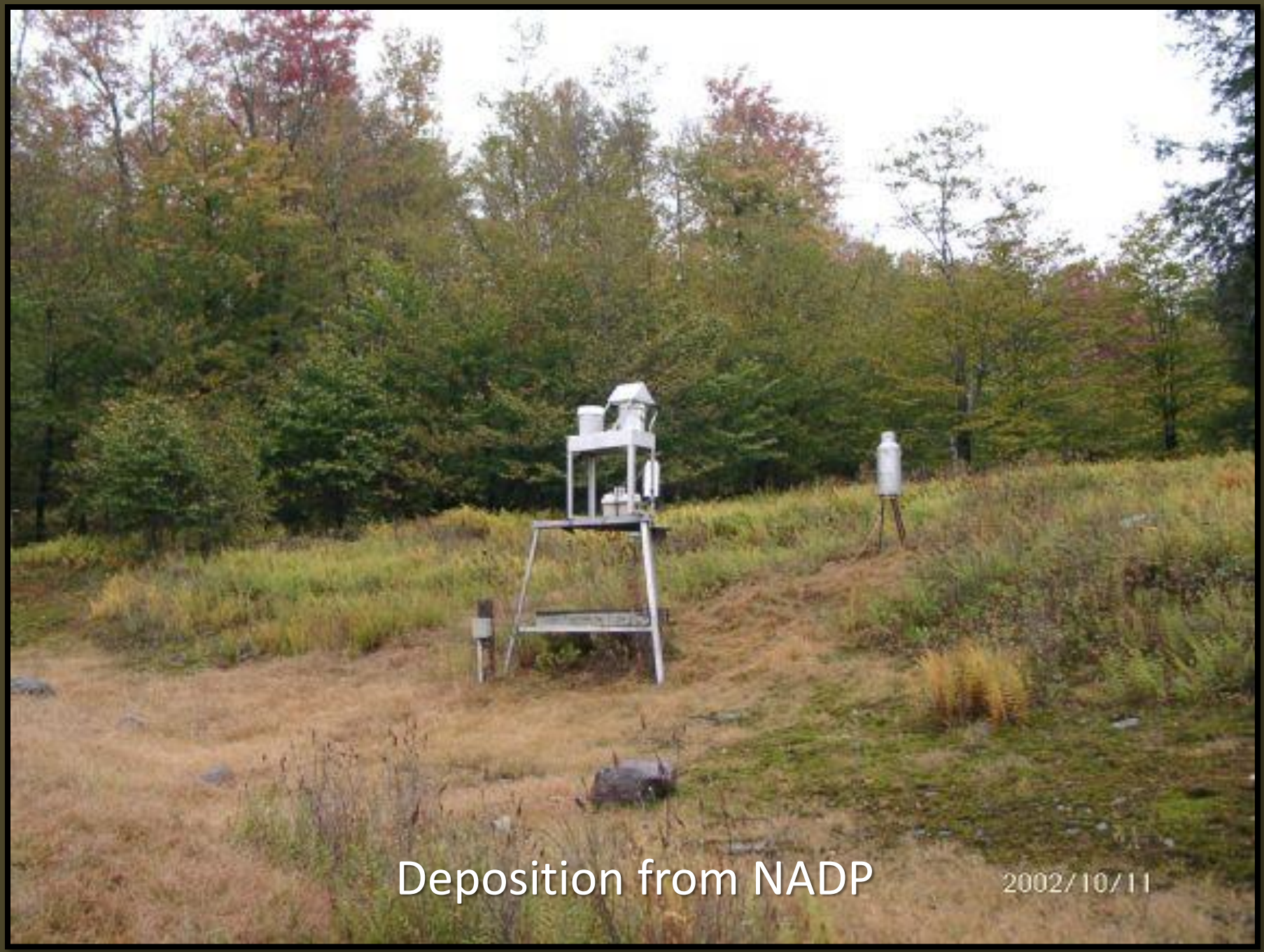
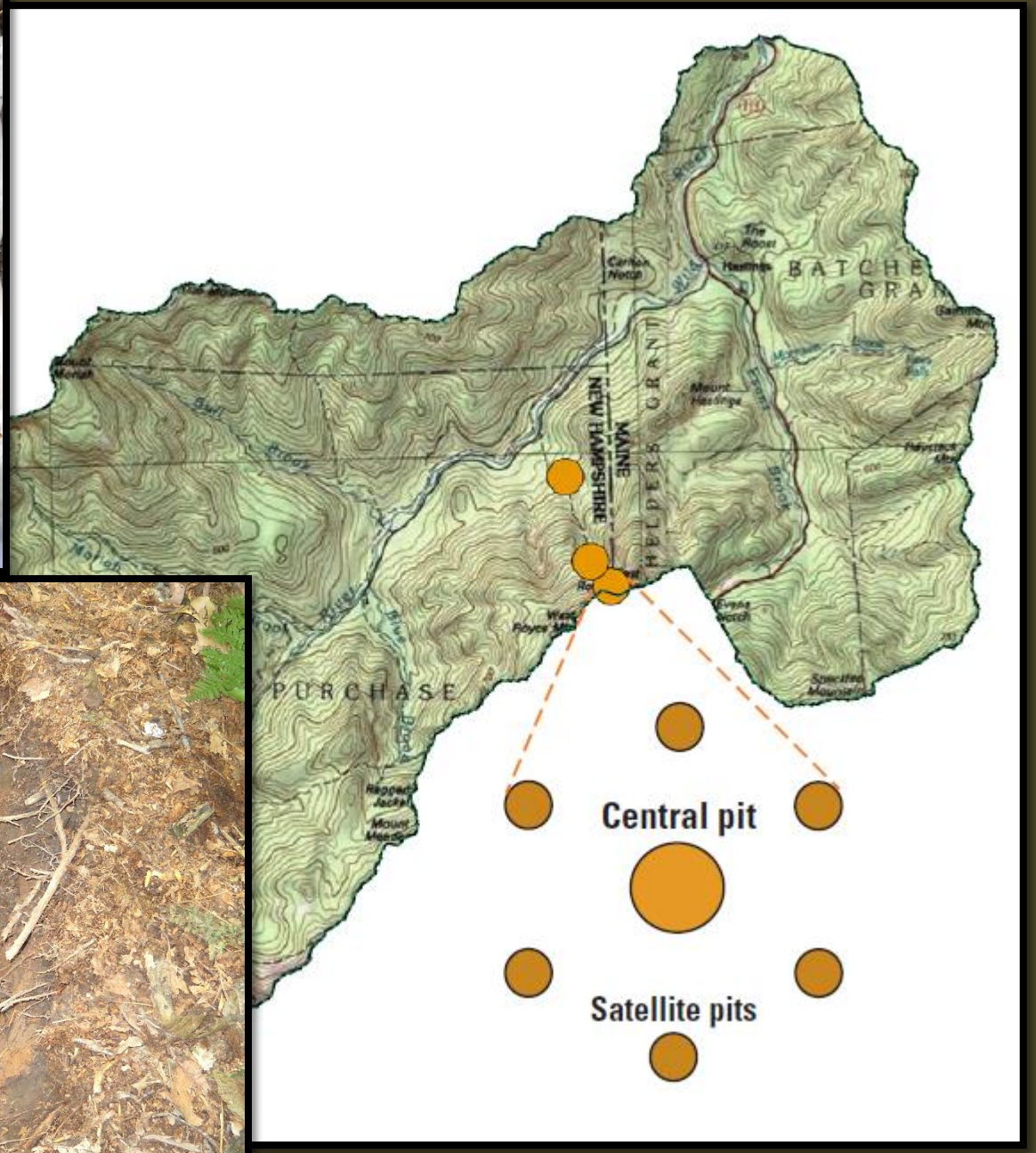
Are Trends in Declining Atmospheric Deposition Reflected in Soil and Streams of the Hydrologic Benchmark Network ?

