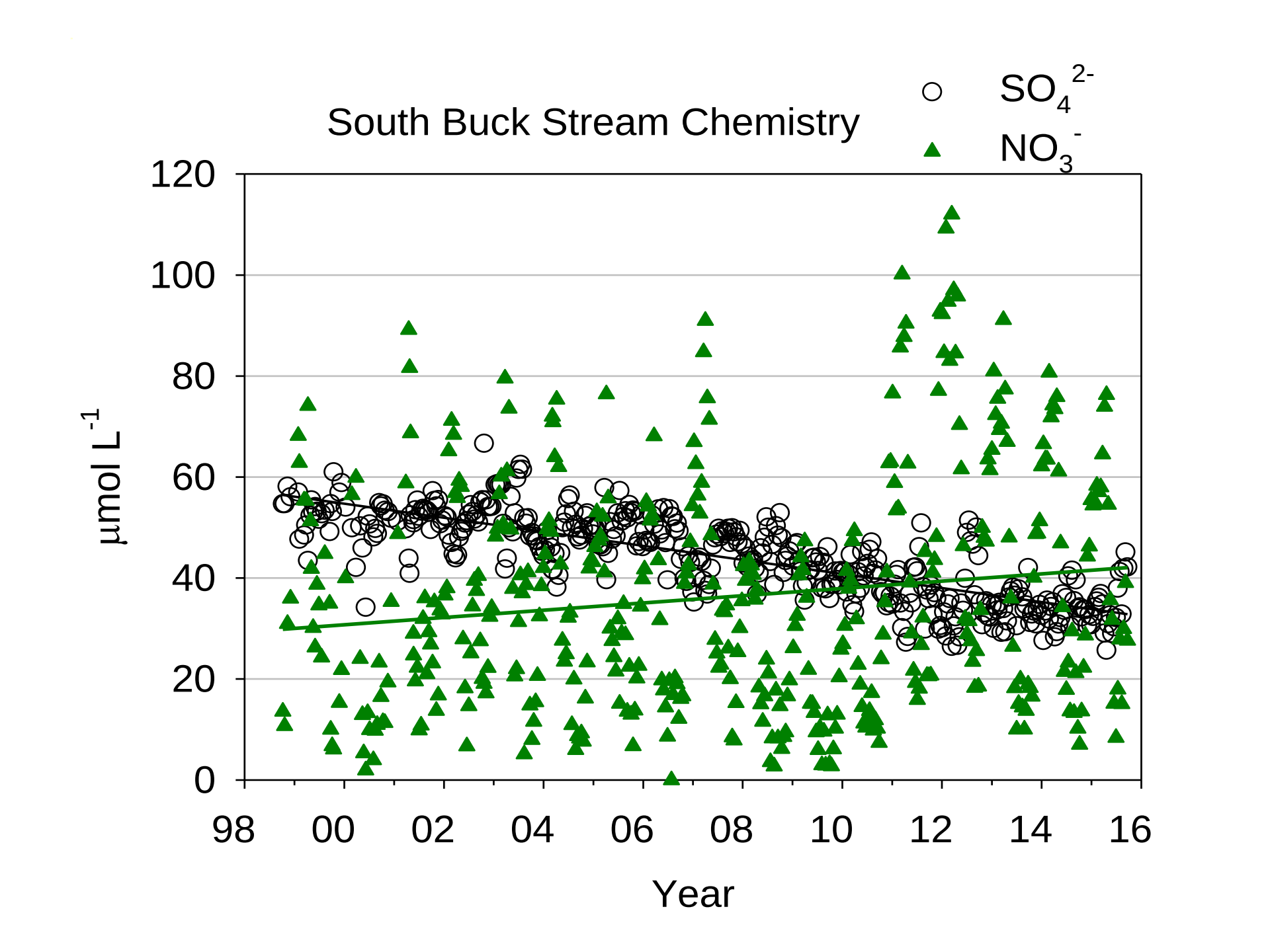
