Great Smoky Mountains National Park

Update on Park Air Resources

Jim Renfro, National Park Service

AAQTF Meeting, Wednesday, April 22, 2015 University of Tennessee - Knoxville, TN

Outline *Policy, Status, Trends, Effects, Projections*

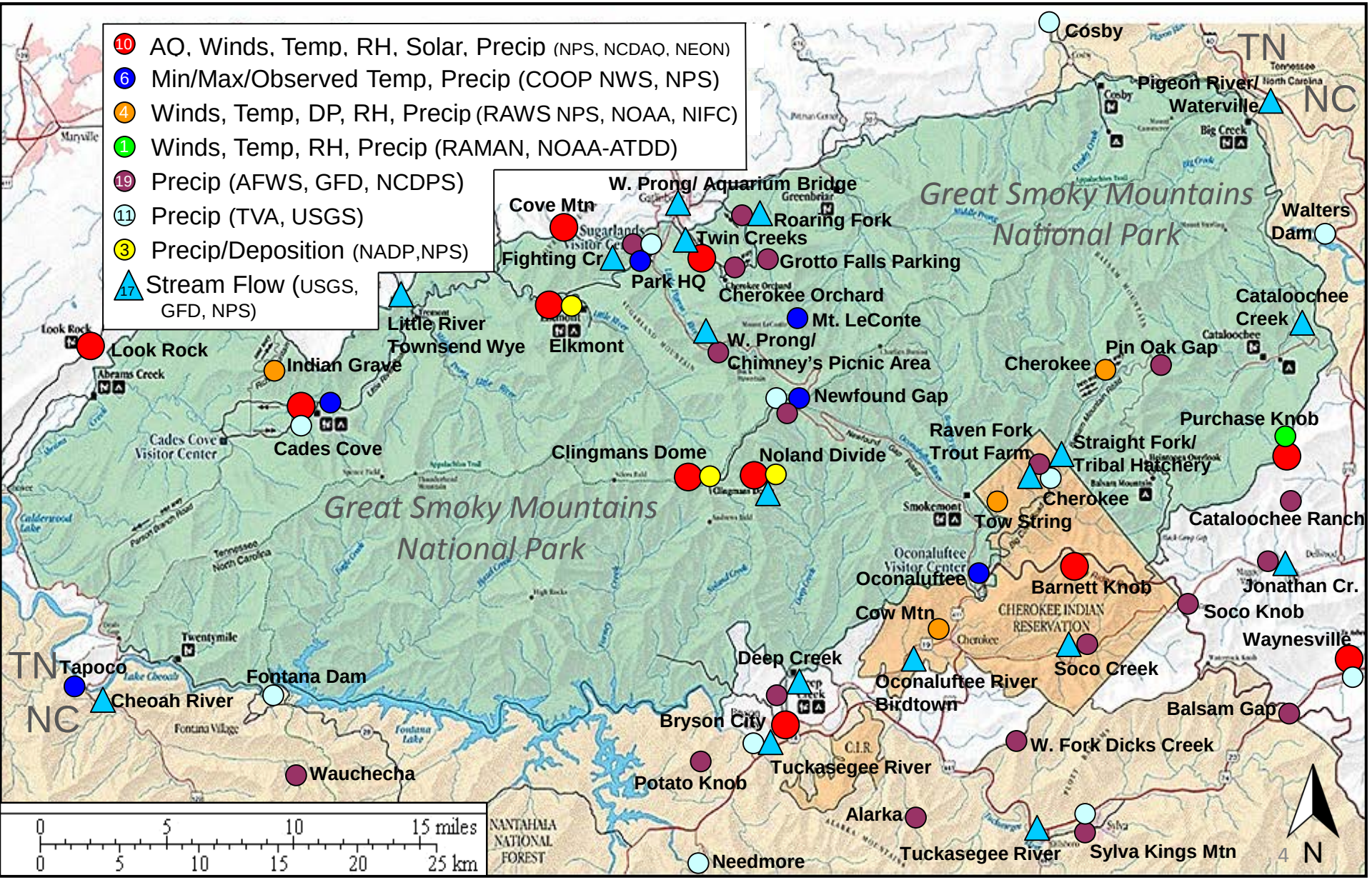
- **Mandates for Clean Air**
- **Emissions**
- **Ozone**
- **Particulate Matter**
- **Regional Haze**
- **Acid Deposition**
- **Mercury**

Good air quality and views are important to the 10 million visitors who come to the Park annually. They expect clean, clear air.

Mandates for Clean Air Protection in National Parks

- **National Park Service Organic Act (1916)**
  - Mission "…*Protect park resources… natural, cultural, historic… <u>unimpaired</u> for future generations*."
- **The Clean Air Act (1970) & Amendments (1977, 1990) afford the greatest protection for <u>Class I Areas</u>:**
  - National Parks > 6,000 acres in size.
- **Requires protection of <u>Air Quality Related Values</u> (AQRVs) – Visibility, soils, water, flora, fauna, ecosystems.**
  - Park should be the cleanest area in the U.S.
  - Federal Land Managers ("FLM") have the affirmative responsibility to protect resources.
  - The FLM has no regulatory authority to control pollution beyond the park boundary. We rely on EPA, State and Local air regulatory programs.
  - Pollutant levels at Great Smoky Mountains historically have been among the highest of any Class I area in U.S. Good news is air quality is improving.
  - The keys to success have been the long-term continuous monitoring, targeted research, collaborative partnerships leveraging resources, education and public outreach, and policies leading to emission reductions. We are expected to know the condition of our resource through our monitoring programs.

Air Quality and Climate Continuous Monitoring Stations in and near Great Smoky Mountains National Park, TN/NC



Prepared by Jim Renfro, Air Resource Specialist, GRSM 01/30/2015

Goals of the NPS Air Monitoring Program

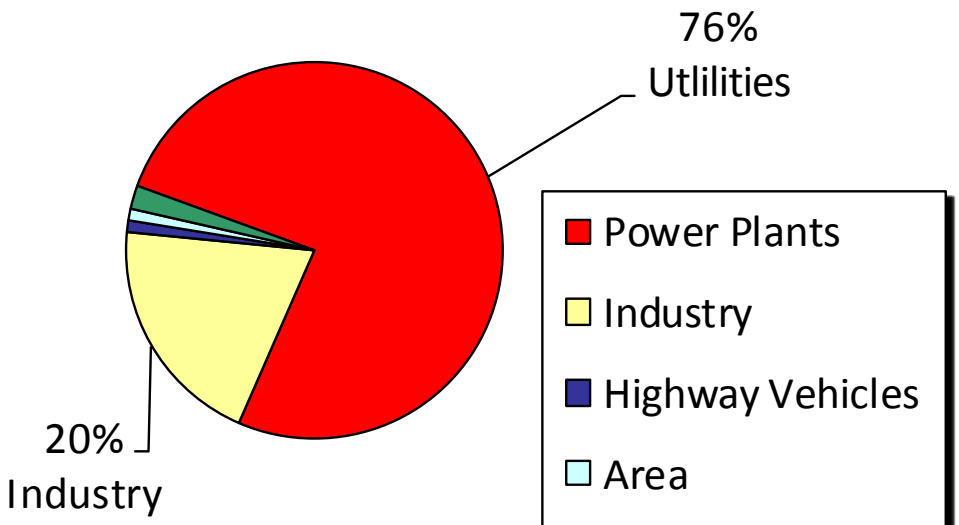
- Determine Compliance with air quality standards;
  - *Do we meet public health and environmental standards?*
- Establish Baseline Conditions to identify areas of concern;
  - *How healthy is the park and how does it compare to other locations ?*
- Determine Trends with Long-term continuous data;
  - *Is the problem getting better or worse?*
- Link to Biological Effects;
  - *How much pollution is too much (e.g. "cause and effect research")?*
- Utilize Modeling as a tool to demonstrate compliance;
  - *How effective are emission control strategies(e.g. attainment, progress)?*
- Review New Sources of pollution:
  - *What are the sources & impacts of new & existing sources (e.g. NSR/PSD program)?*
- Share data to promote understanding with the public, scientific community, Congress, EPA, States and local communities.

Look Rock Air Quality Monitoring Station

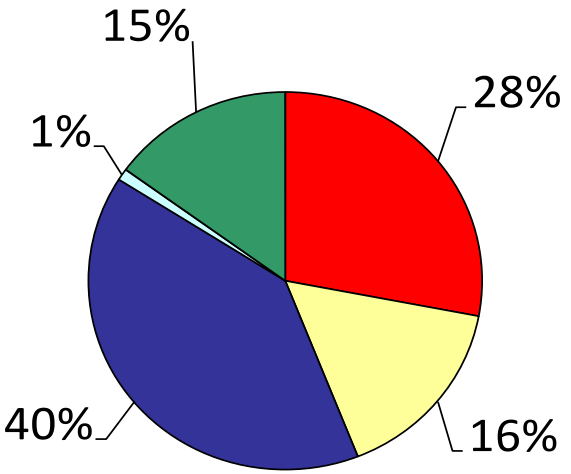
Emissions Inventory of Sulfur Dioxide and Nitrogen Oxide in the Southeast U.S.

SO2 Emissions

(AL, FL, GA, KY, MS, NC, SC, TN, VA, WV)



NOx Emissions



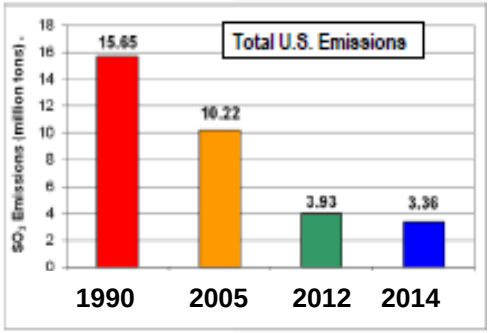
Source: VISTAS 2006

Annual SO_2 Power Plant Emissions 1990-2014 *

75% Reduction

Progress Energy Asheville Plant

GSMNP



Scale: Largest bar equals 2.2 million tons of SO_2 emissions in Ohio, 1990
Source: EPA, 2011

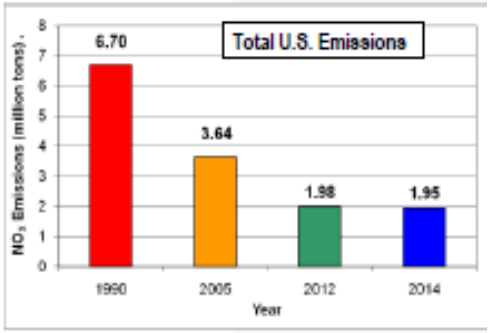
1990
2005
2012 Cross-State Air Pollution Rule
2014 Cross-State Air Pollution Rule
States controlled for fine particles (annual SO2 and NOx) (23 States)
States not covered for fine particles

Annual NO_X Power Plant Emissions 1990-2014 *

71% Reduction

TVA
Bull Run Plant

GSMNP



Scale: Largest bar equals 534 thousand tons of NO_X emissions in Ohio, 1990
Source: EPA, 2011

1990
2005
2012 Cross-State Air Pollution Rule
2014 Cross-State Air Pollution Rule
States controlled for fine particles (annual SO2 and NOx) (23 States)
States not covered for fine particles

Annual SO2 and NOx Emissions for the 4 Eastern TVA Power Plants (in Thousands of Tons)

SO2 and NOx Tons/Year (x 1000)

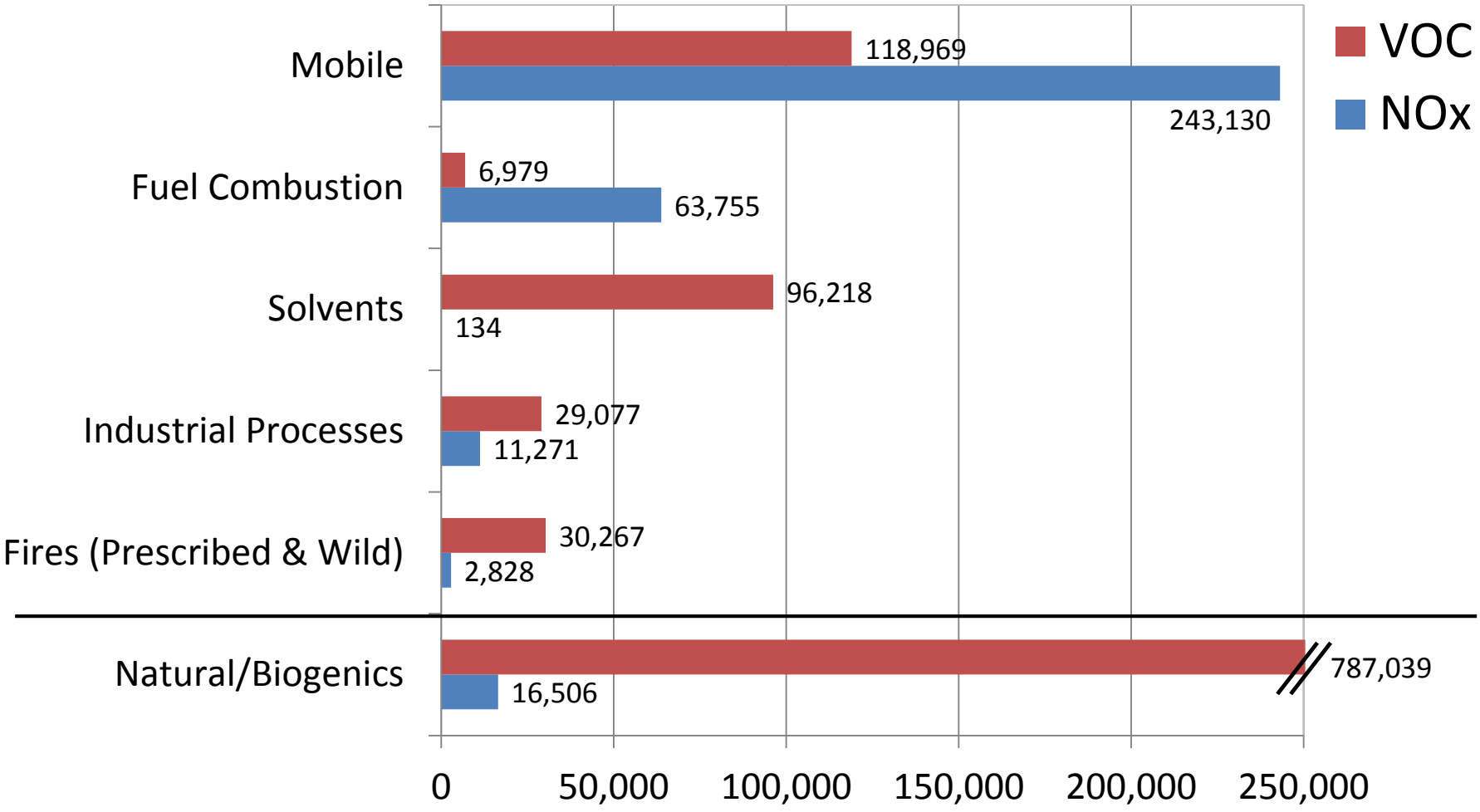
SO2

NOx

Total of 370,000 Tons Reduced in the past 15 years

Down 95%

2011 Tennessee NOx and VOC Emissions by Source Sector



Source: 2011 NEI

Park NOx = 123 TPY
Park VOC = 71 TPY

Park Efforts to Reduce Emissions

- **Cleaner Vehicles and Fuels**
  - Use of biodiesel
    - Fleet (B20) and Park HQ heating (B50)
  - Hybrid electric vehicles
  - Electric utility vehicles in campgrounds
  - No idling buses at visitor centers
  - Cades Cove free of motorized vehicles (M, W)

- **Shuttle Transit Systems**
  - Gatlinburg trolleys to campground (Elkmont), Hiking Trail (Laurel Falls), and Sugarlands VC
  - Cherokee shuttle service between gateway communities
- **Cleaner Electricity**
  - Solar power air quality station and radio system
  - Hot water heater at Sugarlands Visitor Center
  - Green Power Switch (SCES, TVA)

- **LEED Gold Buildings**
  - Twin Creeks Science Center,
  - Oconaluftee Visitor Center
- **Air Quality Action Days**
  - Restrict mowing/weedeating

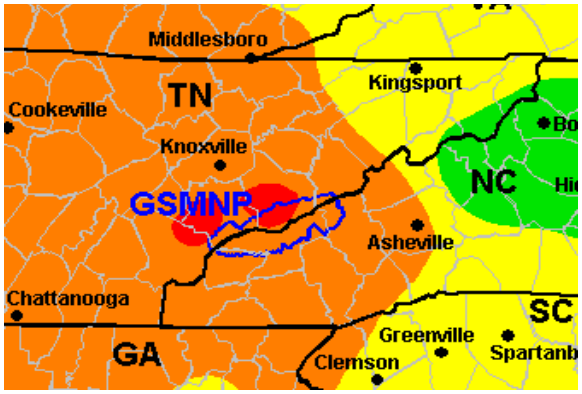
Natural Factors that Predispose Resources

"Natural Ingredients"

- High pressure and frequent air stagnation events;
- Sunlight and heat that increases chemical reactivity;
- Elevation and topography, higher winds, more clouds;
- Rainfall and humidity which affect deposition & haze;
- Organic emissions from trees (isoprene) affects O3 & PM formation;
- Low buffering capacity in streams & acid soils;
- Old-growth, slow growing forests (less N demand)