Jason Siemion, Mike McHale, Douglas Burns, Greg Lawrence, and Mike Antidormi

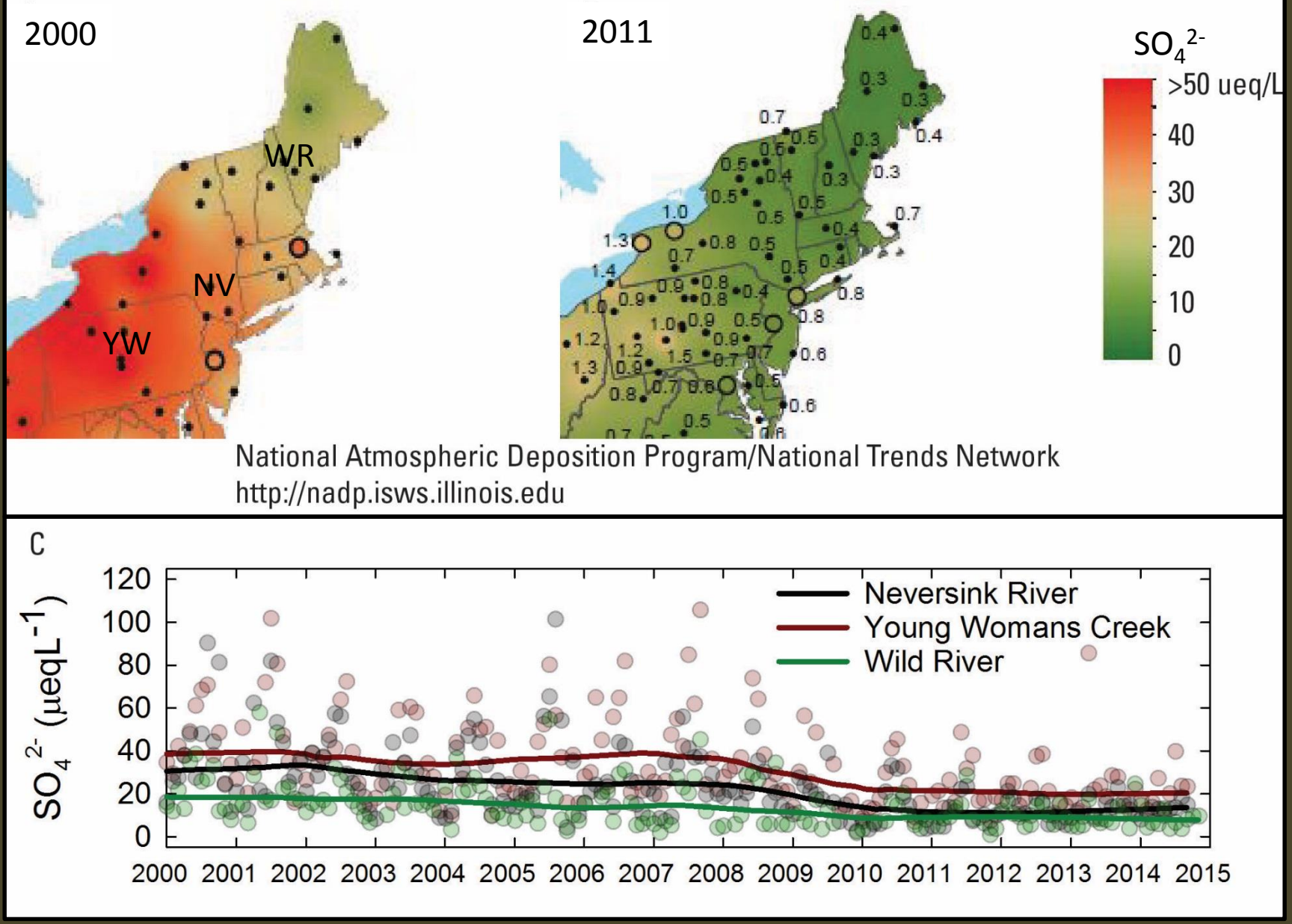

Deposition from NADP
2002/10/11

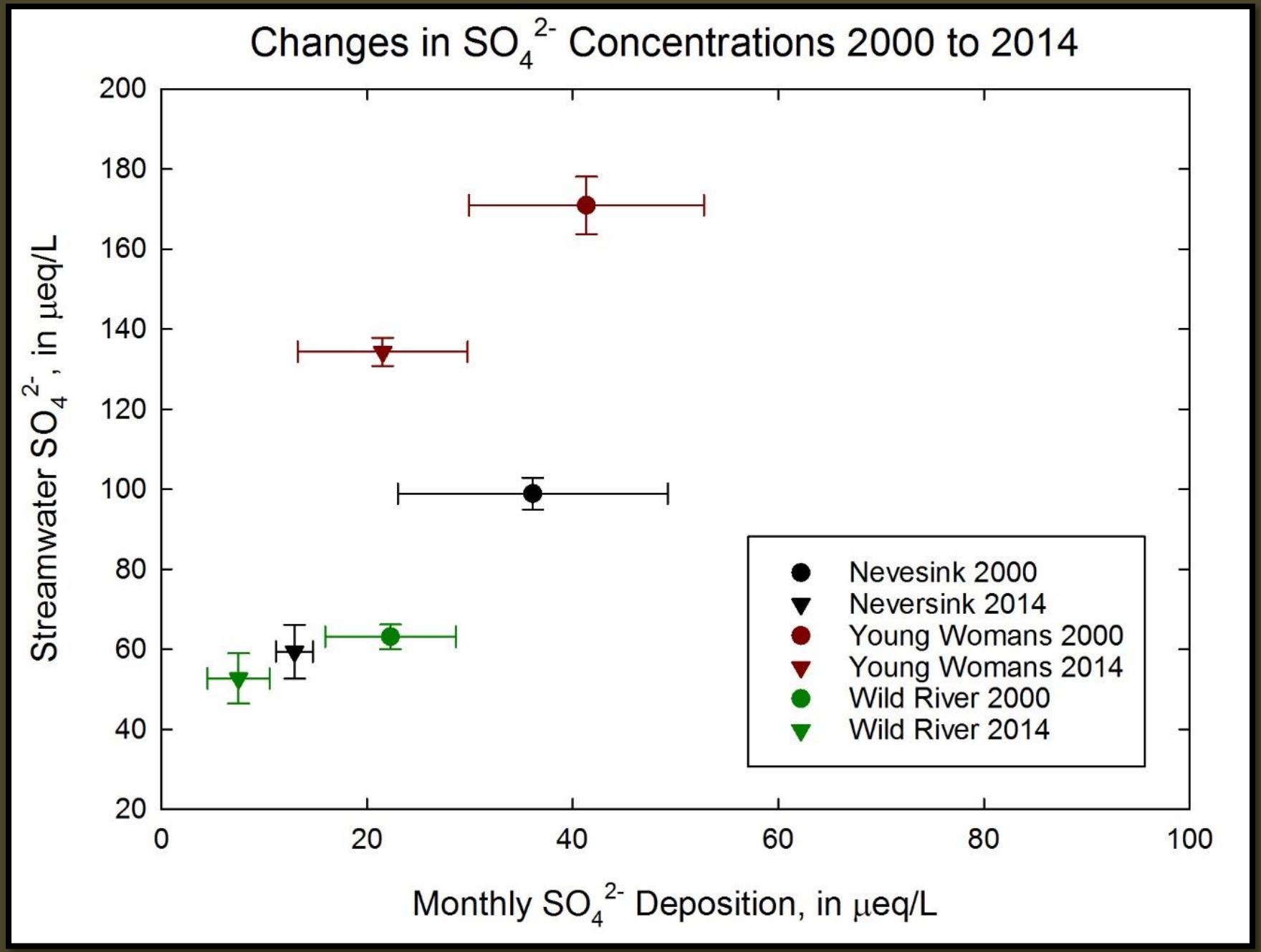

BATCHE
GRA
HELDERS GRANT
NEW HAMPSHIRE
MAINE
PURCHASE
Central pit
Satellite pits

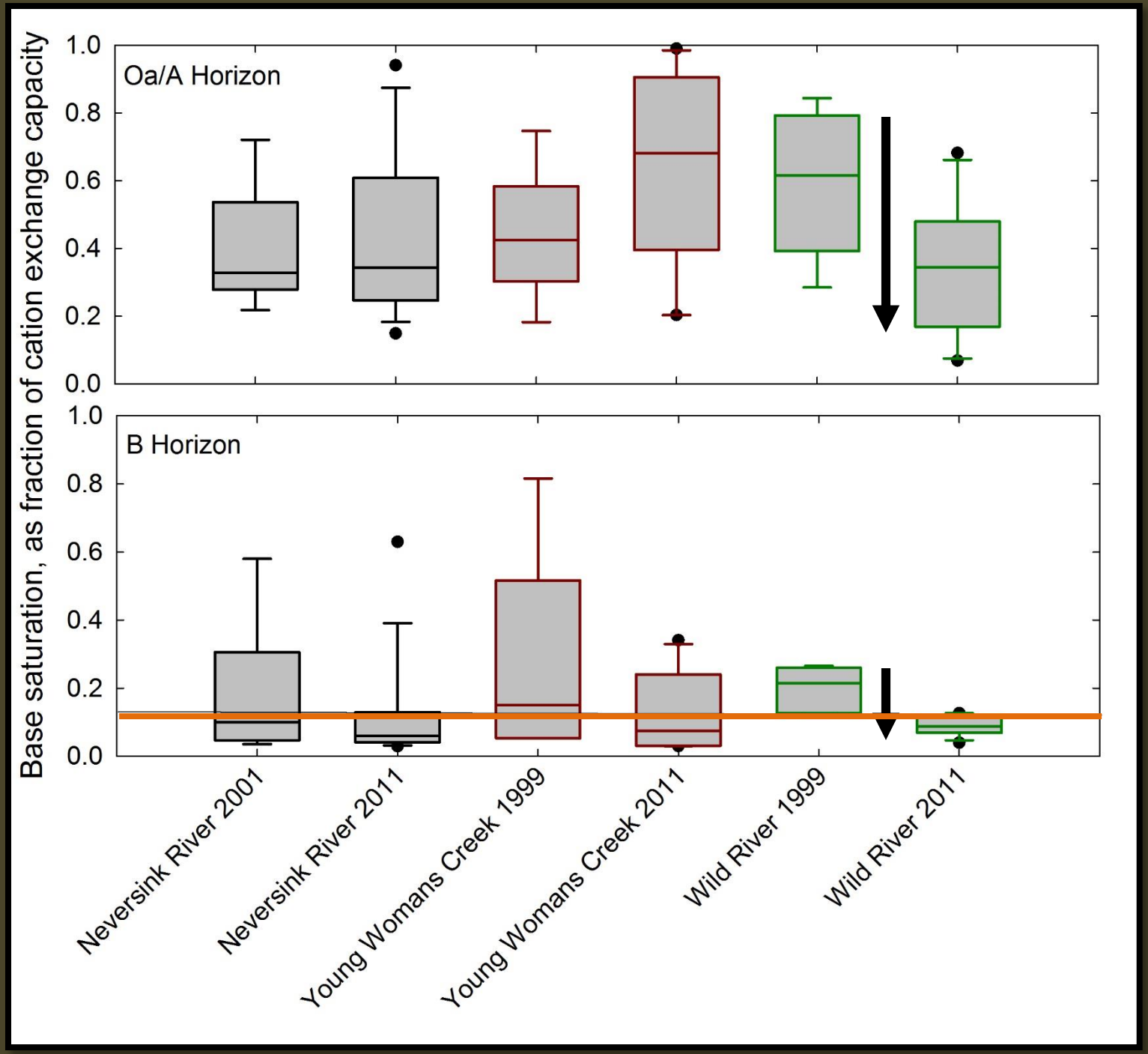

6712
isco
MODEL 6700FR
REFRIGERATED SAMPLER

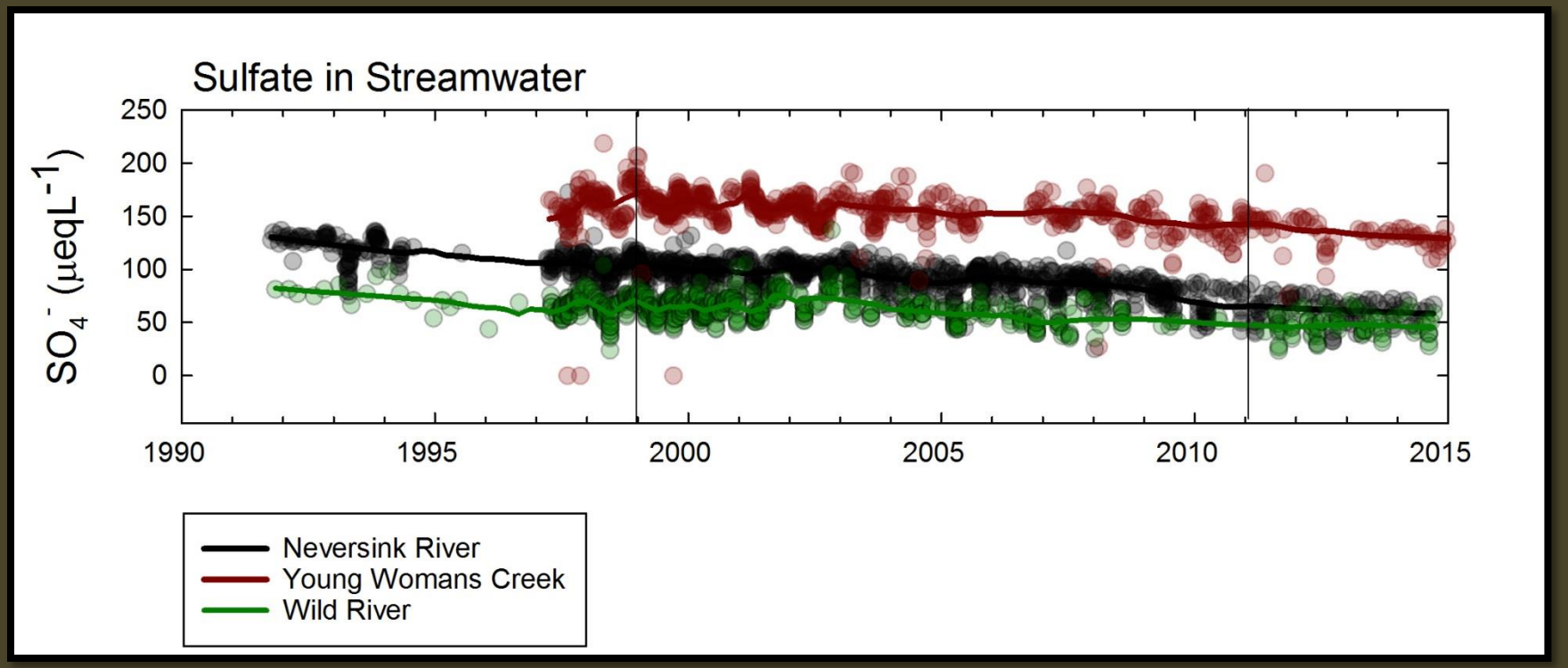
Data Analysis Methods:

- Seasonal Kendall trend analysis for deposition (2000 to 2014) and stream chemistry (1995 to 2014)
- Soil samples (1999 and 2011) t-test or Mann-Whitney
- Subset of archived samples from 1999 re-analysed, 1999 data adjusted if archive re-analysis data was significantly different (paired t-test) from original data
- Data carbon normalized if significant differences in total carbon between the two time periods