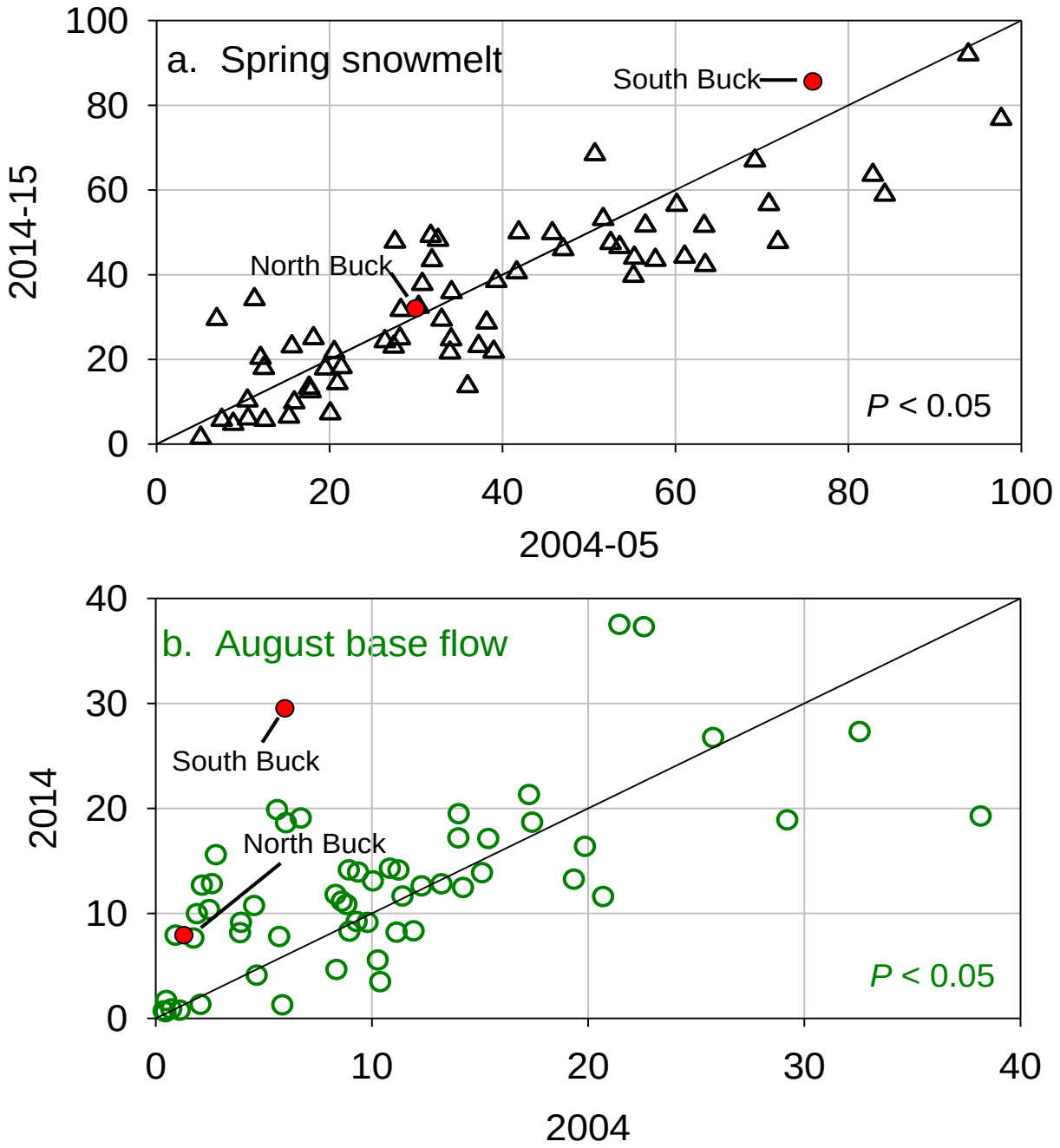