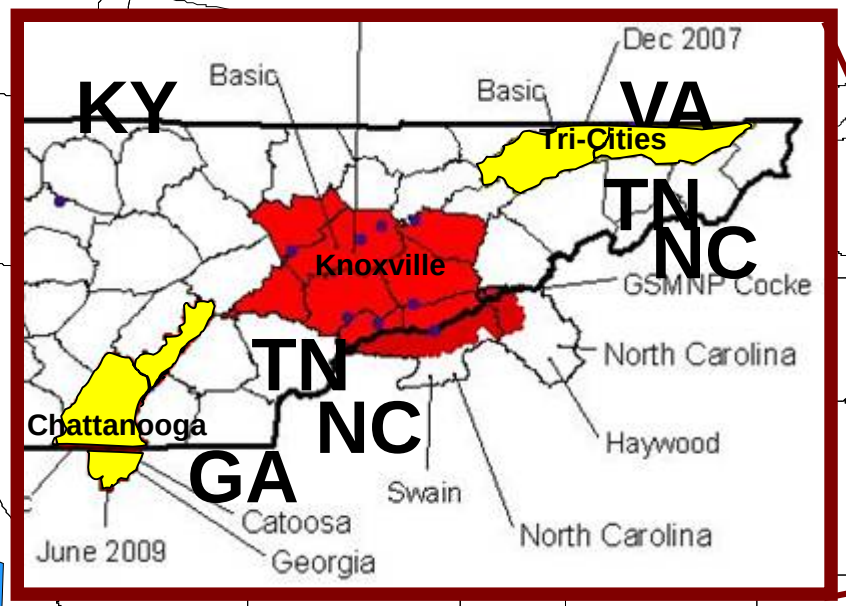
Ozone Pollution

- Powerful respiratory irritant
- Damages forests (and crops)
- NOx + VOC + Sunlight + Heat = O3
- Weather, terrain, elevation influences



Ozone Non-Attainment Areas

(Effective April 15, 2004)

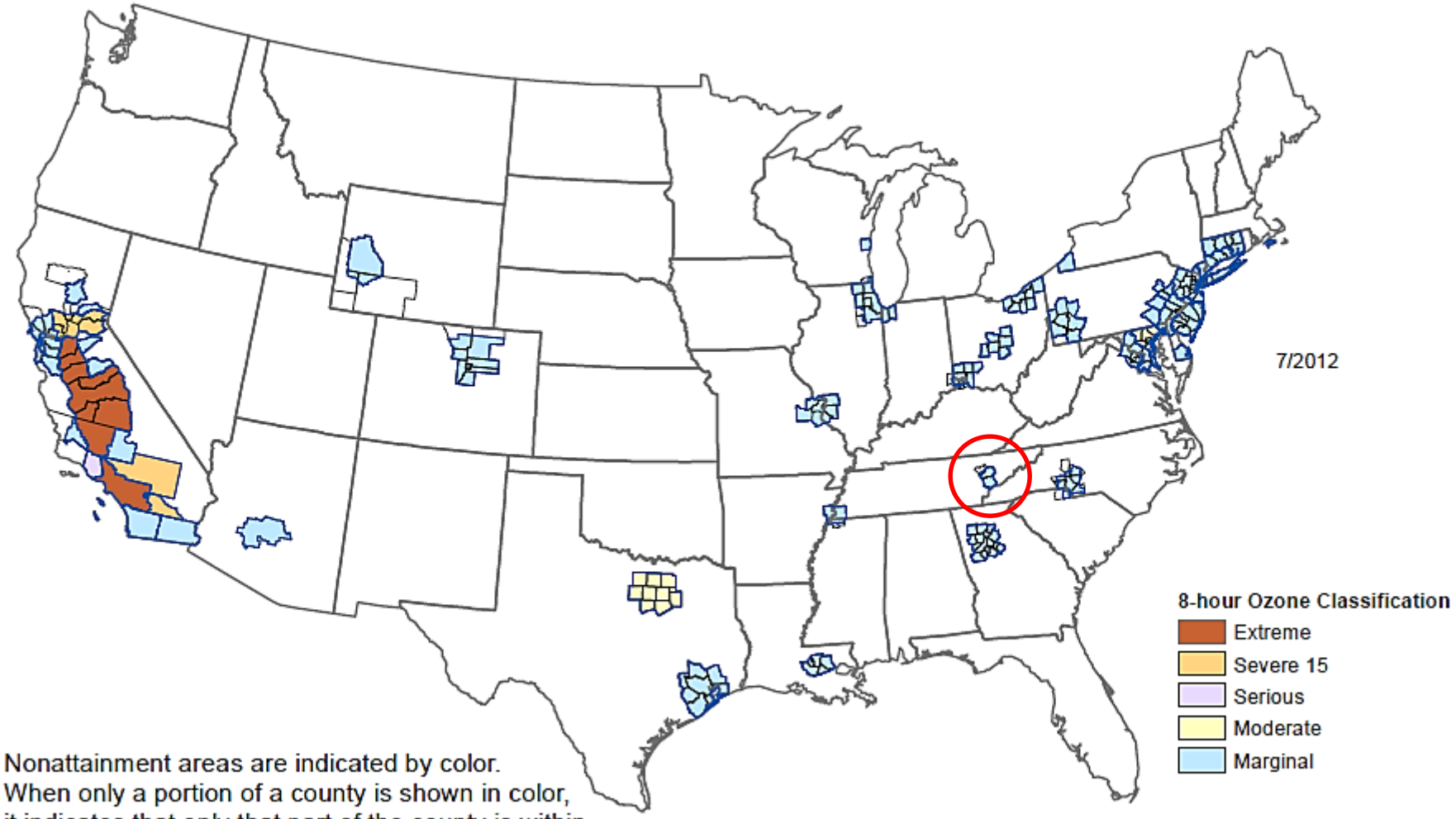


CATEGORY/CLASSIFICATION

- Severe 17 Los Angeles
- Serious - Riverside Co (Coachella Valley), San Joaquin, Sacramento, CA
- Moderate
- Moderate EAC Greensboro, NC
- Marginal
- Subpart 1 (Basic)
- Subpart 1 EAC (Basic)

EPA Ozone Nonattainment Areas

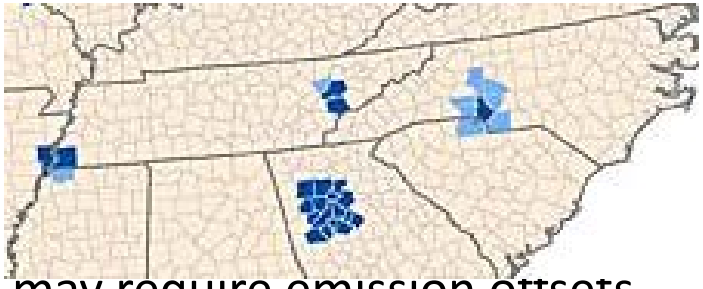
(2008 76 ppb Standard)



Nonattainment areas are indicated by color. When only a portion of a county is shown in color, it indicates that only that part of the county is within a nonattainment area boundary.

What does Nonattainment mean?

- Area that exceeds or contributes to an area that exceeds the public health standard.
- Stigma of a "bad air" area
- Economic growth concerns

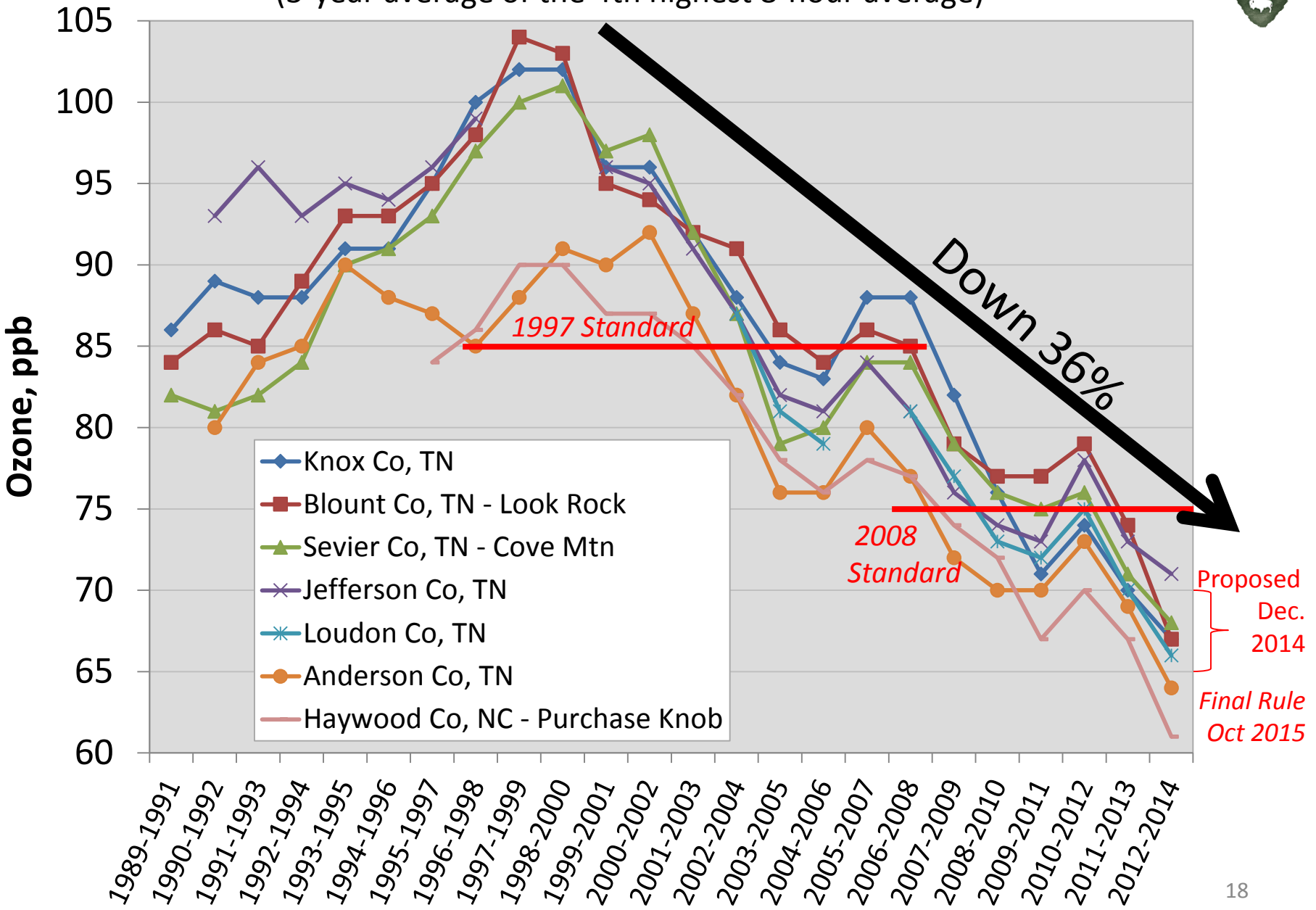


  - Permitting polluting industry more difficult; may require emission offsets.
  - Federal highway funds can be frozen; Conformity test for all new roads.
- State Implementation Plans & Contingency Measures due to EPA.
- TDEC & EPA working on re-attainment designation.

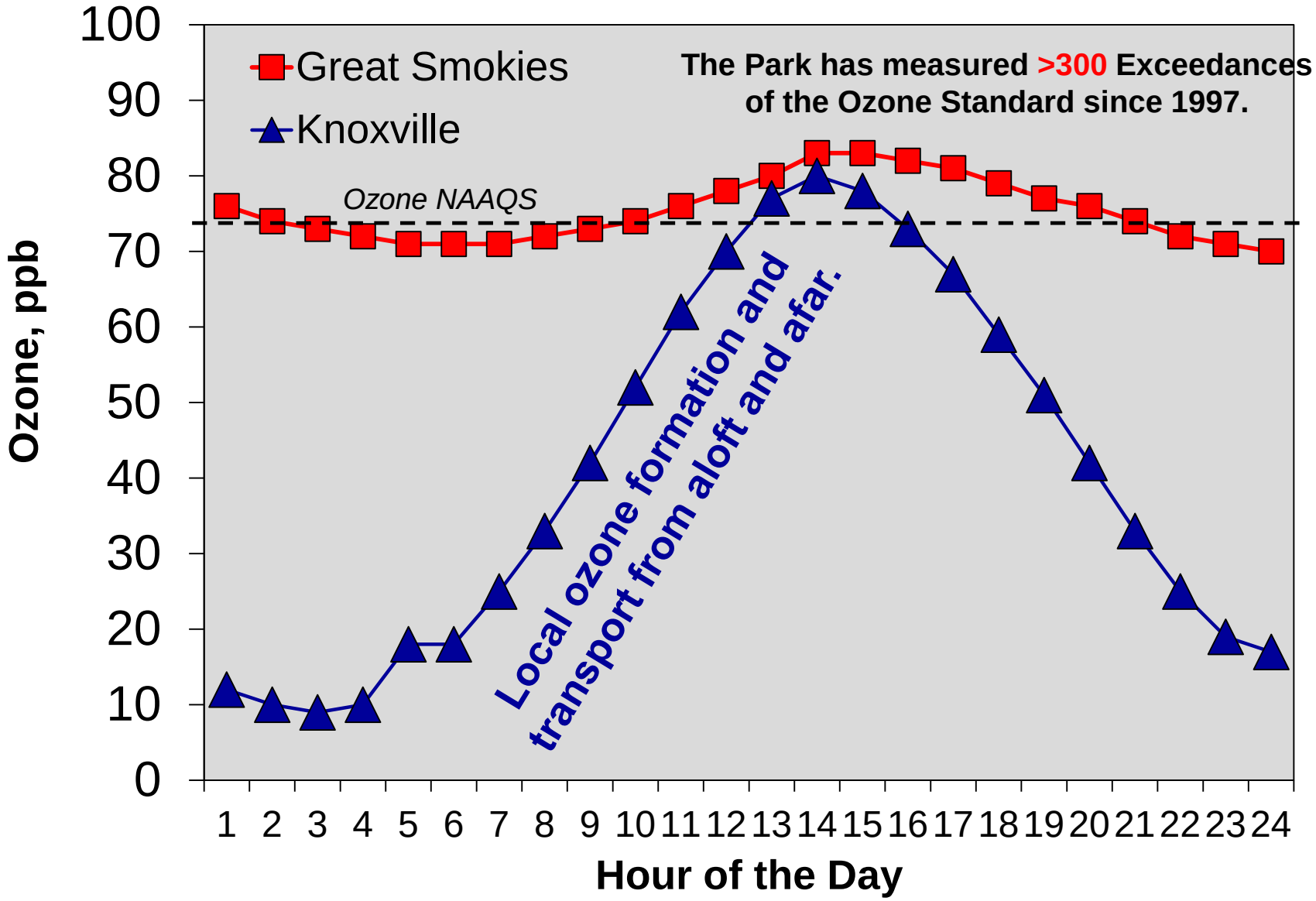
- EPA has proposed tightening the 2008 Standard from 75 ppb to 65-70 ppb.
  - Proposed new rule (Dec. 2014); Final rule (Oct. 1, 2015)
- Need for a Secondary Ozone Standard to protect Vegetation
  - Park effects data is part of EPA's Integrated Science & Risk Assessment
  - EPA considering a requisite primary standard equal to seasonal exposures

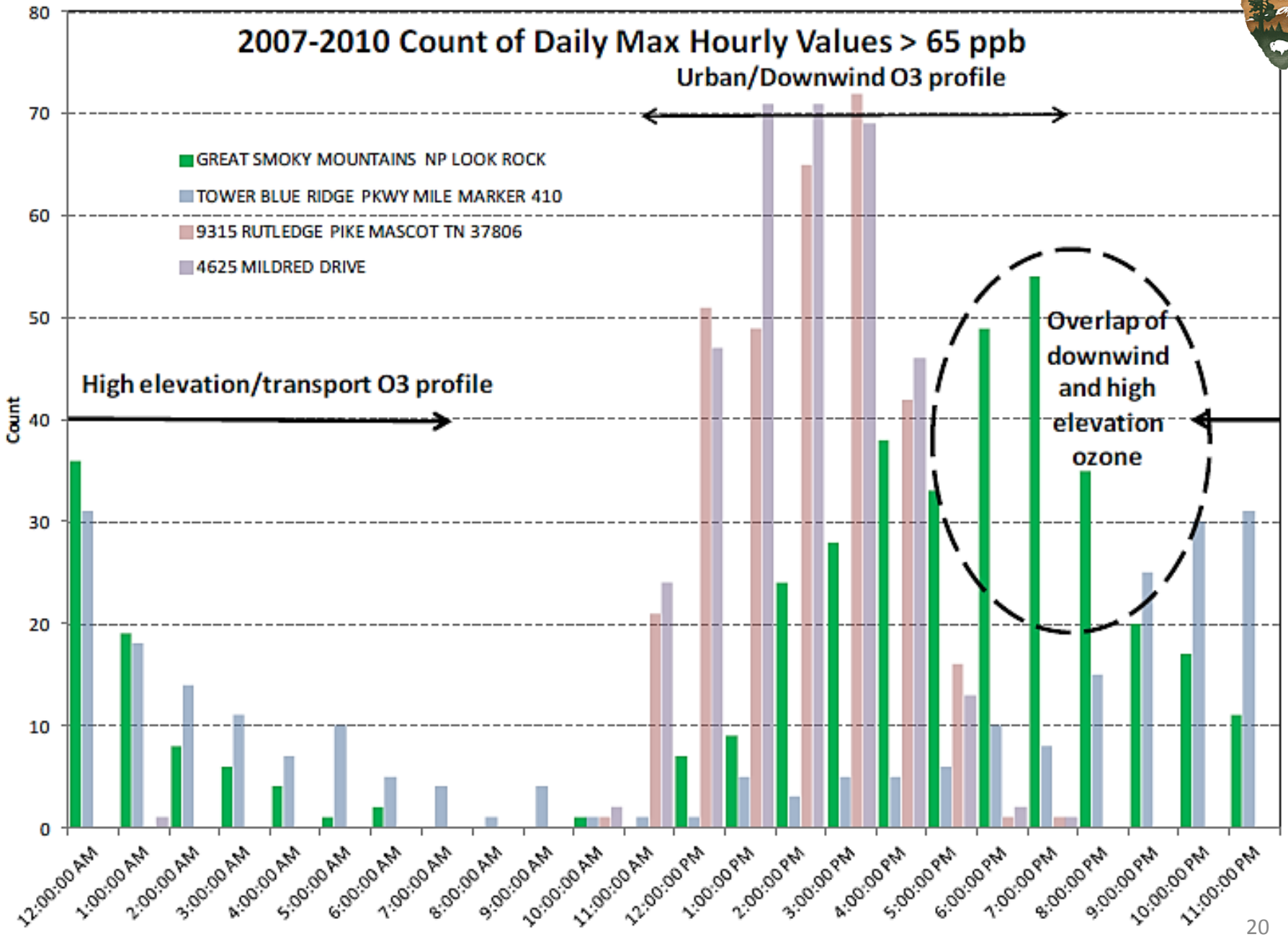
Trend in Ozone Design Values for GRSM & Knoxville Area Monitors