2000
2011
WR
NV
YW
SO_4^{2-}
>50 ueq/L
40
30
20
10
0
National Atmospheric Deposition Program/National Trends Network
http://nadp.isws.illinois.edu
C
SO_4^{2-} (μeqL^{-1})
120
100
80
60
40
20
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Neversink River
Young Womans Creek
Wild River


Changes in SO_4^{2-} Concentrations 2000 to 2014
Streamwater SO_4^{2-}, in µeq/L
Monthly SO_4^{2-} Deposition, in µeq/L
200
180
160
140
120
100
80
60
40
20
0
20
40
60
80
100
Nevesink 2000
Neversink 2014
Young Womans 2000
Young Womans 2014
Wild River 2000
Wild River 2014


Oa/A Horizon
B Horizon
Base saturation, as fraction of cation exchange capacity
1.0
0.8
0.6
0.4
0.2
0.0
Neversink River 2001
Neversink River 2011
Young Womans Creek 1999
Young Womans Creek 2011
Wild River 1999
Wild River 2011



- Neversink River -2.5 ueq/yr
- Young Womans Creek -2 ueq/yr
- Wild River -1 ueq/yr

Trend Results for Deposition, Soil, and Streamwater Chemistry in the Neversink Watershed, 2001 to 2011

	SO_4^{2-}	NO_3^-	H^+ or H_{ex}	Al or Al_{ex}	Ca^{2+} or Ca_{ex}	Mg^{2+} or Mg_{ex}	ANC or BS
Deposition	↓↓	↓↓	↓↓	--	ns	ns	--
Soil A Horizon	--	--	ns	ns	ns	ns	ns
Soil upper B Horizon	--	--	↑↑	ns	ns	ns	ns
Stream water	↓↓	ns	↓↓	↓↓	ns	↓↓	↑↑

Trend Results for Deposition, Soil, and Streamwater Chemistry in the Neversink Watershed, 2001 to 2011

	SO_4^{2-}	NO_3^-	H^+ or H_{ex}	Al or Al_{ex}	Ca^{2+} or Ca_{ex}	Mg^{2+} or Mg_{ex}	ANC or BS
Deposition	↓↓	↓↓	↓↓	--	ns	ns	--
Soil A Horizon	--	--	ns	ns	ns	ns	ns
Soil upper B Horizon	--	--	↑↑	ns	ns	ns	ns
Stream water	↓↓	ns	↓↓	↓↓	ns	↓↓	↑↑