a. Atmospheric deposition
kg N ha-1 y-1
12
10
8
6
4
2
0
Nitrogen
P < 0.01
Sulfur
b. Watershed export
kg N ha-1 y-1
10
8
6
4
2
0
South Buck
North Buck
P > 0.10
2000
2004
2008
2012
2016

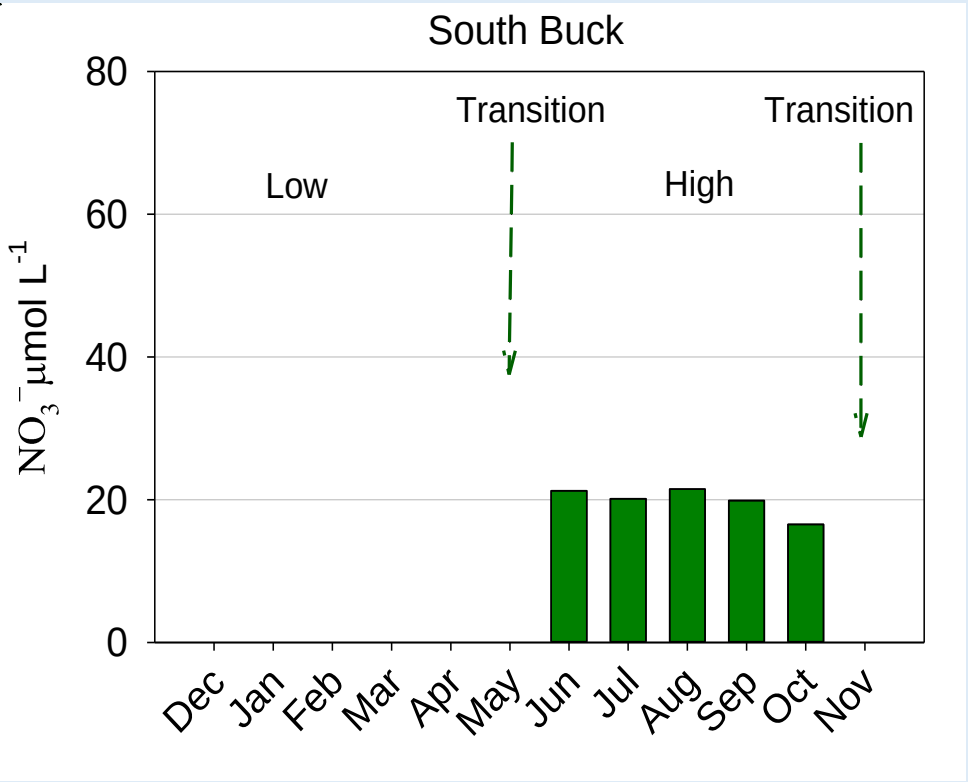

North Buck Stream Chemistry
140
120
100
80
60
40
20
0
µmol L-1
98
00
02
04
06
08
10
12
14
16
Year
SO4 2-
NO3 -