(3-year average of the 4th highest 8-hour average)

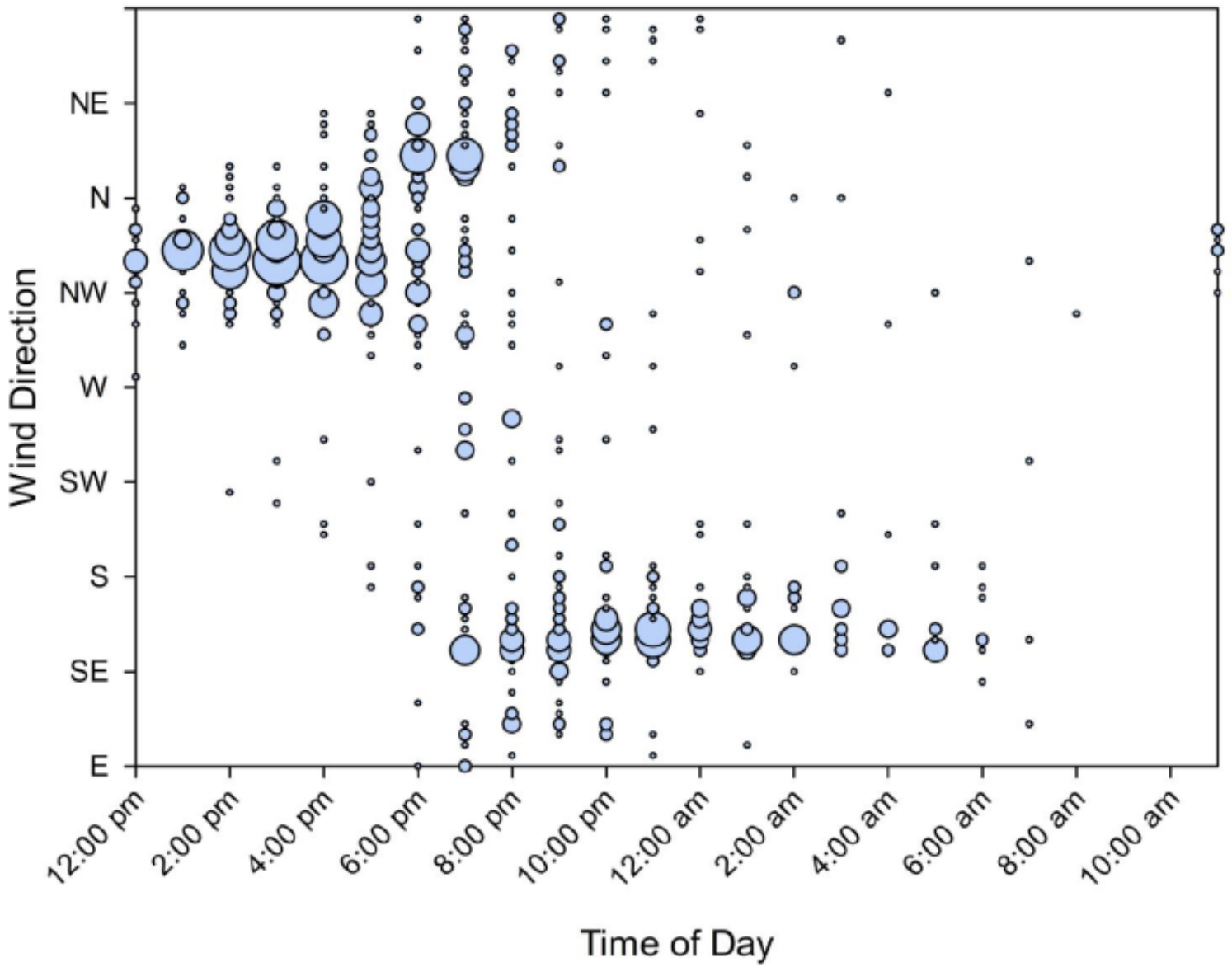


Typical Daily Ozone Pattern at Knoxville and GRSM Ridgetop Monitors - April 14, 2010

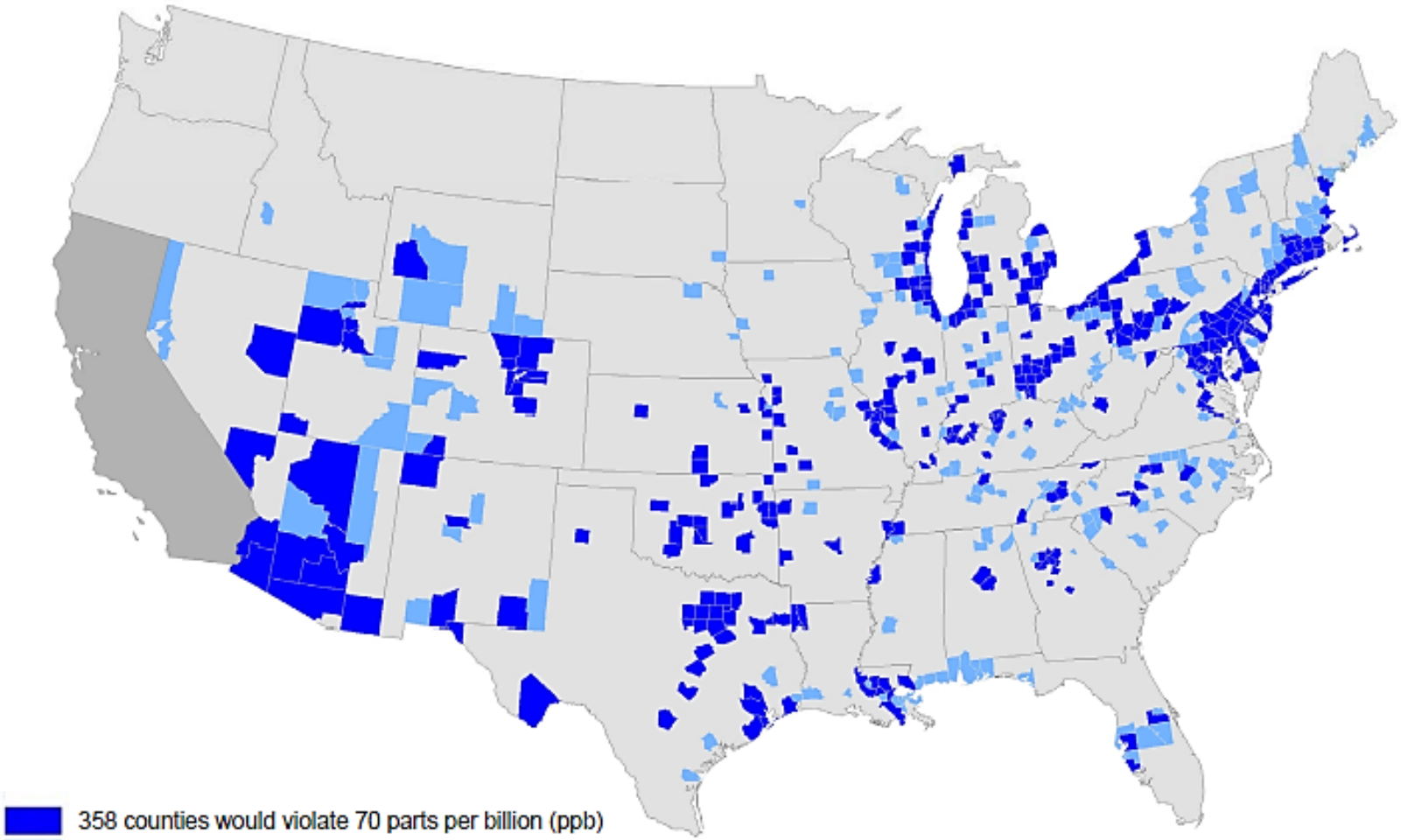



2007-2010 Count of Daily Max Hourly Values > 65 ppb
Urban/Downwind O3 profile
GREAT SMOKY MOUNTAINS NP LOOK ROCK
TOWER BLUE RIDGE PKWY MILE MARKER 410
9315 RUTLEDGE PIKE MASCOT TN 37806
4625 MILDRED DRIVE
High elevation/transport O3 profile
Overlap of downwind and high elevation ozone
Count
80
70
60
50
40
30
20
10
0
12:00:00 AM
1:00:00 AM
2:00:00 AM
3:00:00 AM
4:00:00 AM
5:00:00 AM
6:00:00 AM
7:00:00 AM
8:00:00 AM
9:00:00 AM
10:00:00 AM
11:00:00 AM
12:00:00 PM
1:00:00 PM
2:00:00 PM
3:00:00 PM
4:00:00 PM
5:00:00 PM
6:00:00 PM
7:00:00 PM
8:00:00 PM
9:00:00 PM
10:00:00 PM
11:00:00 PM

Frequency of Look Rock Ozone Hourly Values > 75 ppb by Wind Direction and Time of Day



Counties Where Measured Ozone is Above Proposed Range of Standards (65 – 70 parts per billion)



358 counties would violate 70 parts per billion (ppb)

200 additional counties would violate 65 ppb for a total of 558

Based on 2011 – 2013 monitoring data

Ozone Effects to Forests

- Park has a long history of ozone effects to vegetation research (since 1982).

- Ozone below the primary standard damages 30 species of plants by interfering with photosynthesis causing:
  - visible leaf injury
  - growth reductions
  - species composition changes
  - water quantity changes in soils & streams

Ozone-Injured Black Cherry

Ozone-Injured Tall Milkweed and Cut-leaf Coneflower

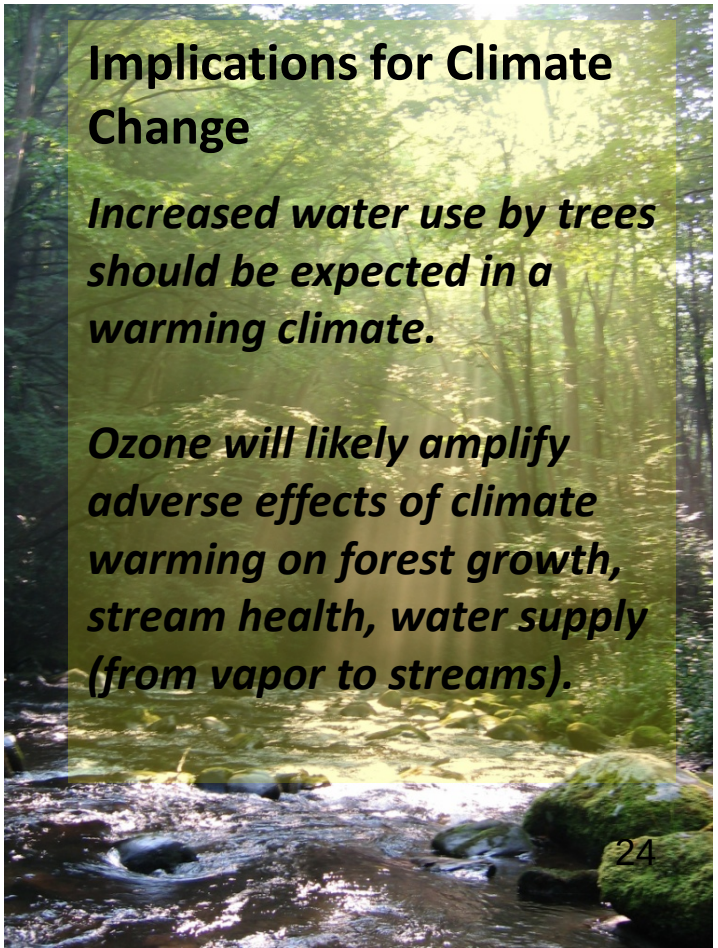
Recent Results – Water flux alterations

Research papers published in the journal New Phytologist

1. S.B. McLaughlin et al. 2007. "Interactive effects of ozone and climate on tree growth and water use in a S. App forest."
2. S.B. McLaughlin et al. 2007. "Interactive effects of ozone and climate on water use, soil moisture content and streamflow in a S. App. forest.

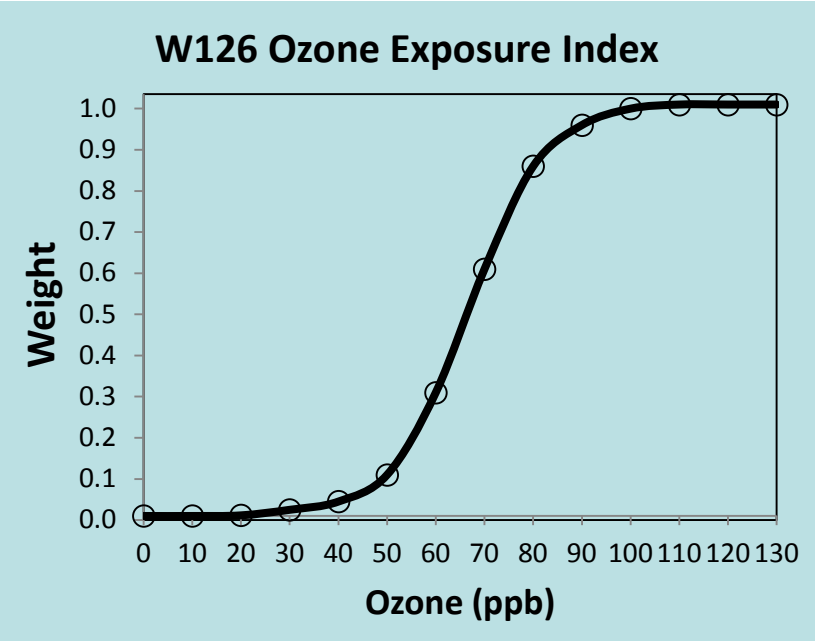
Key summary of findings:

1. Ozone was associated with a slowdown in mature forest tree growth patterns (water loss, sap flow) contributing to episodic and net seasonal losses in stem growth of 30-50% for most species studied in a high ozone year.
2. Increased whole-tree canopy stomatal conductance, **depletion of soil moisture** in the rooting zone, increased night-time respiration, and **reduced late-season streamflow** in forested watersheds were detected in response to increasing ambient ozone levels.



W126

- W126 is a sigmoidally weighted function (“S” curve) assigning higher weights to higher ozone levels. It’s a cumulative exposure index, not an average.



- Step 1 – compute weighted concentration for each hour from 8am through 7 pm (Mar-Oct);
- Step 2 - Add hourly values for the daily sum;
- Step 3 - Add daily values for the monthly sum;
- Step 4 – Select highest 3 consecutive-month sum;
- Step 5 – Compute the 3-year average of the maximum 3-month sum from each 3-year period.