Trend Results for Deposition, Soil, and Streamwater Chemistry in the Young Womans Creek Watershed, 1999 to 2011

	SO_4^{2-}	NO_3^-	H^+ or H_{ex}	Al or Al_{ex}	Ca^{2+} or Ca_{ex}	Mg^{2+} or Mg_{ex}	ANC or BS
Deposition	↓↓	↓↓	↓↓	--	ns	ns	--
Soil A Horizon	--	--	ns	↓↓	ns	ns	ns
Soil upper B Horizon	--	--	↑↑	ns	ns	ns	ns
Stream water	↓↓	ns	ns	--	ns	↓↓	↑↑

Trend Results for Deposition, Soil, and Streamwater Chemistry in the Young Womans Creek Watershed, 1999 to 2011

	SO_4^{2-}	NO_3^-	H^+ or H_{ex}	Al or Al_{ex}	Ca^{2+} or Ca_{ex}	Mg^{2+} or Mg_{ex}	ANC or BS
Deposition	↓↓	↓↓	↓↓	--	ns	ns	--
Soil A Horizon	--	--	ns	↓↓	ns	ns	ns
Soil upper B Horizon	--	--	↑↑	ns	ns	ns	ns
Stream water	↓↓	ns	ns	--	ns	↓↓	↑↑

Trend Results for Deposition, Soil, and Streamwater Chemistry in the Wild River Watershed, 1999 to 2011

	SO_4^{2-}	NO_3^-	H^+ or H_{ex}	Al or Al_{ex}	Ca^{2+} or Ca_{ex}	Mg^{2+} or Mg_{ex}	ANC or BS
Deposition	↓↓	↓↓	↓↓	--	ns	ns	--
Soil Oa Horizon	--	--	↑↑	↑↑	ns	ns	↓↓
Soil upper B Horizon	--	--	↑↑	↑↑	↓	ns	↓↓
Stream water	↓↓	ns	ns	ns	ns	ns	ns

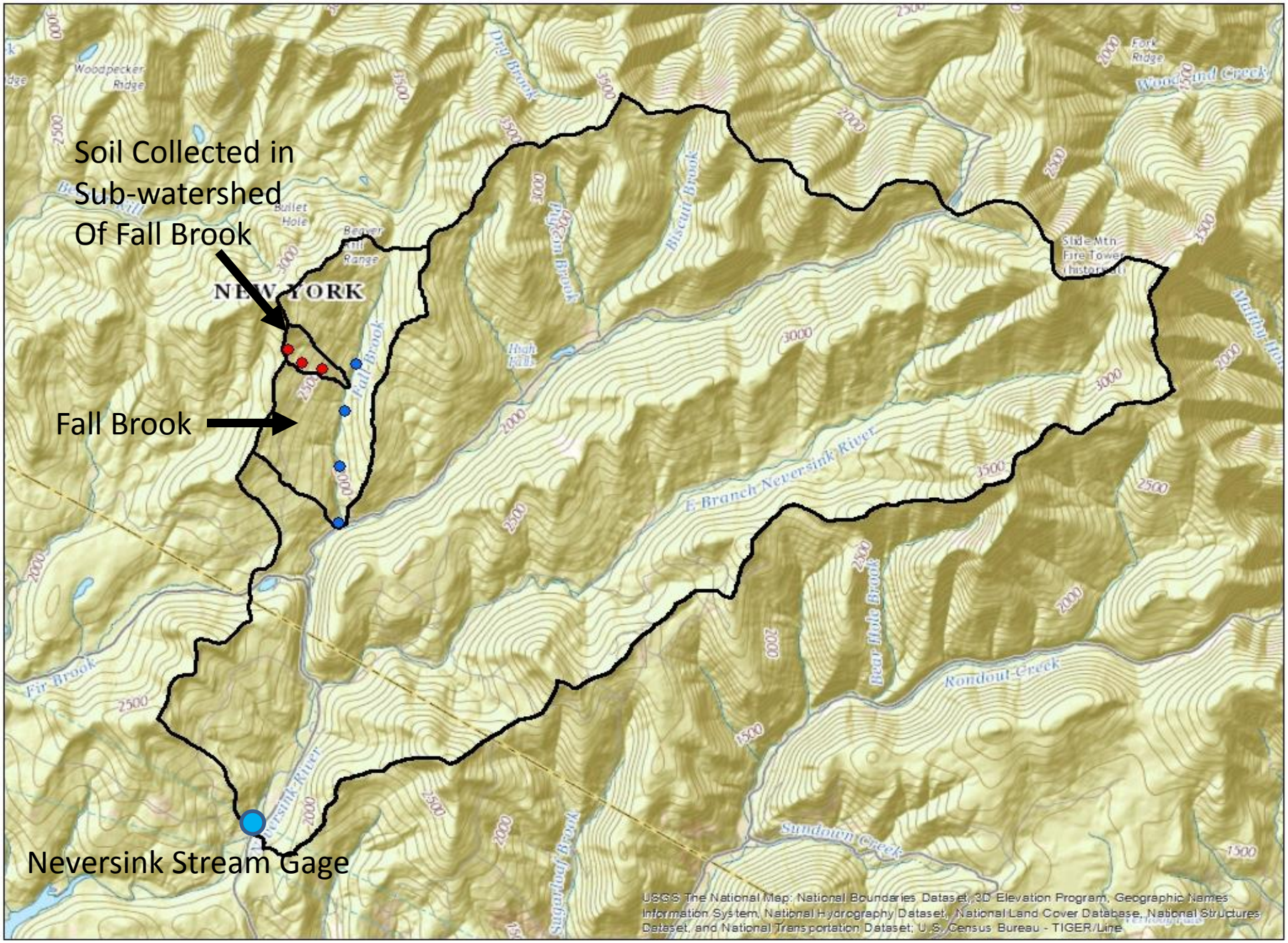
Trend Results for Deposition, Soil, and Streamwater Chemistry in the Wild River Watershed, 1999 to 2011