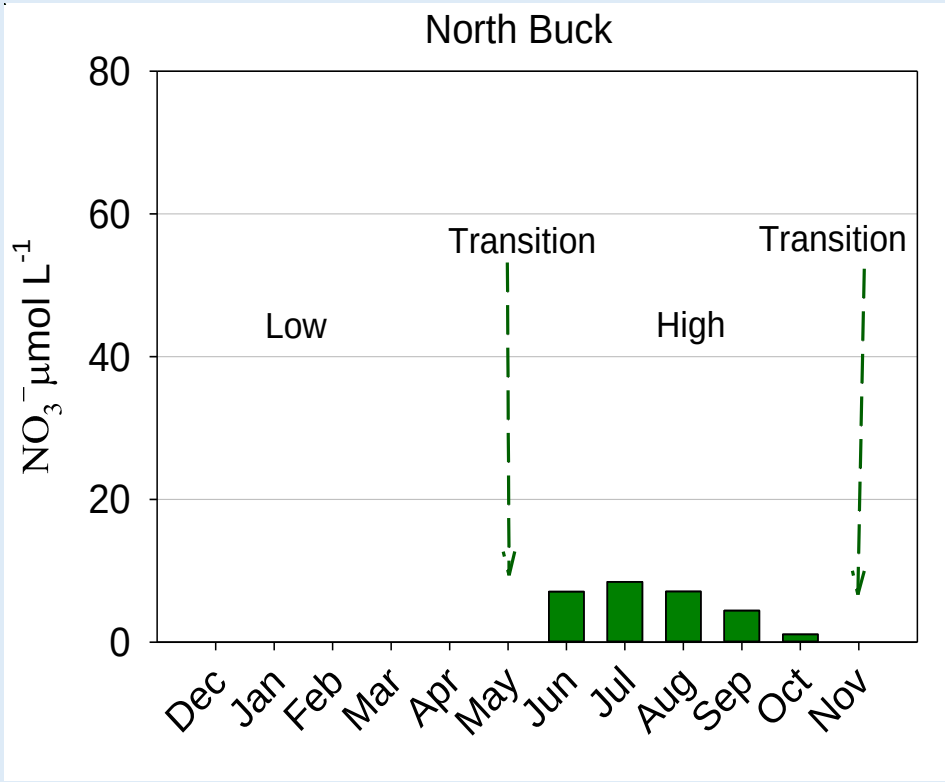

South Buck Stream Chemistry
SO_4^{2-}
NO_3^-
120
100
80
60
40
20
0
µmol L^{-1}
98
00
02
04