Trends in W126 Ozone Exposures at GRSM

3-yr avg. of the 3-mo. maximum daylight (8am-8pm)

Look Rock, Blount Co, TN
Cove Mountain, Sevier Co, TN
Clingmans Dome, Sevier Co, TN
Purchase Knob, Haywood Co, NC
Cades Cove, Blount Co, TN

W126 (ppm-hours)

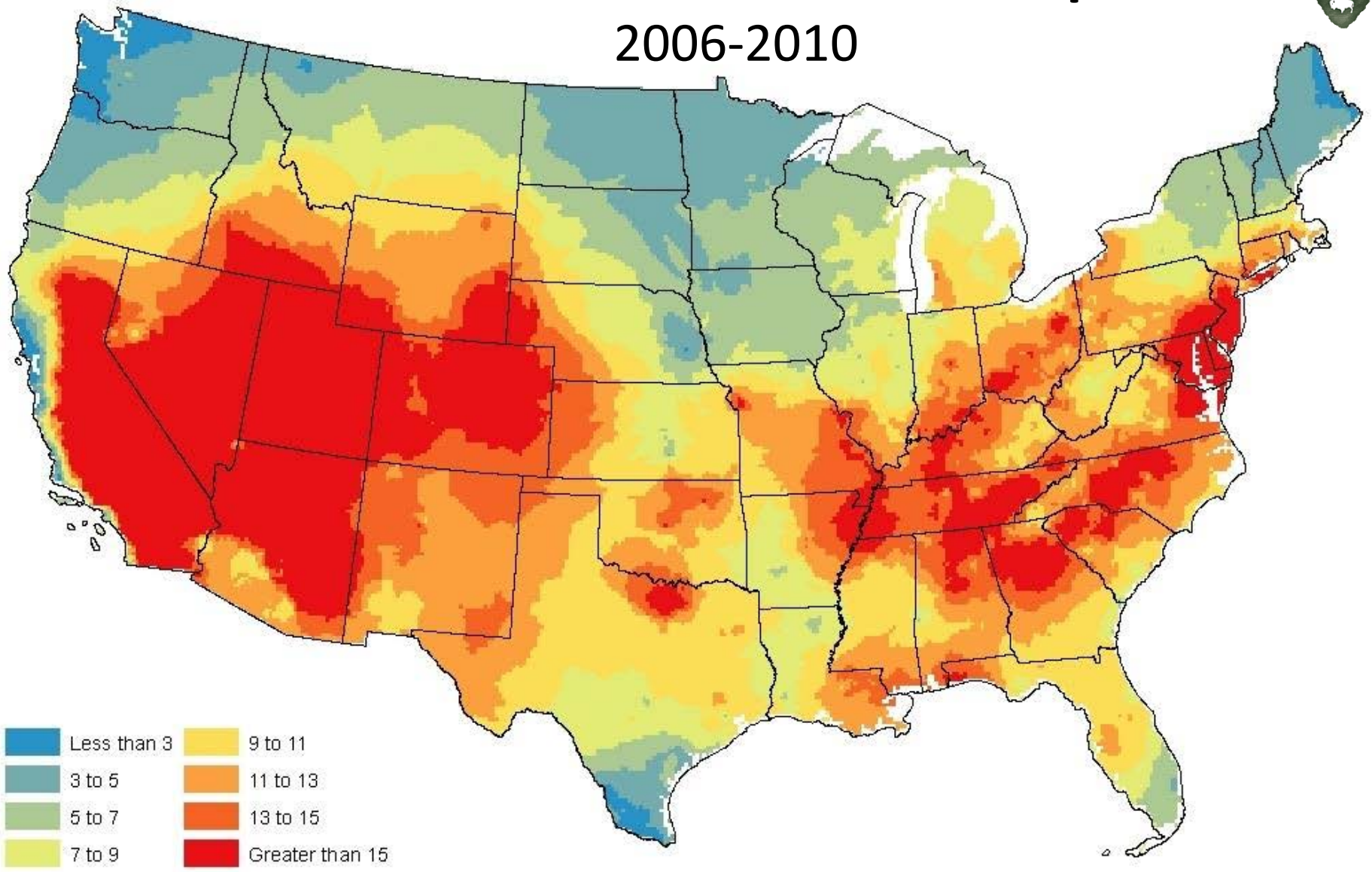
0 5 10 15 20 25 30 35 40 45

1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013

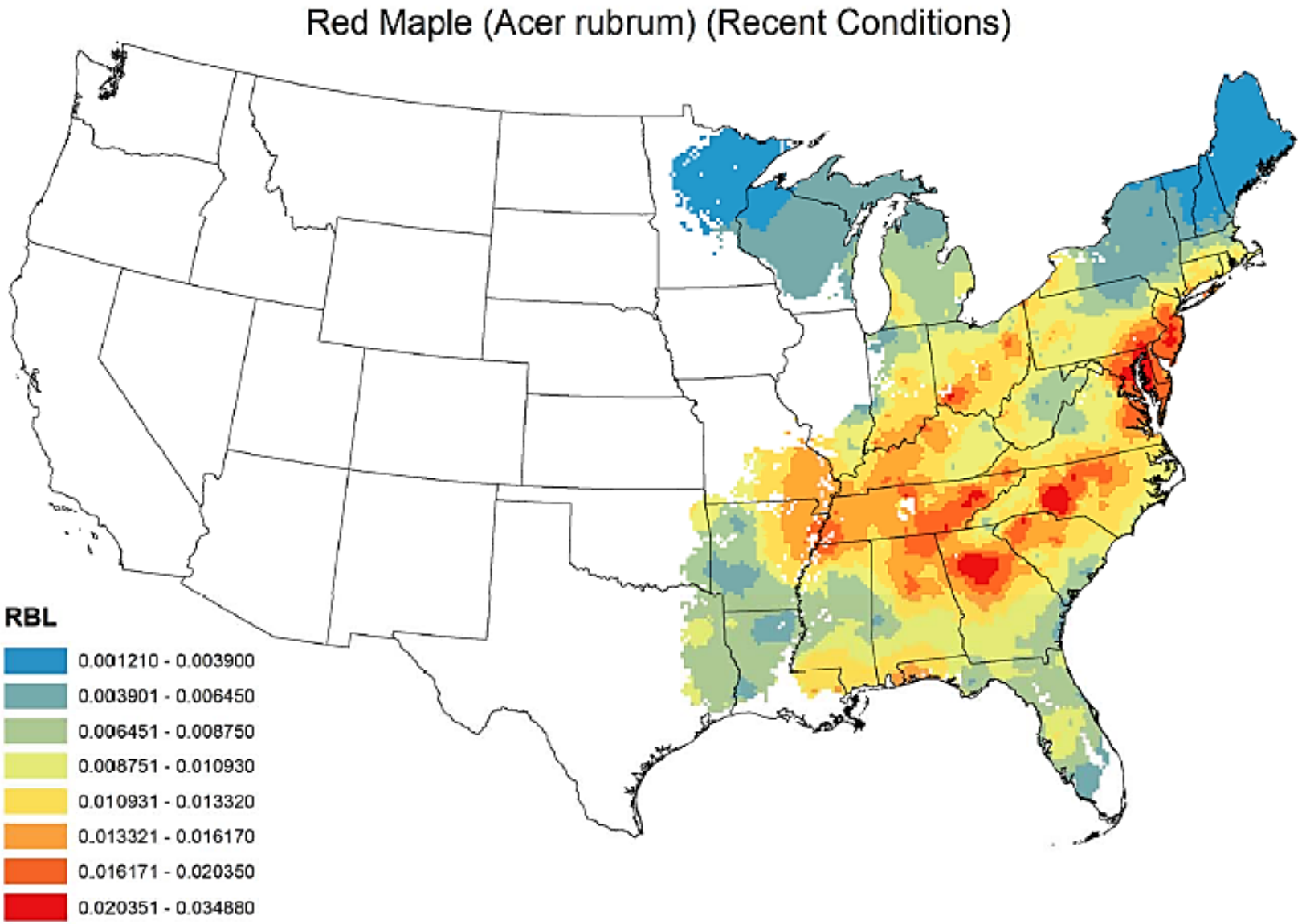
EPA Proposed Secondary Ozone NAAQS 13-17 ppm-hrs range; also considering 7-13 ppm-hrs

National Surface W126 Ozone Exposures

2006-2010

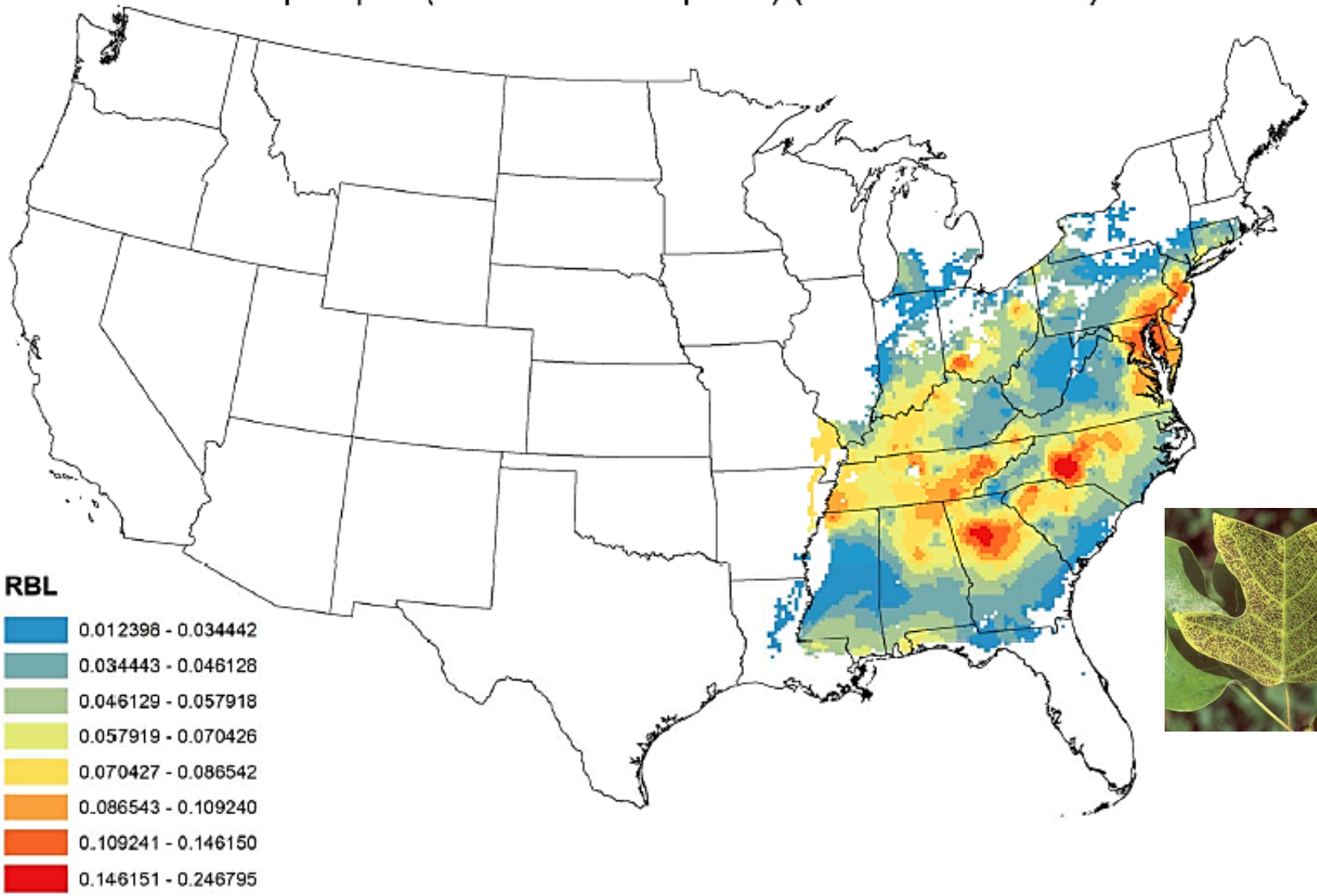


Source: EPA Welfare Risk and Exposure Assessment for the Ozone NAAQS



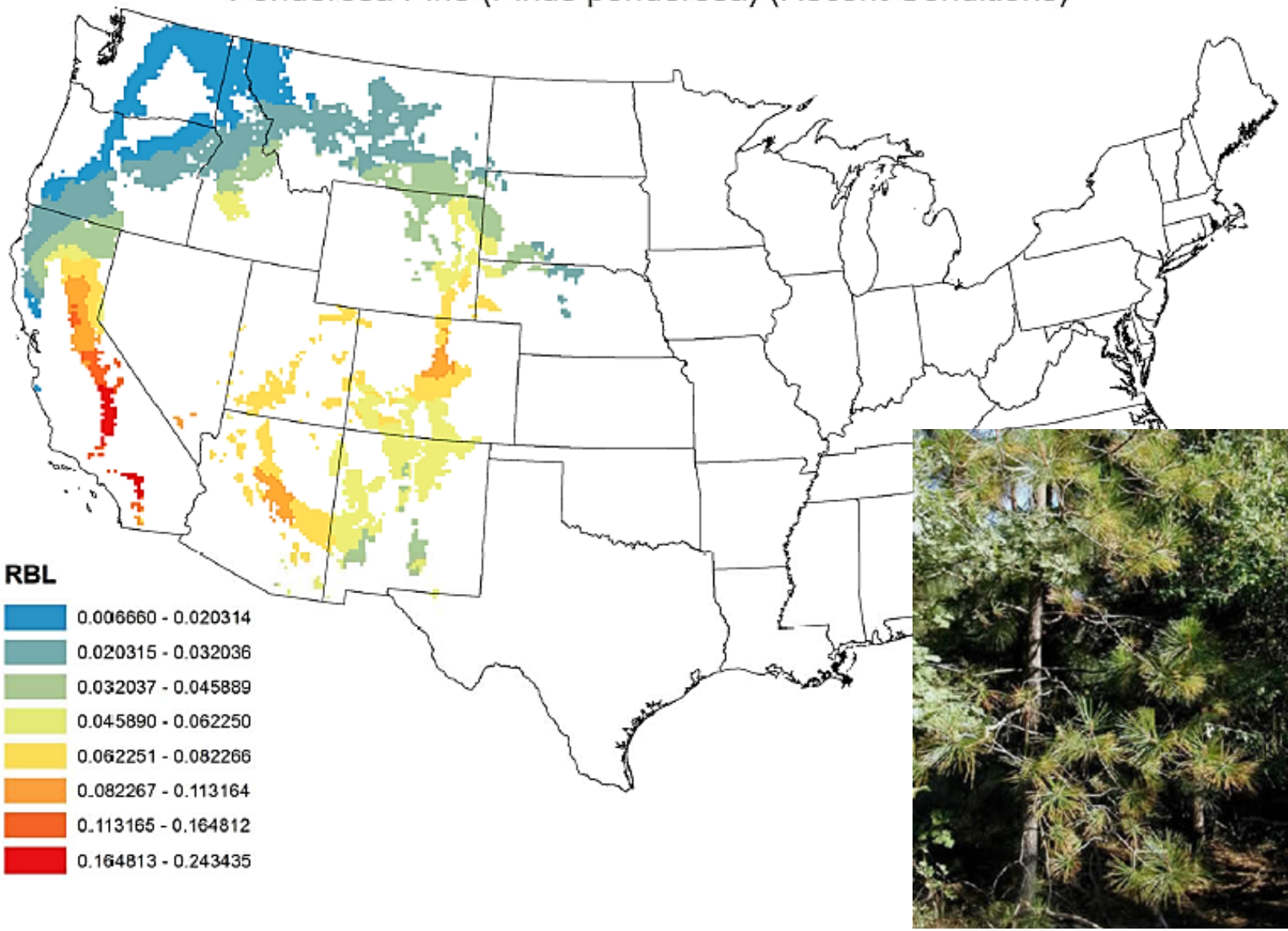
Source: EPA Welfare Risk and Exposure Assessment for the Ozone NAAQS

Tulip Poplar (Liriodendron tulipifera) (Recent Conditions)

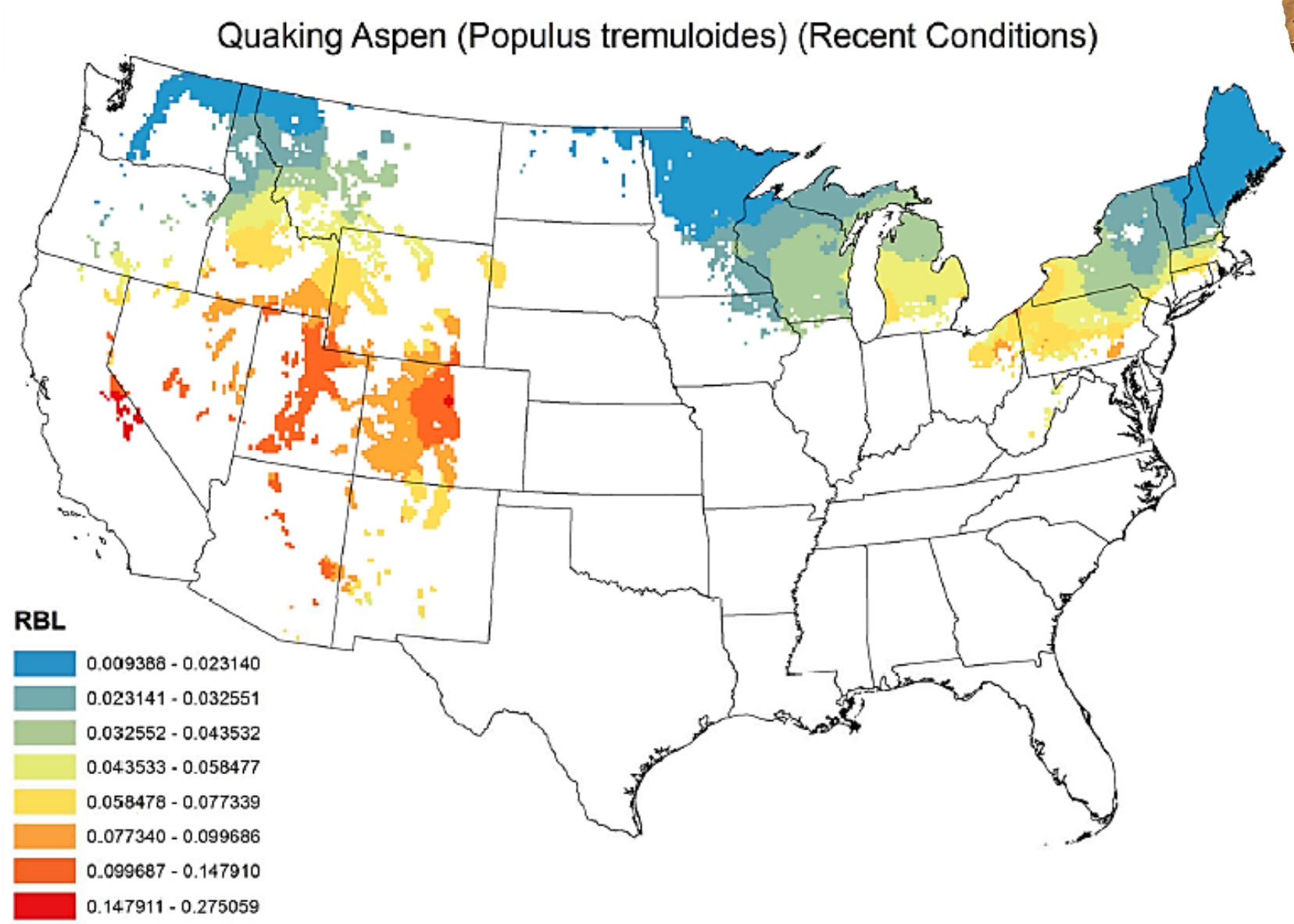


Source: EPA Welfare Risk and Exposure Assessment for the Ozone NAAQS

Ponderosa Pine (Pinus ponderosa) (Recent Conditions)