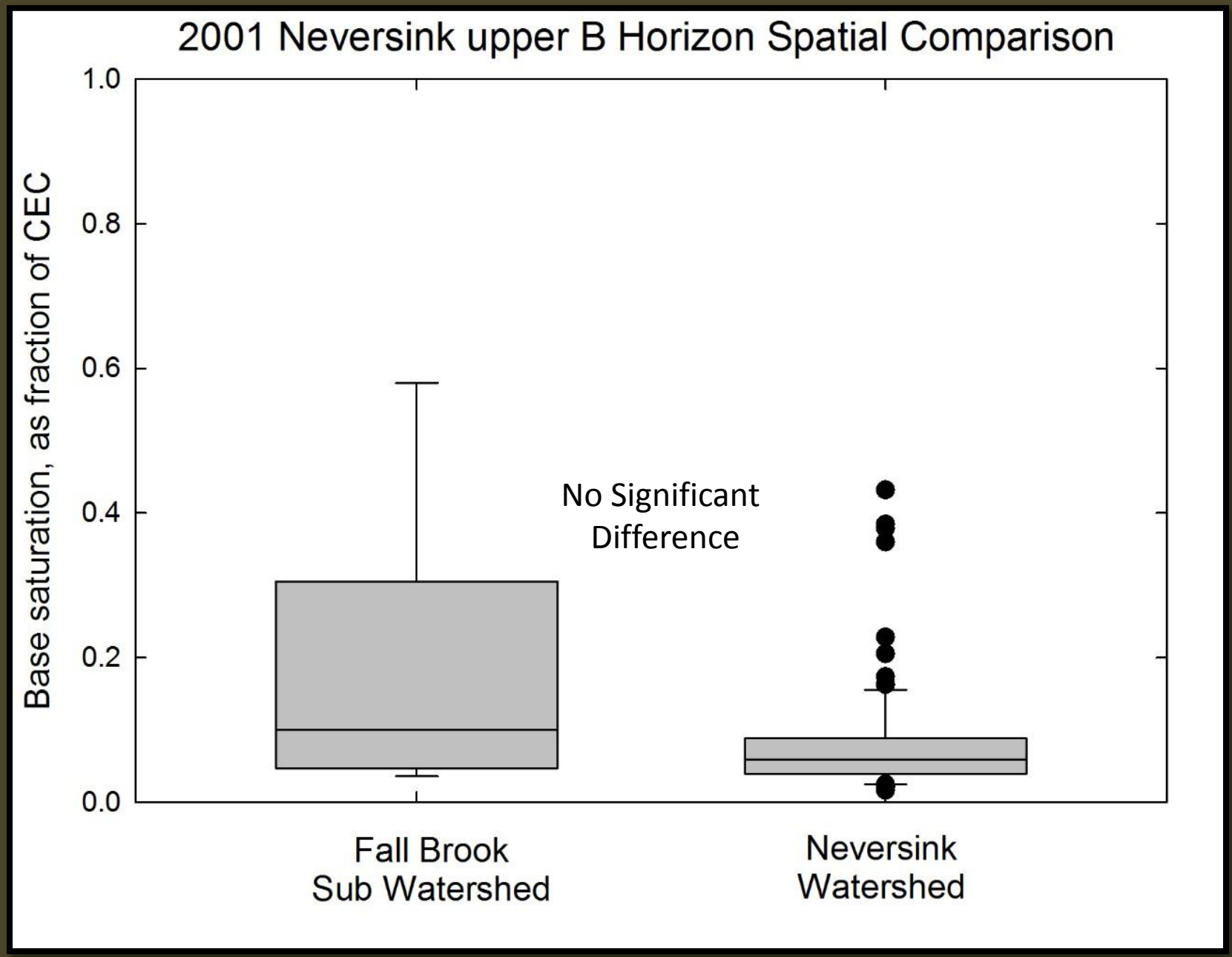
	SO_4^{2-}	NO_3^-	H^+ or H_{ex}	Al or Al_{ex}	Ca^{2+} or Ca_{ex}	Mg^{2+} or Mg_{ex}	ANC or BS
Deposition	↓↓	↓↓	↓↓	--	ns	ns	--
Soil Oa Horizon	--	--	↑↑	↑↑	ns	ns	↓↓
Soil upper B Horizon	--	--	↑↑	↑↑	↓	ns	↓↓
Stream water	↓↓	ns	ns	ns	ns	ns	ns

Disconnect between deposition, soil, and stream recovery.