06
08
10
12
14
16
Year

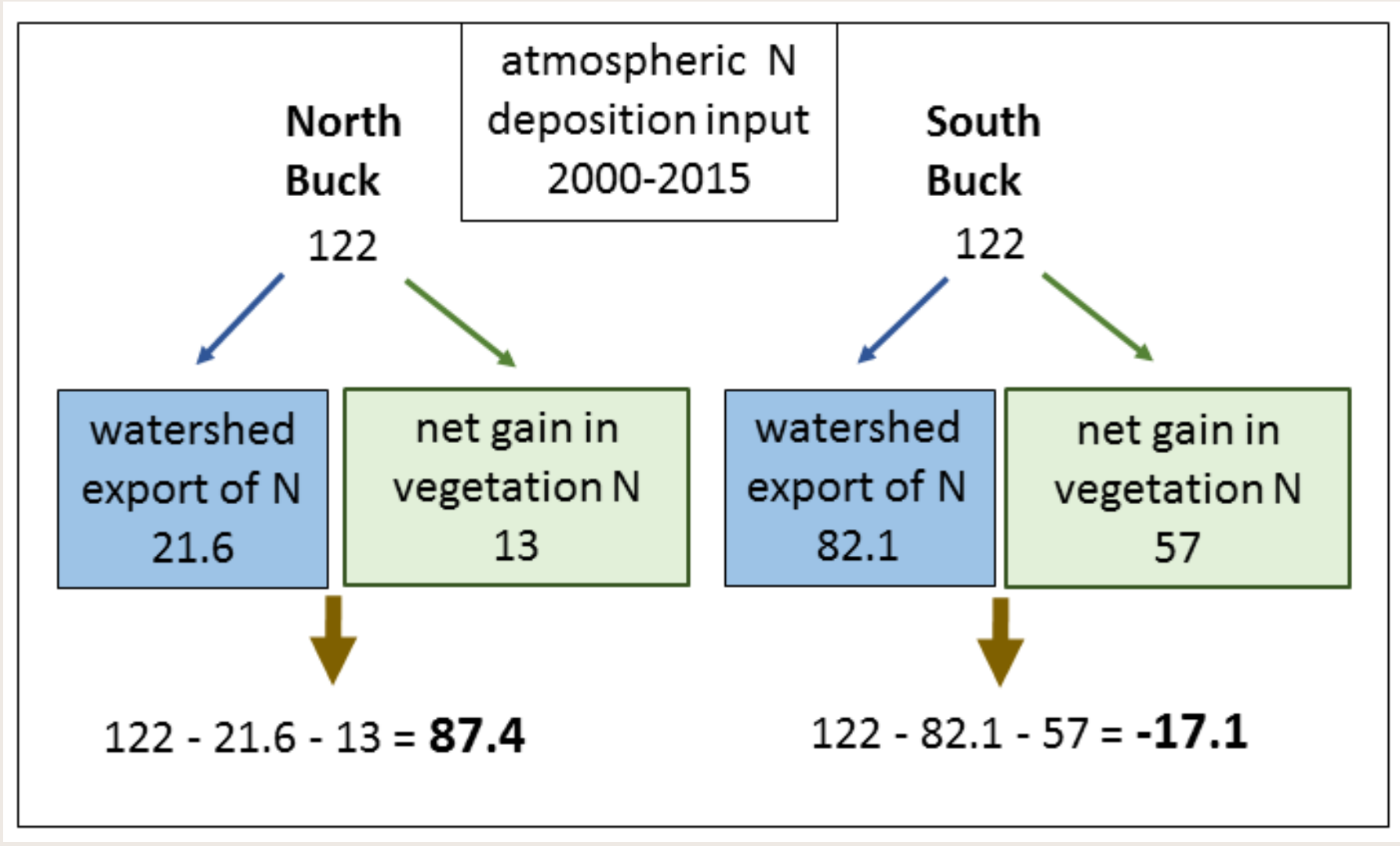
Nitrate Concentrations in Western Adirondack Stream Surveys (WASS)