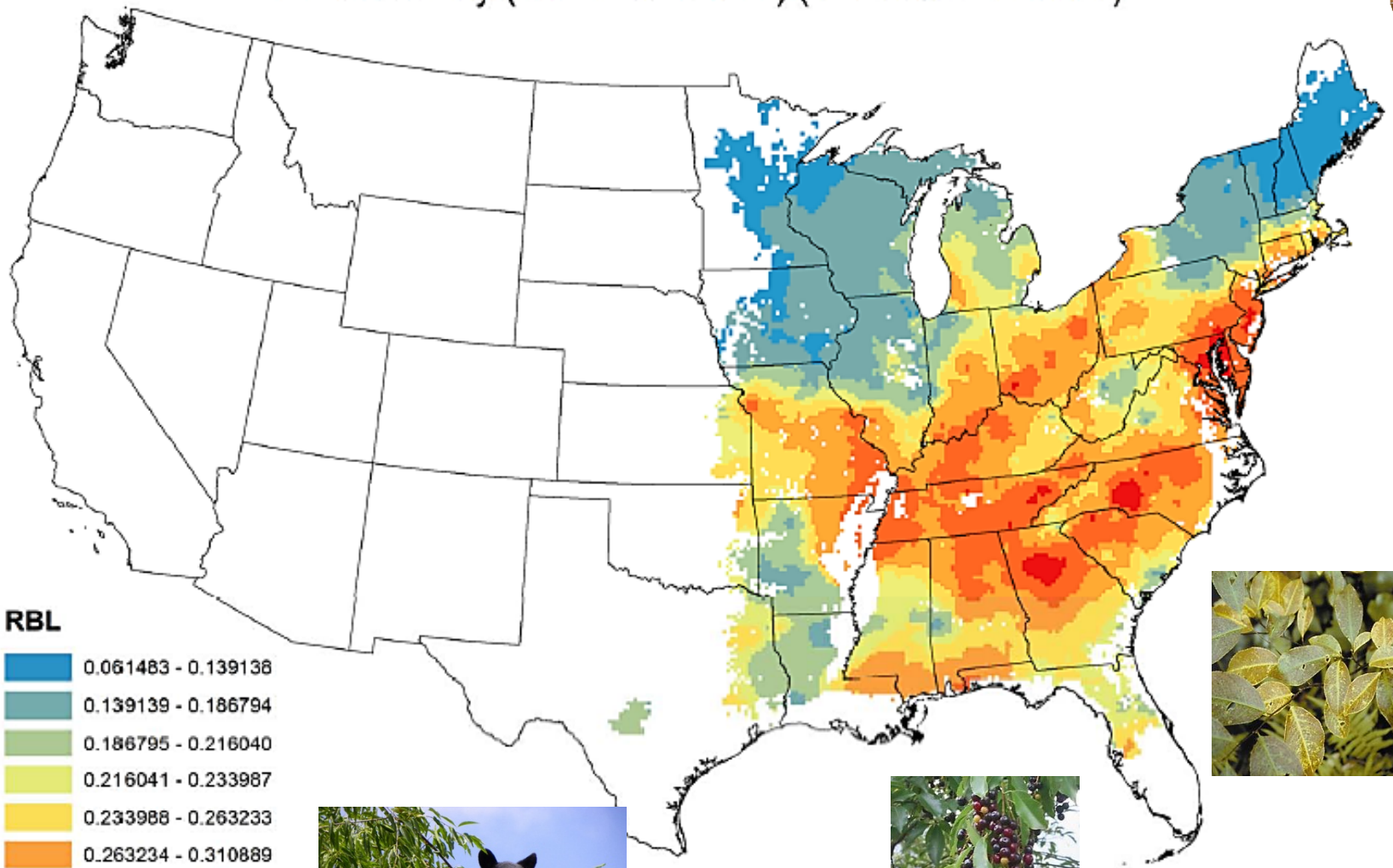


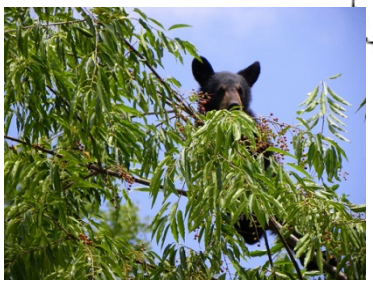
Source: EPA Welfare Risk and Exposure Assessment for the Ozone NAAQS



Source: EPA Welfare Risk and Exposure Assessment for the Ozone NAAQS

Black Cherry (Prunus serotina) (Recent Conditions)

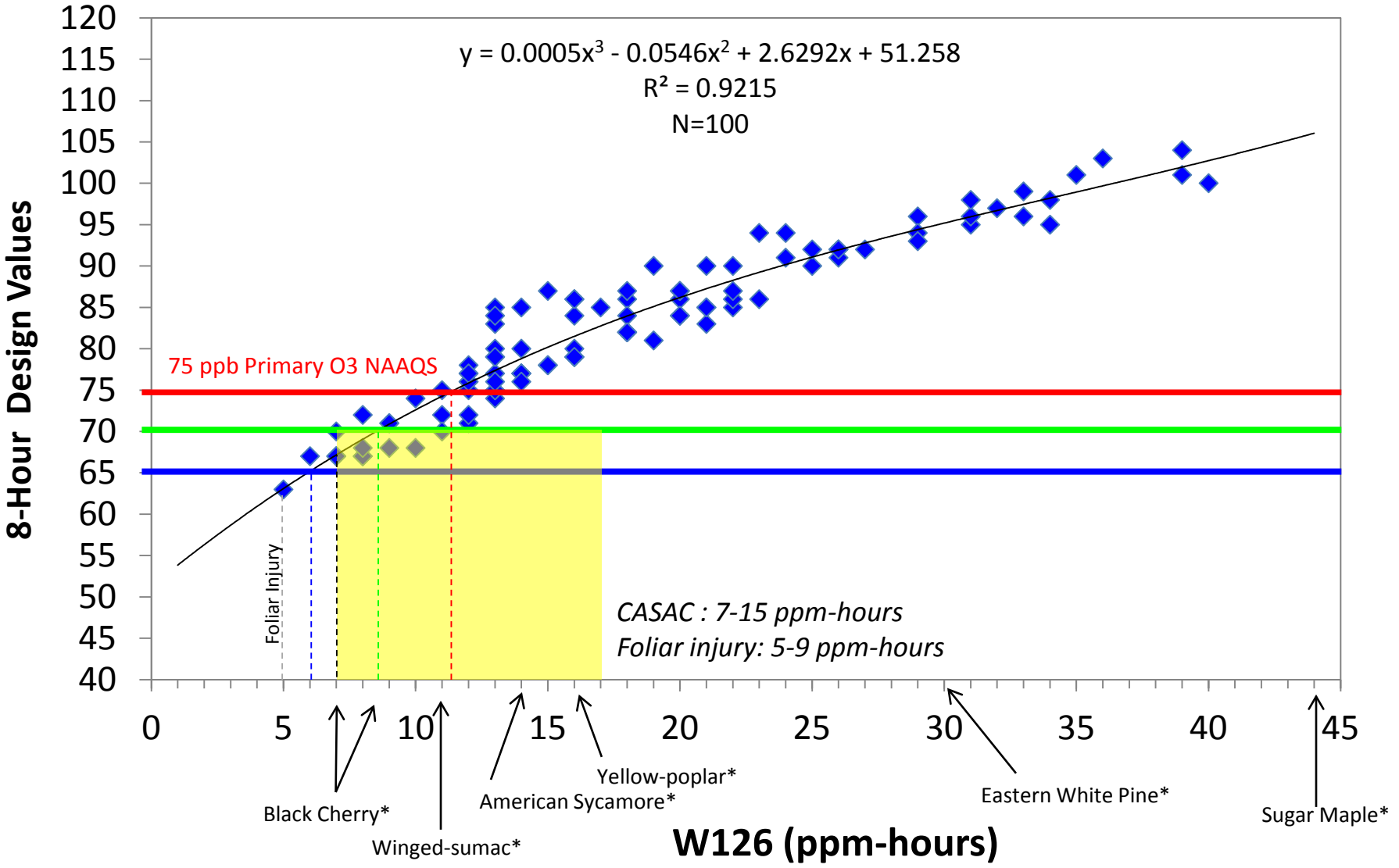




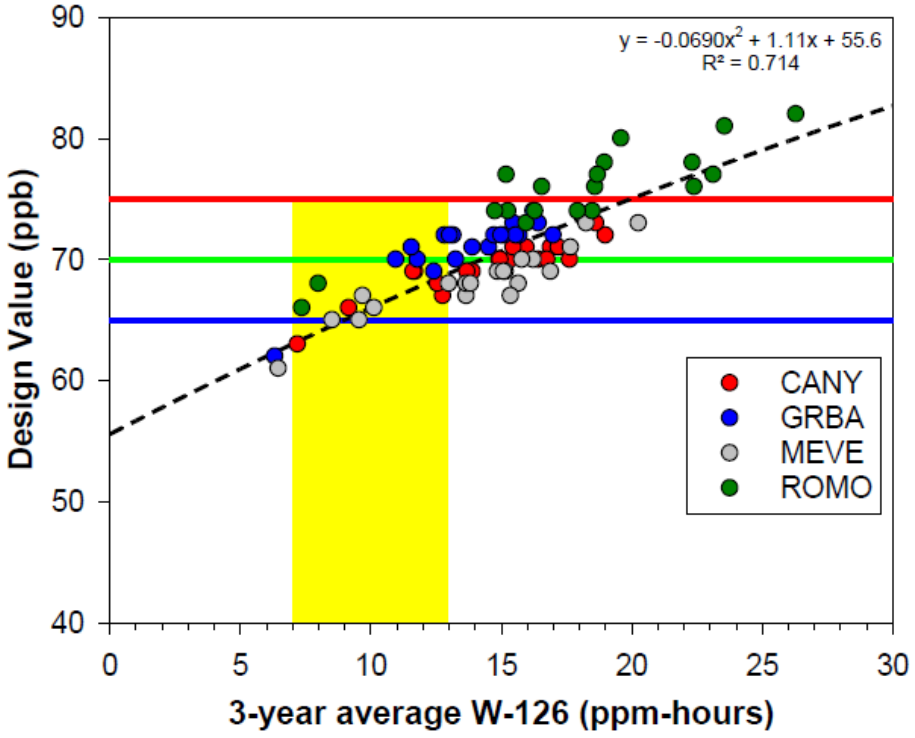
Source: EPA Welfare Risk and Exposure Assessment for the Ozone NAAQS

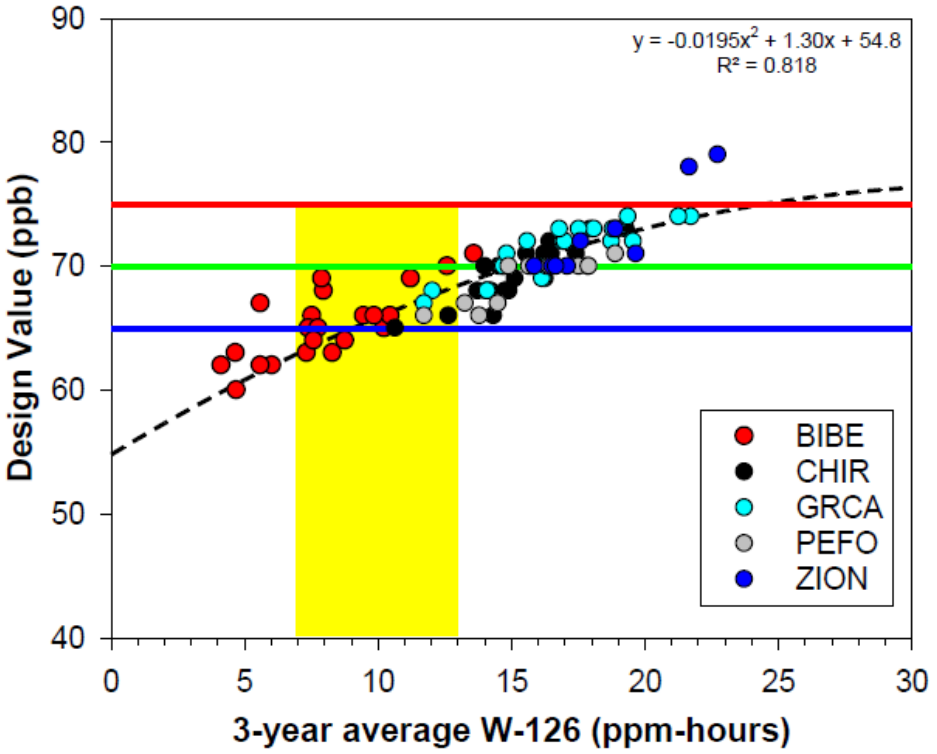
Regression Analysis for the W126 Ozone Index and 8-Hour Ozone Design Value using Ozone Monitoring Data from GRSM

3-yr Avg of 3-mo max daylight (8am-8pm) W126 and 3-yr avg of 4th highest 8-Hour avg (1989-2013)

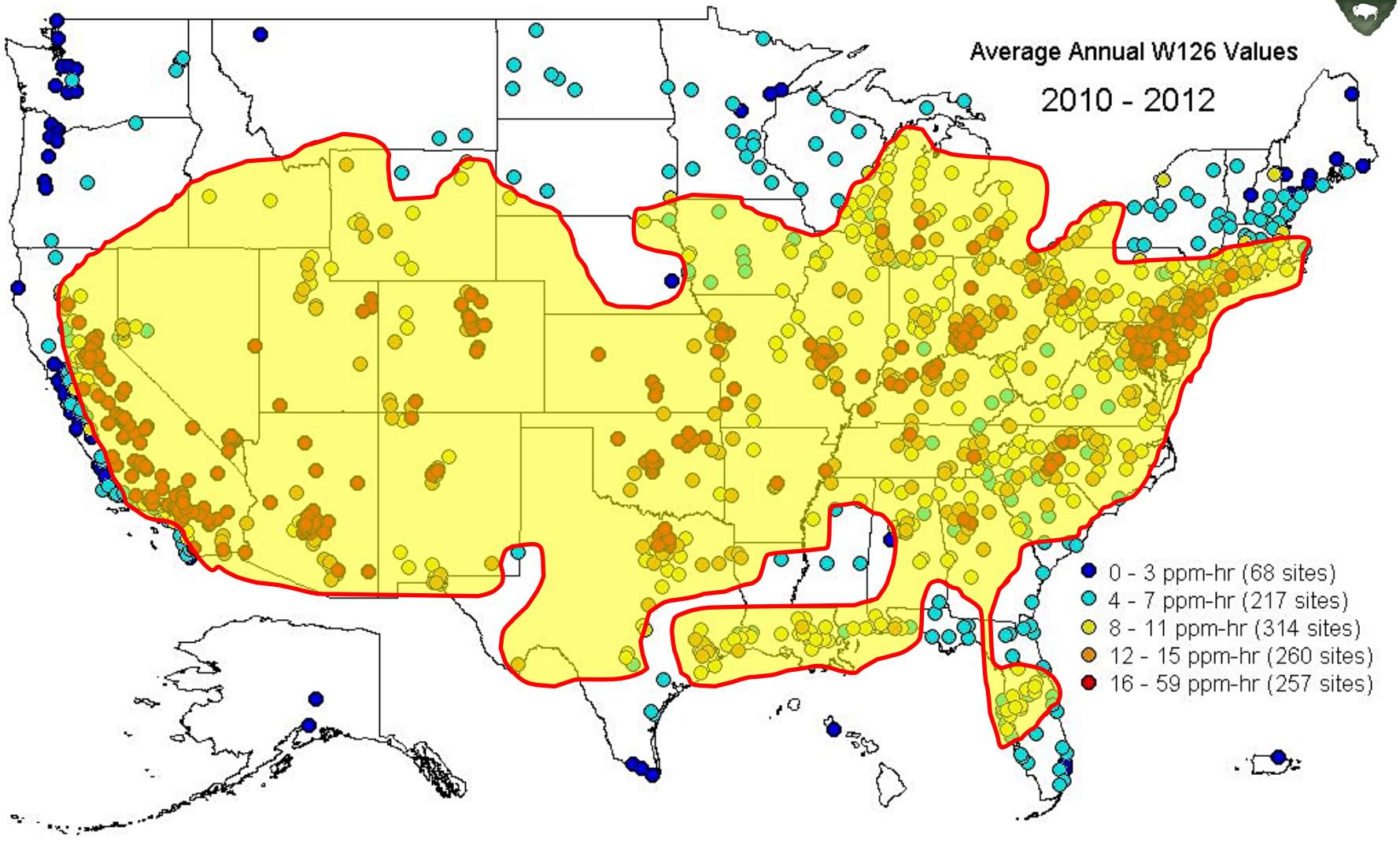


* W126 exposure to cause >10% growth reduction for plant species of known sensitivity at GRSM