Young Womans Creek and Neversink River greater deposition, but more recovery than Wild River.

Why?


Soil Collected in
Sub-watershed
Of Fall Brook
Fall Brook
Neversink Stream Gage
NEW YORK
Fall Brook
E Branch Neversink River
Bear Hole Brook
Rondout Creek
Sundown Creek
Sugarloaf Brook
Fir Brook
Neversink River
Biscuit Brook
Dry Brook
Parkman Brook
Woodpecker Ridge
Bullet Hole
Beaver Kill Range
High Hill
Fort Ridge
Slide Mtn Fire Tower (historical)
USGS The National Map: National Boundaries Dataset, 3D Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; U.S. Census Bureau - TIGER/Line

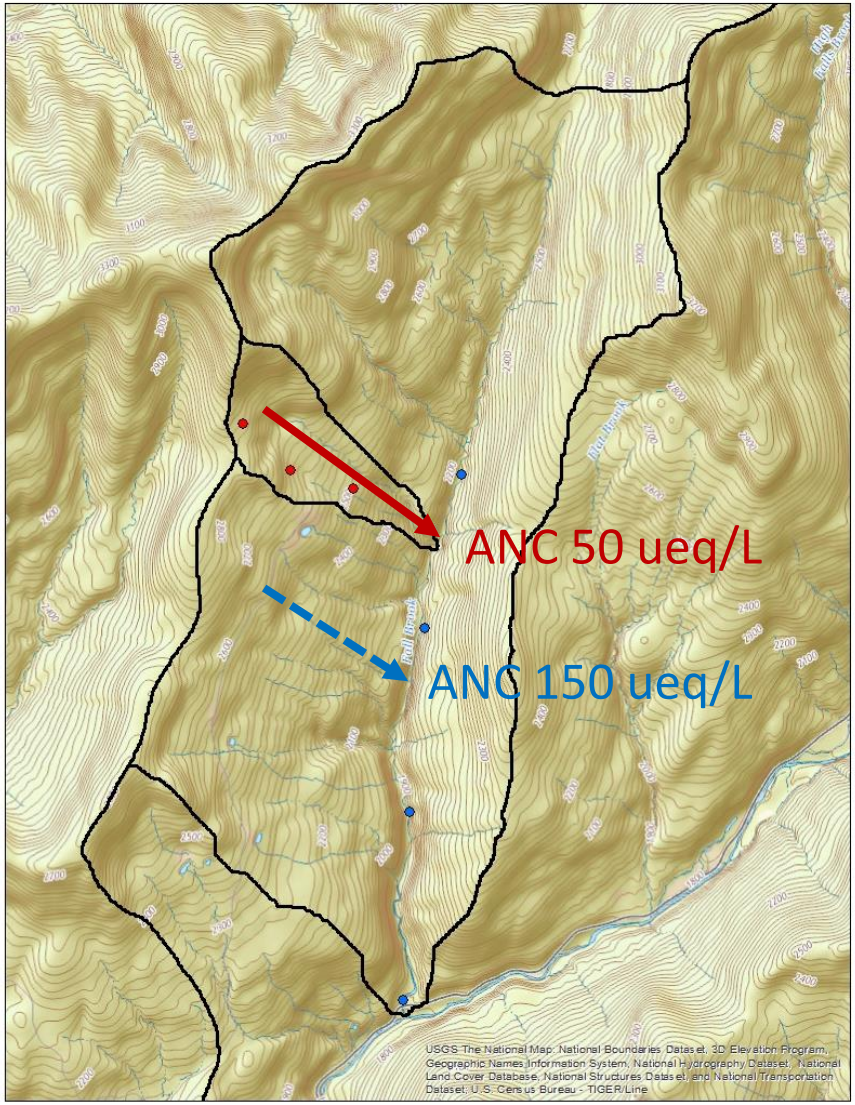

2001 Neversink upper B Horizon Spatial Comparison
Base saturation, as fraction of CEC
1.0
0.8
0.6
0.4
0.2
0.0
No Significant
Difference
Fall Brook
Sub Watershed
Neversink
Watershed

Differences in Site Characteristics: Bedrock Geology

- Pockets of sparse, local “base rich” sedimentary bedrock deposits (<10% carbonate) in Neversink (Ver Straeten, 2013) and Young Womans (Colton and Stanley, 1965)
- More evidence of this in the Neversink than Young Womans
- Metamorphic bedrock in Wild River (gneiss, schists, and quartzites)

Sparse “Base Rich” Bedrock Sources in the Neversink River watershed :

- Evidence of shallow and deep ground water sources to streams (Burns et al 1998)
- Groundwater in contact with “base rich” bedrock



Differences in Site Characteristics: Forest Type

- Neversink…northern hardwoods, spruce-fir on ridge tops
- Young Womans…Oak-Hickory and northern hardwoods
- Wild River…northern hardwoods, more spruce-fir at high elevations and ridge tops

Summary

- Disconnect between deposition, soils and streams
- Significant declines in deposition
- Little to no recovery in soil chemistry
- Evidence of stream recovery, but not uniform…differences in site characteristics
- Limited role of soils in stream recovery