Buck Creek Paired Watershed Study






atmospheric N deposition input 2000-2015
North Buck
122
South Buck
122
watershed export of N 21.6
net gain in vegetation N 13
watershed export of N 82.1
net gain in vegetation N 57
122 - 21.6 - 13 = 87.4
122 - 82.1 - 57 = -17.1
Soil Sink
Soil Source

Legacy Effects of Acidic Deposition on Soils

1. Depletion of soil calcium and other bases.

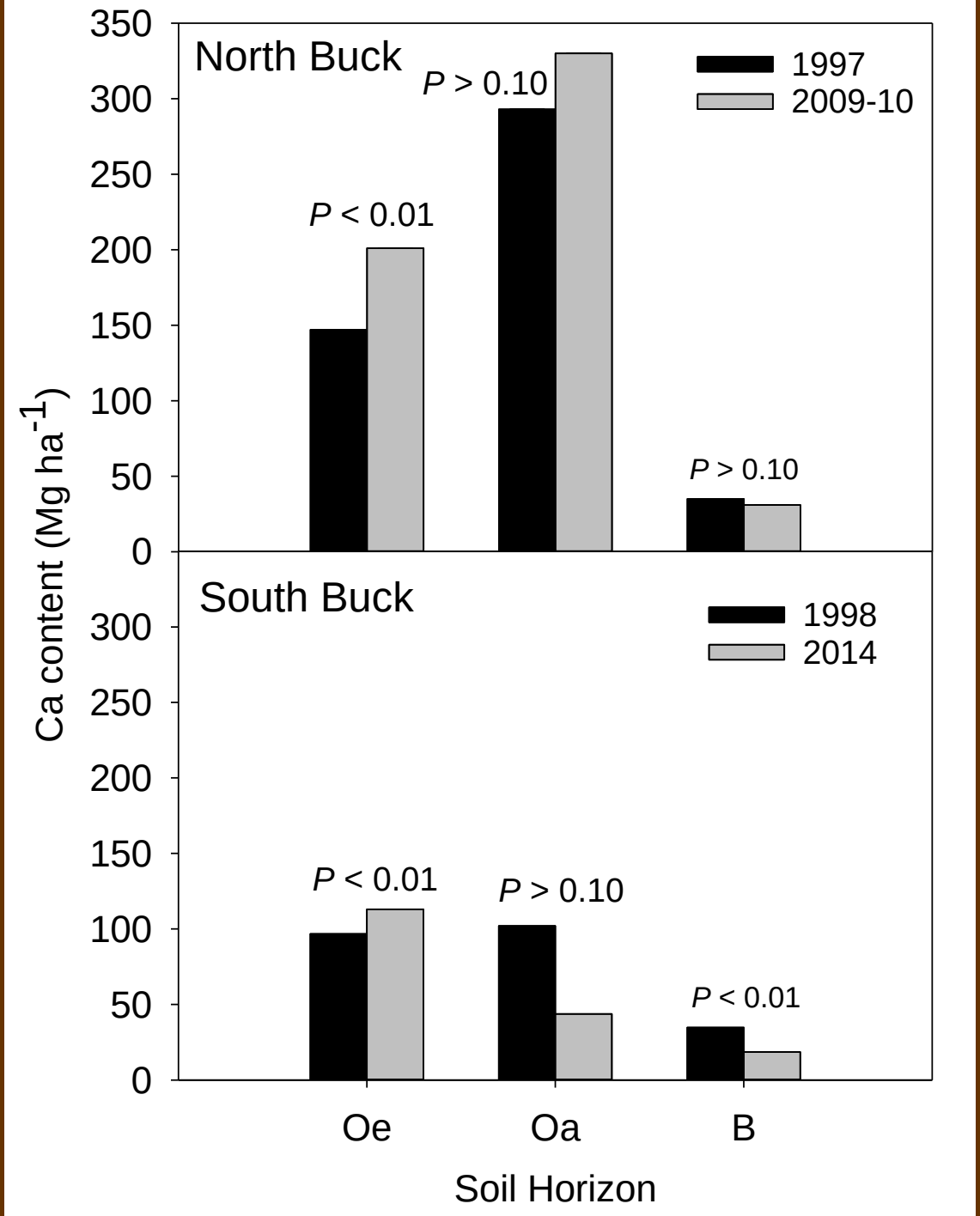
2. Increased concentrations of mobile aluminum in the forest floor (Oe and Oa horizons).