Ponderosa Pine
Quaking Aspen

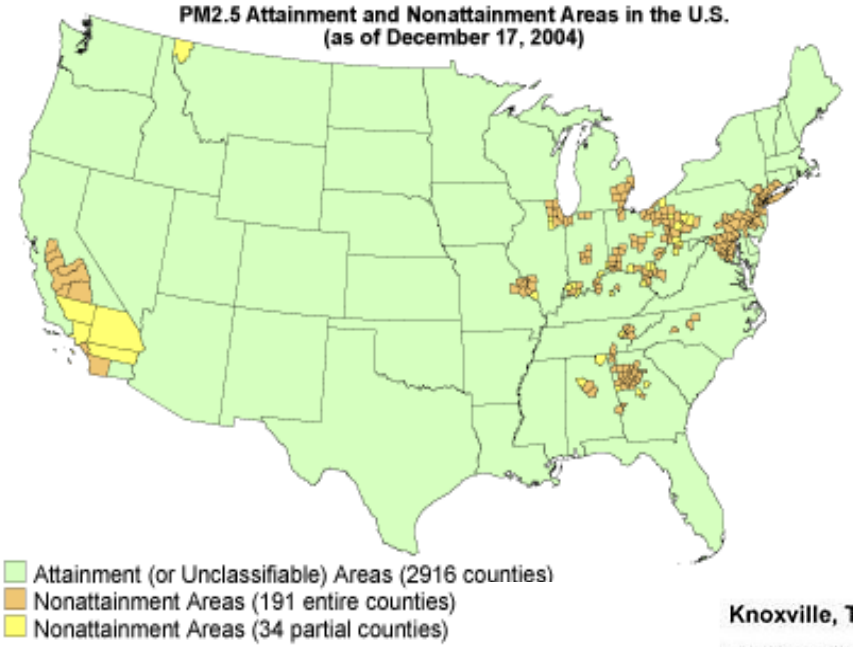

Average Annual W126 Values
2010 - 2012
0 - 3 ppm-hr (68 sites)
4 - 7 ppm-hr (217 sites)
8 - 11 ppm-hr (314 sites)
12 - 15 ppm-hr (260 sites)
16 - 59 ppm-hr (257 sites)

Particulate Matter (PM2.5)

- PM2.5 is made up of particles (≤2.5 microns in diameter): sulfate, organics, ammonium, nitrate, elemental carbon, soil, dust, sea salt
- EPA has 2 PM2.5 public health standards

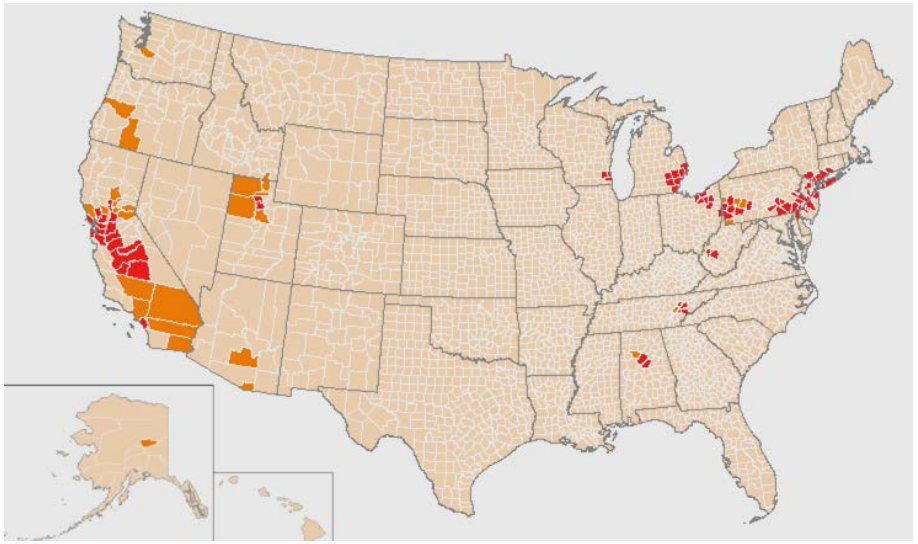
- Annual PM2.5 Standard

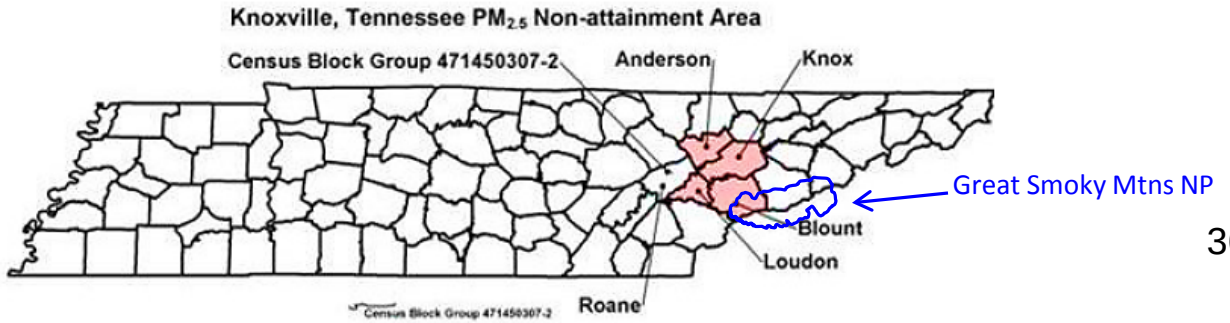
  15 µg/m^3 (1997)



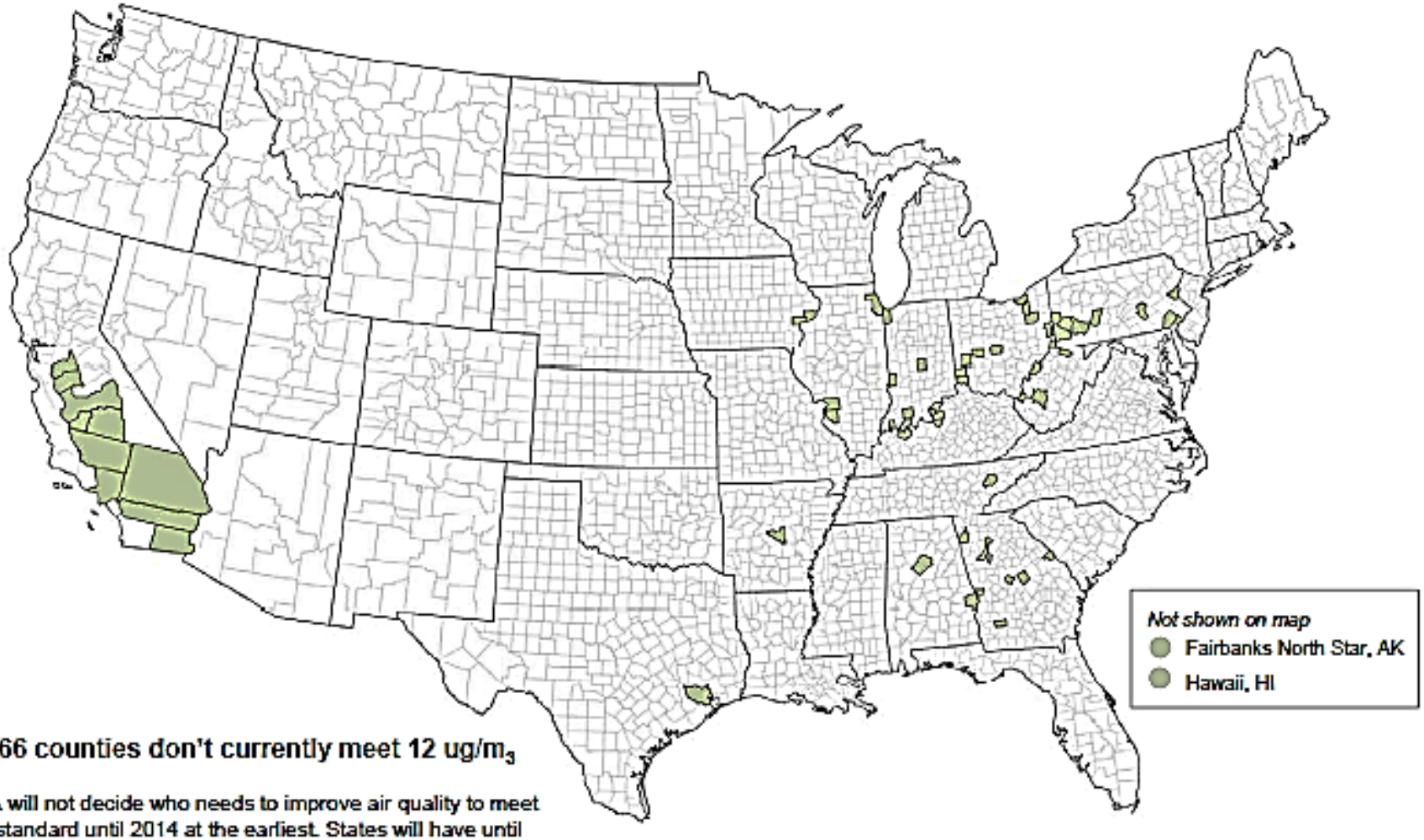
- Daily PM2.5 Standard

  35 µg/m^3 (was 65 µg/m^3 1997-2006)





Areas Violating the 2012 Annual PM2.5 Public Health Standard (Non-attainment Areas)



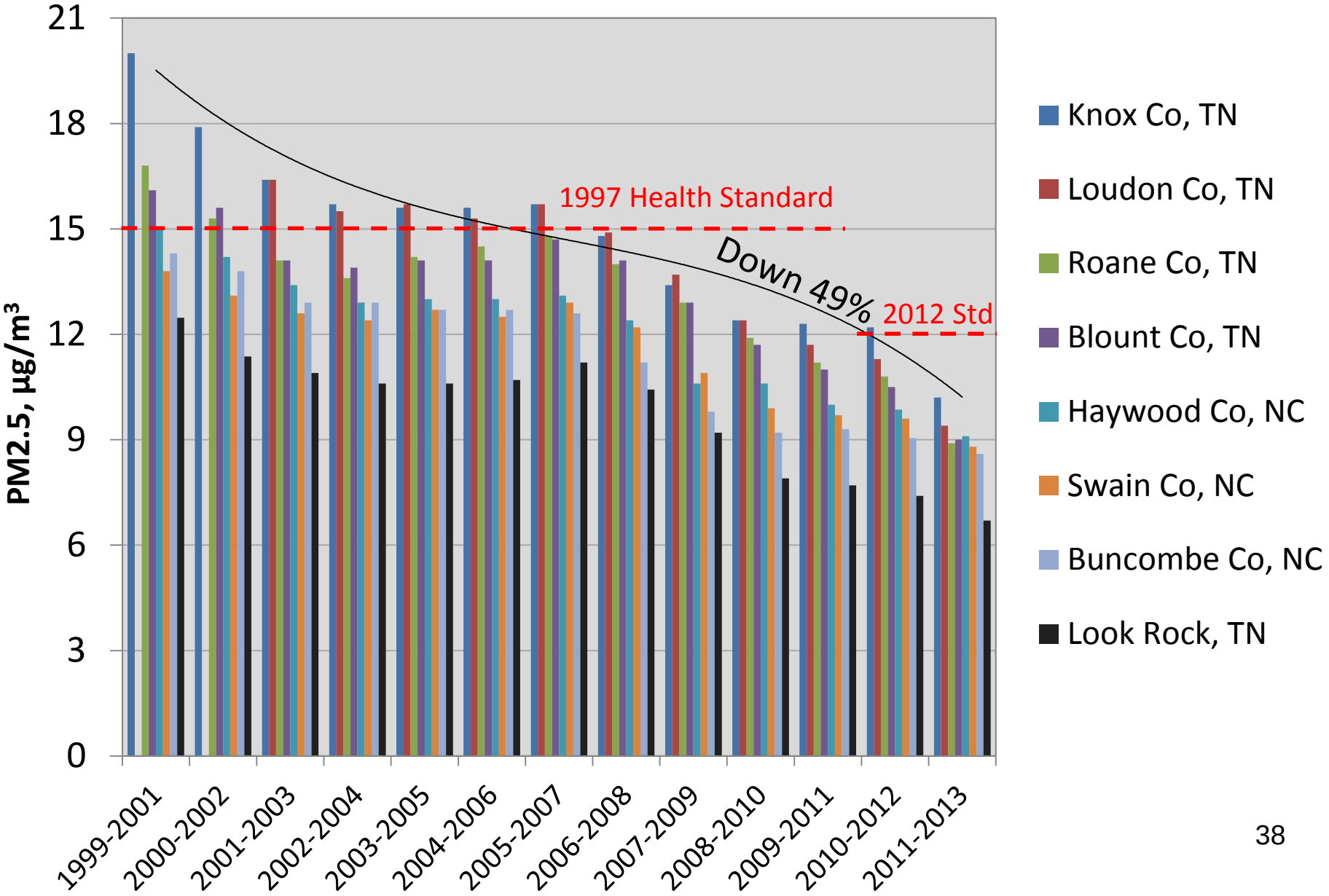
66 counties don't currently meet 12 ug/m_3

EPA will not decide who needs to improve air quality to meet the standard until 2014 at the earliest. States will have until 2020-2025 to meet the standard.

Source: 2009-2011 air quality data as of July 15, 2012
For more information: www.epa.gov/pm

Annual $PM_{2.5}$ Design Values in the GRSM Region

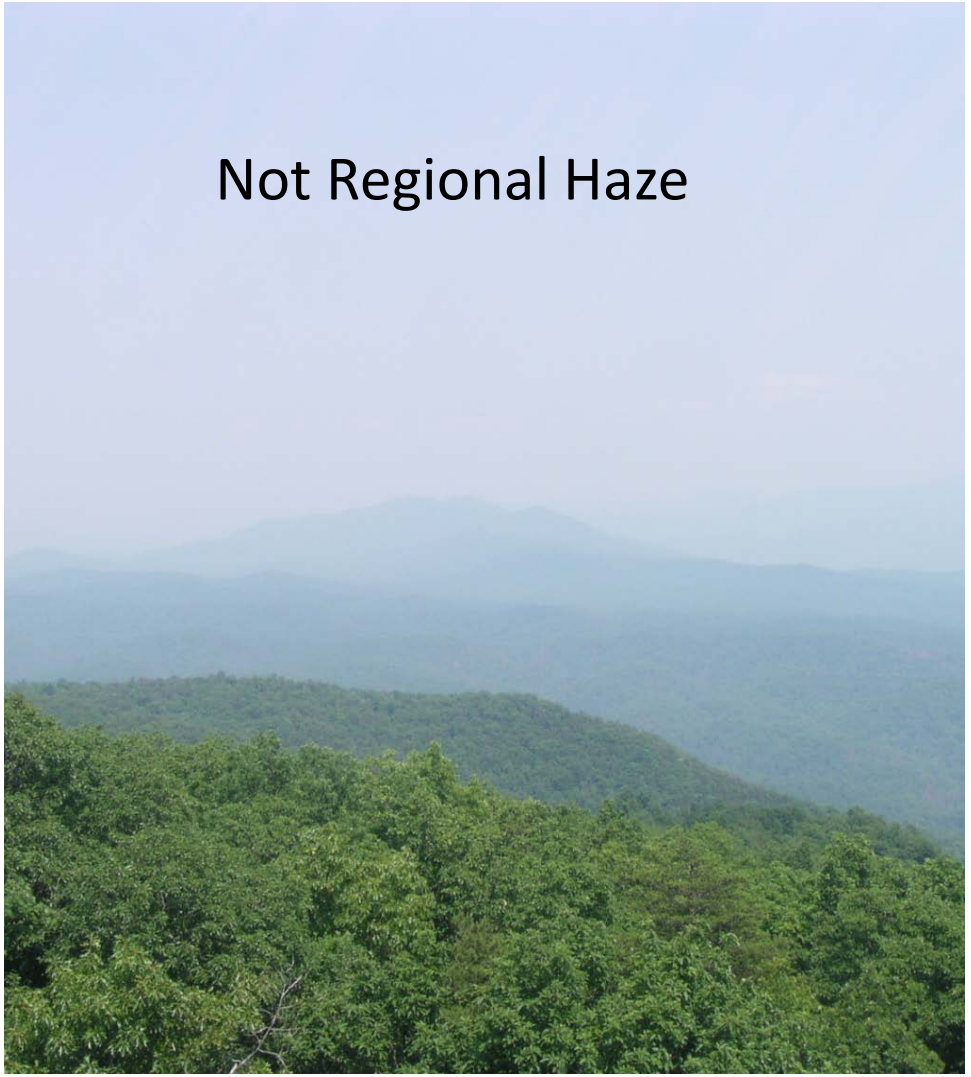
3-Year Rolling Annual Average $PM_{2.5}$ Concentrations



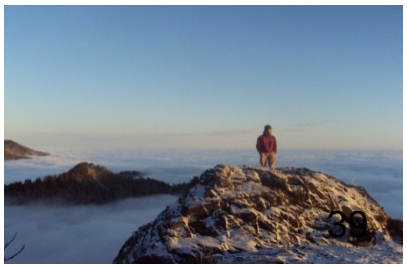
Visibility
Concerns with Regional Haze

"Shaconage"

Cherokee word for…"land of blue mist-like smoke",

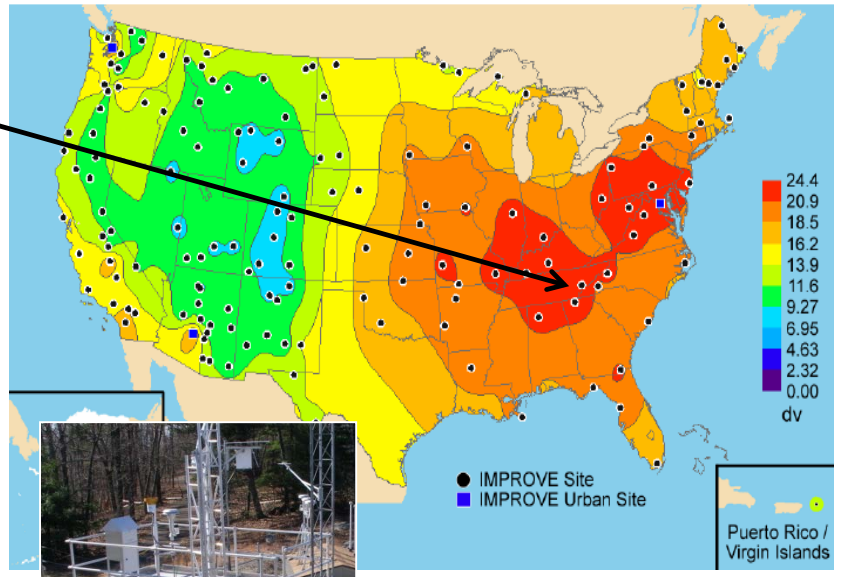


"Viewing Scenery" is the #1 reason ~10 million visitors come to the Park annually which generate nearly $2 billion in local revenues.



EPA Regional Haze Rule (1999)

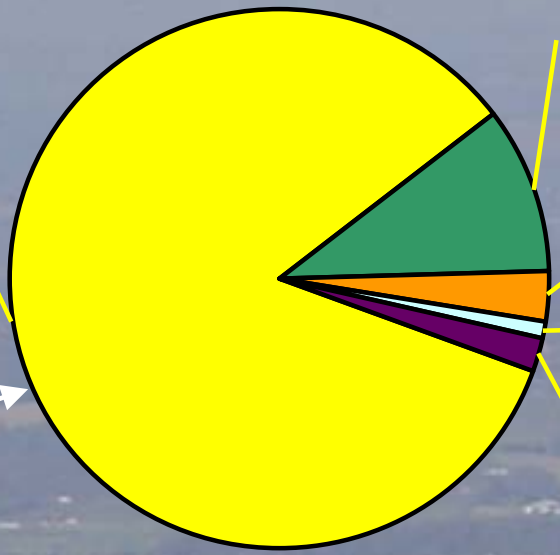
- Monitor Baseline Visibility at all 156 Class I Areas
  - 5-Yr Baseline 2000-2004
  - At Look Rock since 1980
- Goals of the Haze Rule
  - Restore the 20% haziest days
  - Protect 20% best/clearest days
  - Be at natural conditions by 2064



- State Implementation Plans (SIPs)
  Reasonable Progress & Retrofit Emission Controls
  - TN & NC have EPA-approved Haze SIPs (2008)
    - NPS reviewed Interim Progress SIPs (TN & NC 2013)

Particle Contributions to 20% Haziest Days

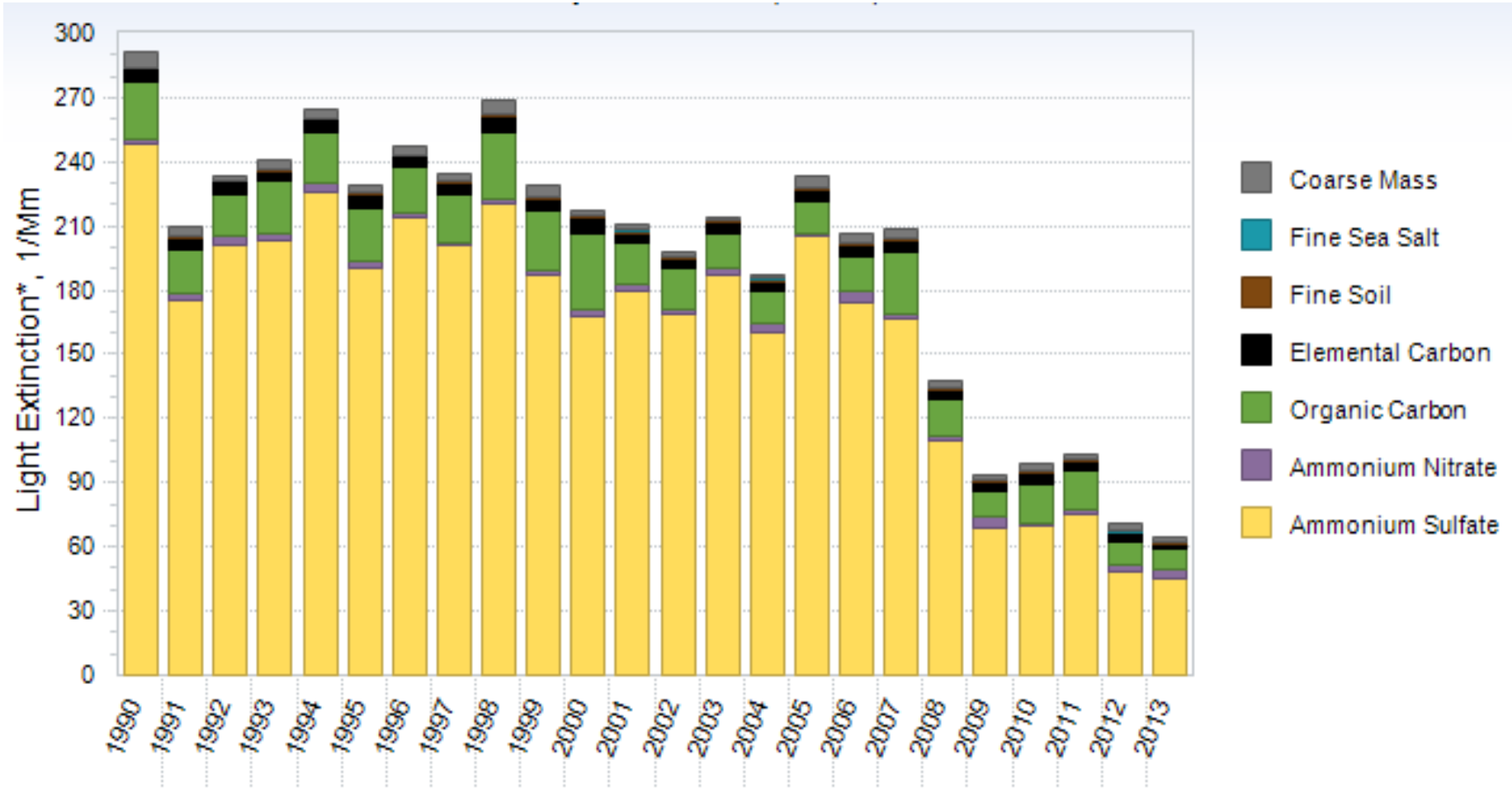
Mixture of particles collected on filter



Source: IMPROVE 2004-2008

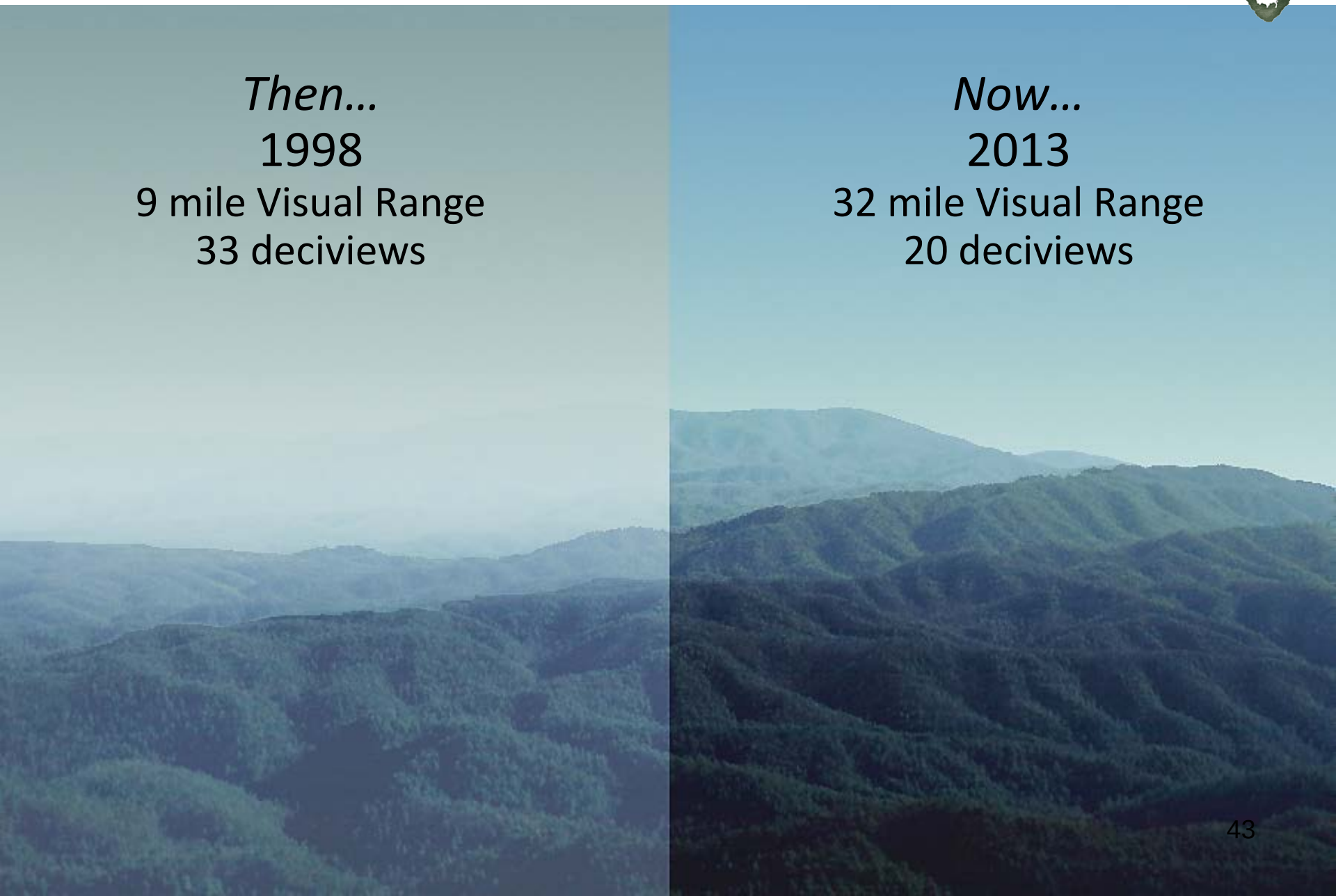
Light Extinction on the 20% Haziest Days by Year

Great Smoky Mountains National Park – Look Rock (Source IMPROVE)



*Light extinction: the loss in light intensity due to scattering and absorption measured in inverse megameters (Mm-1).

Monitor ID: GRSM1, TN

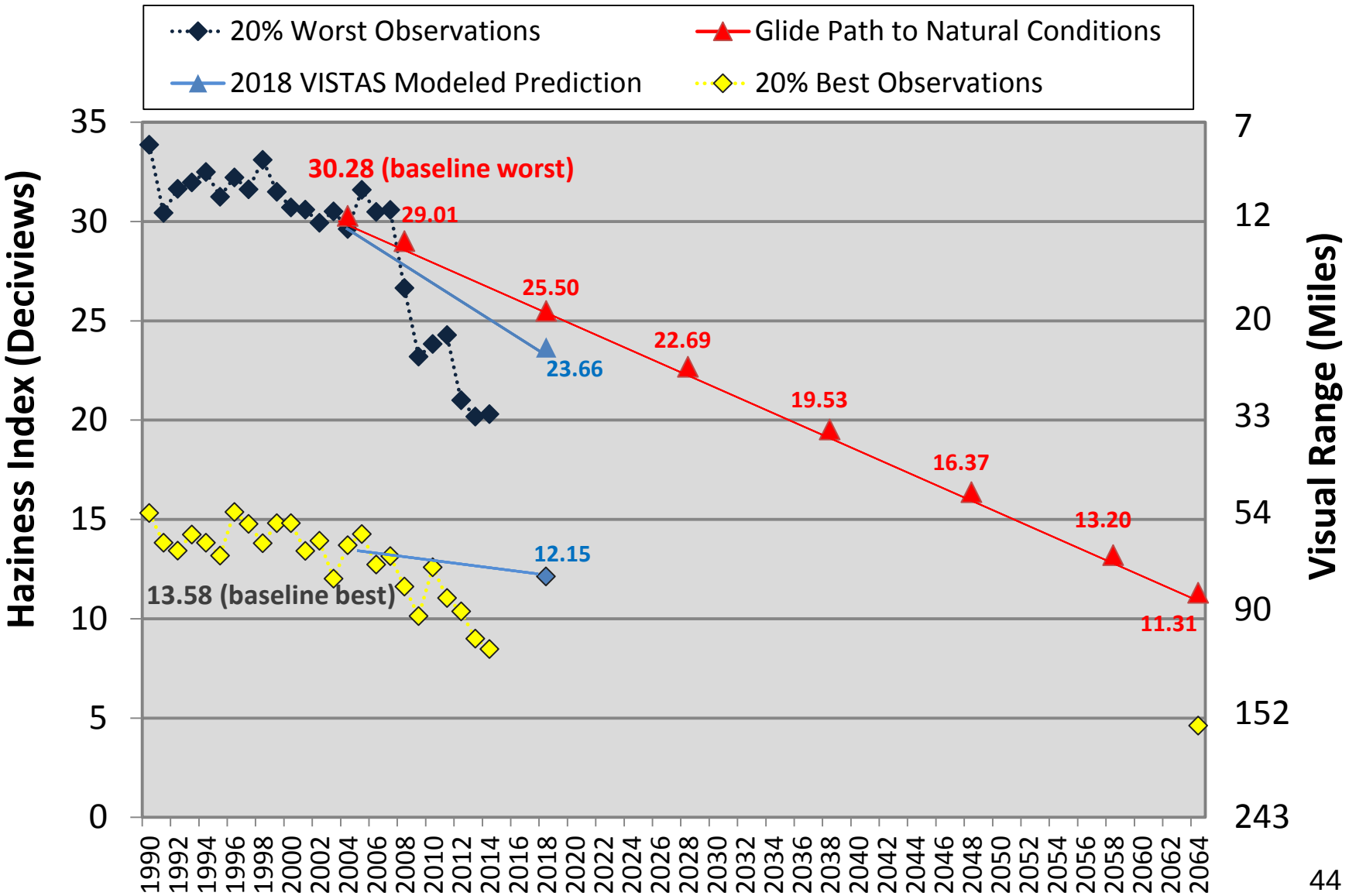


Then…
1998
9 mile Visual Range
33 deciviews

Now…
2013
32 mile Visual Range
20 deciviews

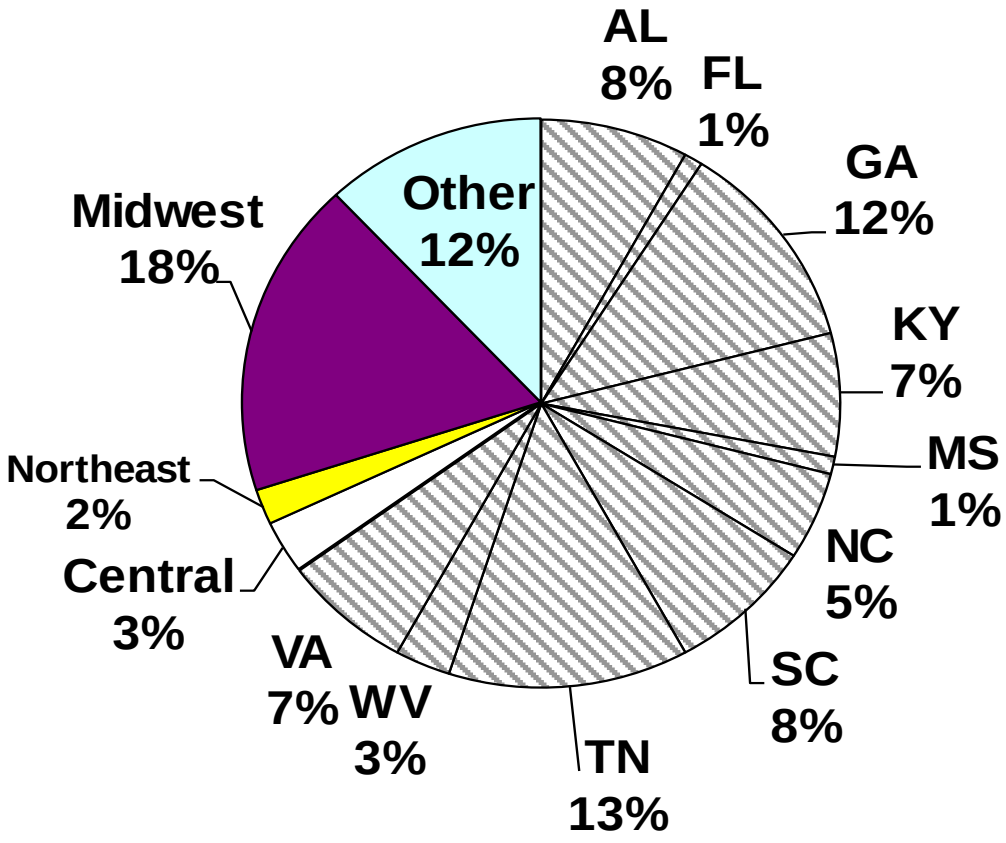
Glide Path to Natural Visibility Conditions

Great Smoky Mountains National Park - 20% Worst & Best Days



Where is the Sulfate Haze Coming From that is Measured at the Park?