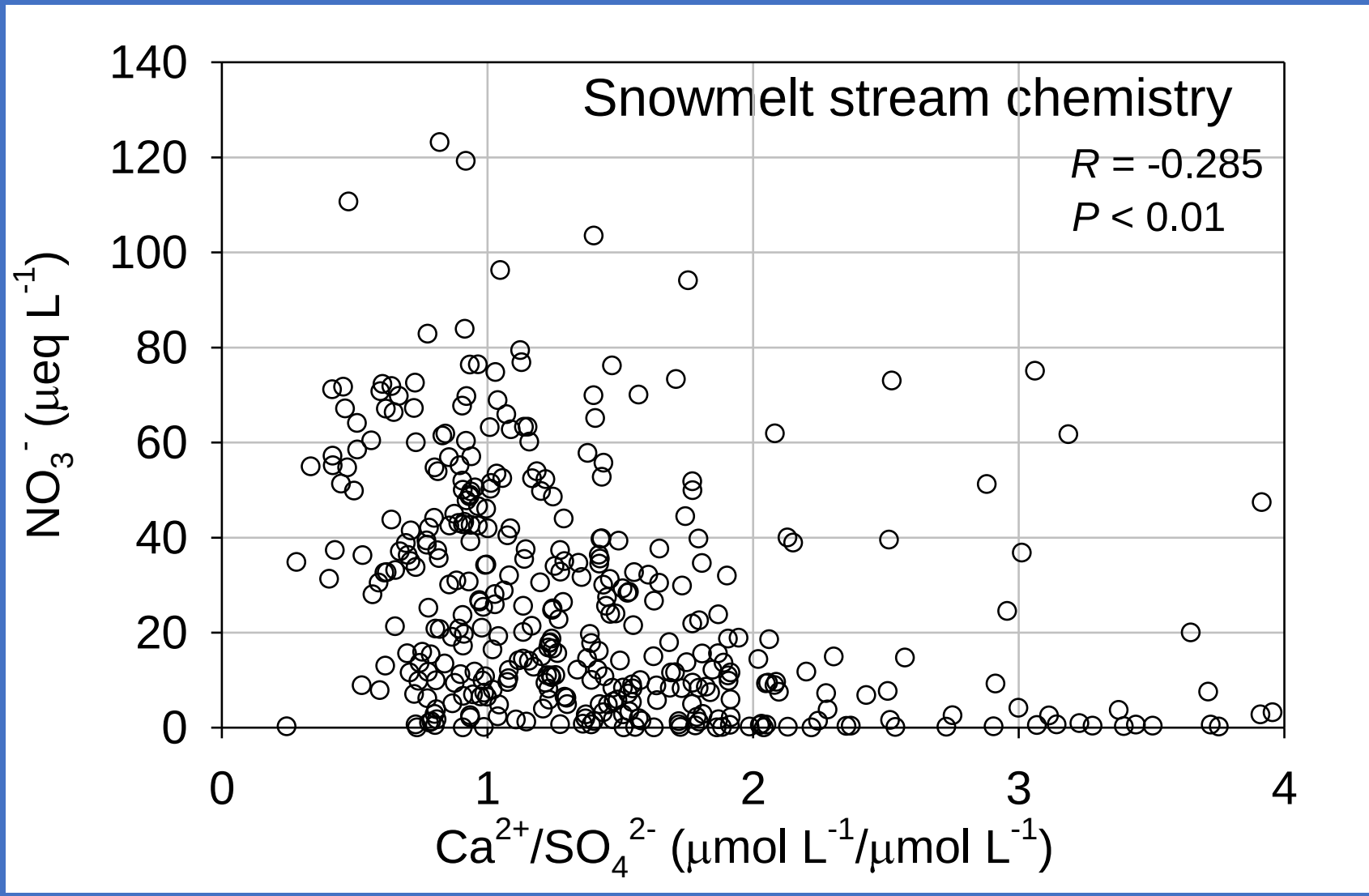
3. Increased organic matter content (more carbon and nitrogen storage).

Soil Resampling Results

	North Buck		South Buck	
O horizon	**1997**	**2009-10**	**1998**	**2014**
N (Mg ha^{-1})	4.6	5.2*	2.4	1.6*
C (Mg ha^{-1})	114	123	44	30*
Base sat. (%)	38.1	41	**47**	**67***
Al sat. (%)	26.9	18*	**28**	**12***

*paired T test $p < 0.05$
n = 28 North Buck
n = 23 South Buck


North Buck
1997
2009-10
P > 0.10
P < 0.01
P > 0.10
South Buck
1998
2014
P < 0.01
P > 0.10
P < 0.01
350
300
250
200
150
100
50
0
300
250
200
150
100
50
0
Ca content (Mg ha-1)
Oe
Oa
B
Soil Horizon


Snowmelt stream chemistry
R = -0.285
P < 0.01
NO3- (μeq L-1)
Ca2+/SO4 2- (μmol L-1/μmol L-1)
0
20
40
60
80
100
120
140
0
1
2
3
4

SUMMARY

1. Acid rain caused past increases in forest floor carbon and nitrogen content.

2. Decreases in sulfur deposition have reversed #1 by increasing decomposition and releasing carbon and nitrogen.

3. As a result of #2, many Adirondack watersheds are still releasing nitrogen.

4. Past depletion of soil calcium is impeding the reversal of nitrogen saturation.