65% of the sulfate comes from the Southeast U.S.

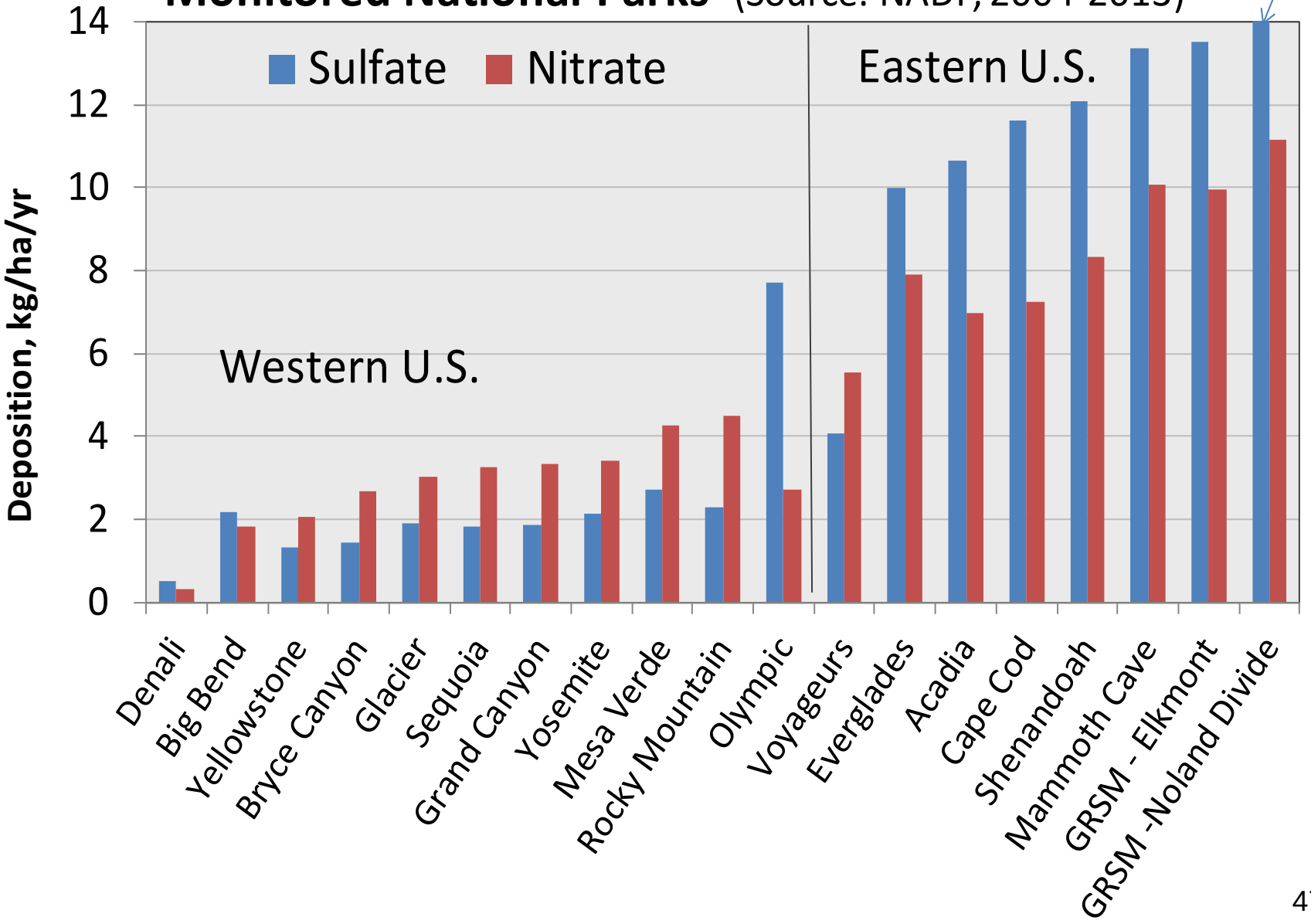


Source: VISTAS

Acid Deposition

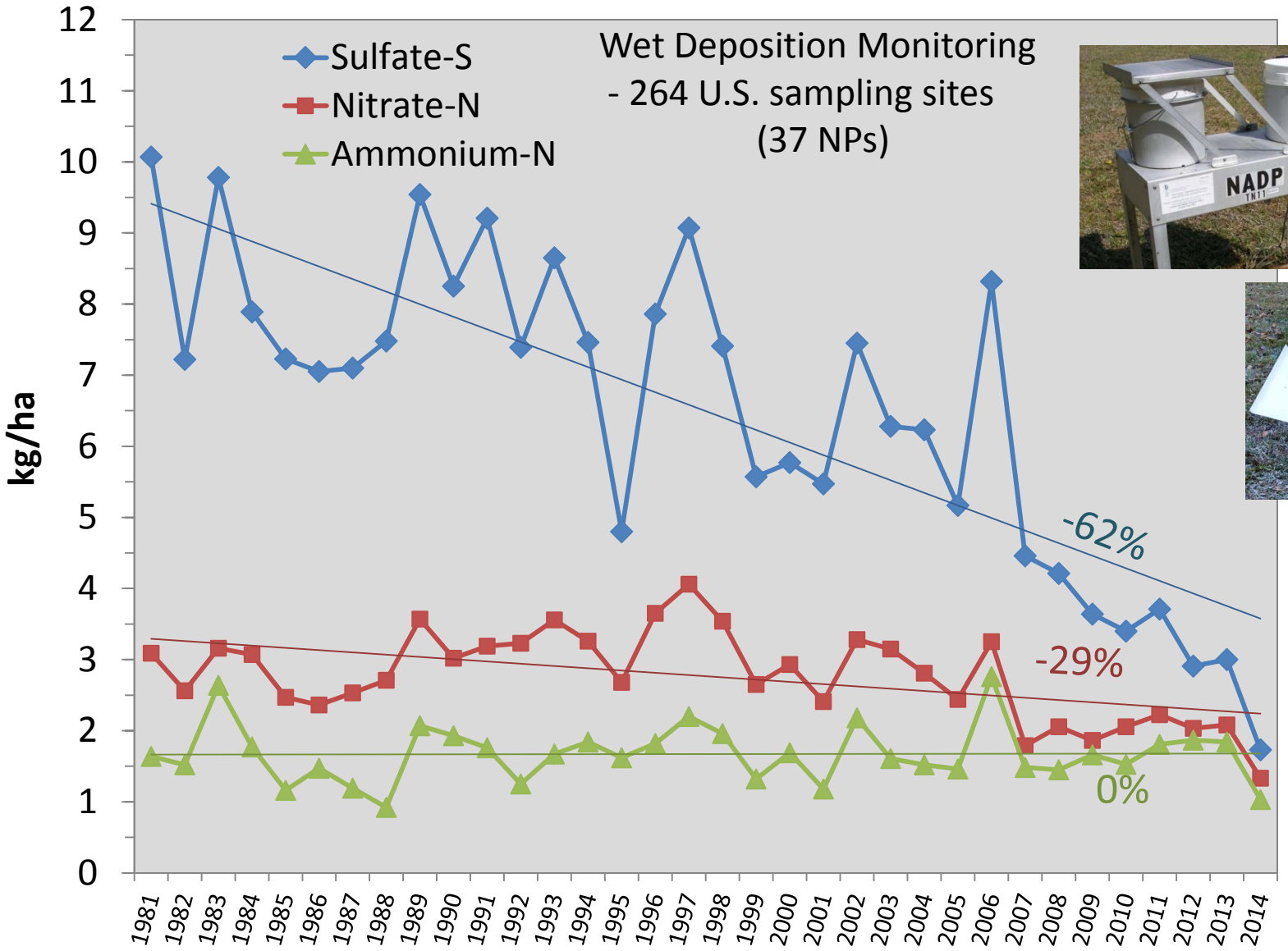
Effects to soil quality, water quality, aquatic organisms, forest health

Annual Sulfate & Nitrate Wet Deposition in Monitored National Parks (Source: NADP, 2004-2013)



Trends in Sulfate, Nitrate and Ammonium Deposition at

GRSM- Elkmont Source: (NADP-TN11)

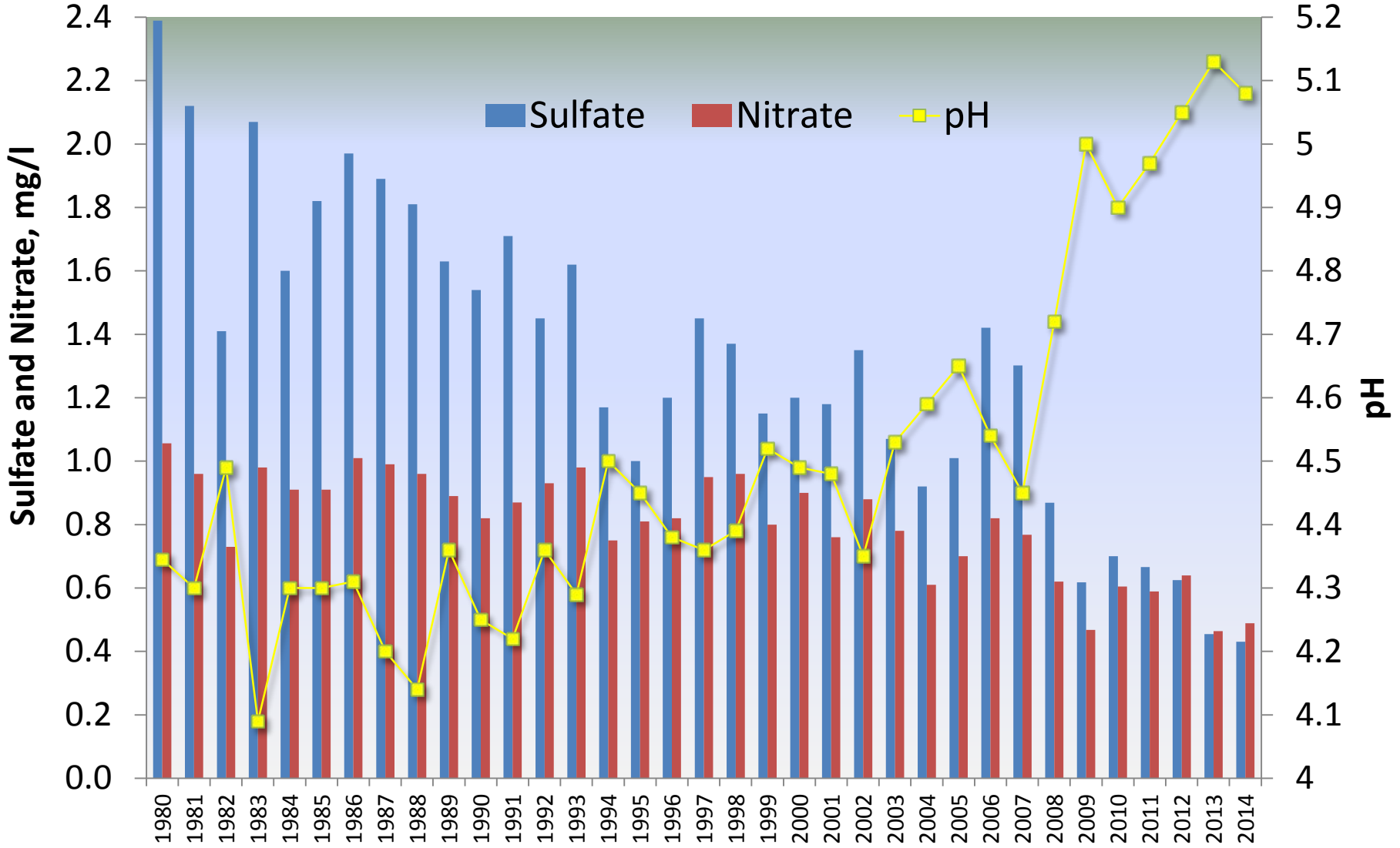


Aerochem Collector

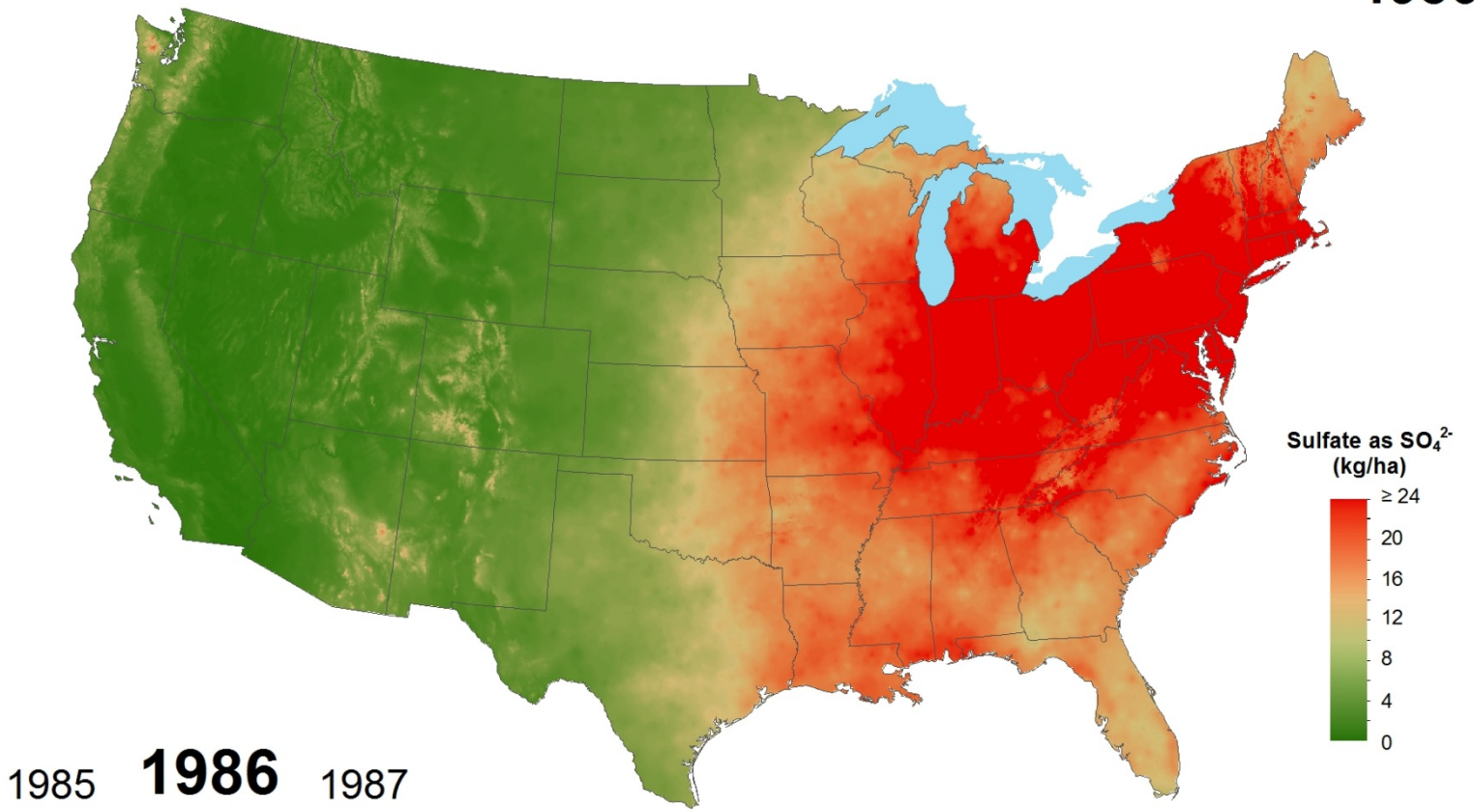
N-CON Collector

Annual Average pH and Precipitation-Weighted Mean Sulfate and Nitrate Concentrations at GRSM-Elkmont

(Source: NADP-TN11)



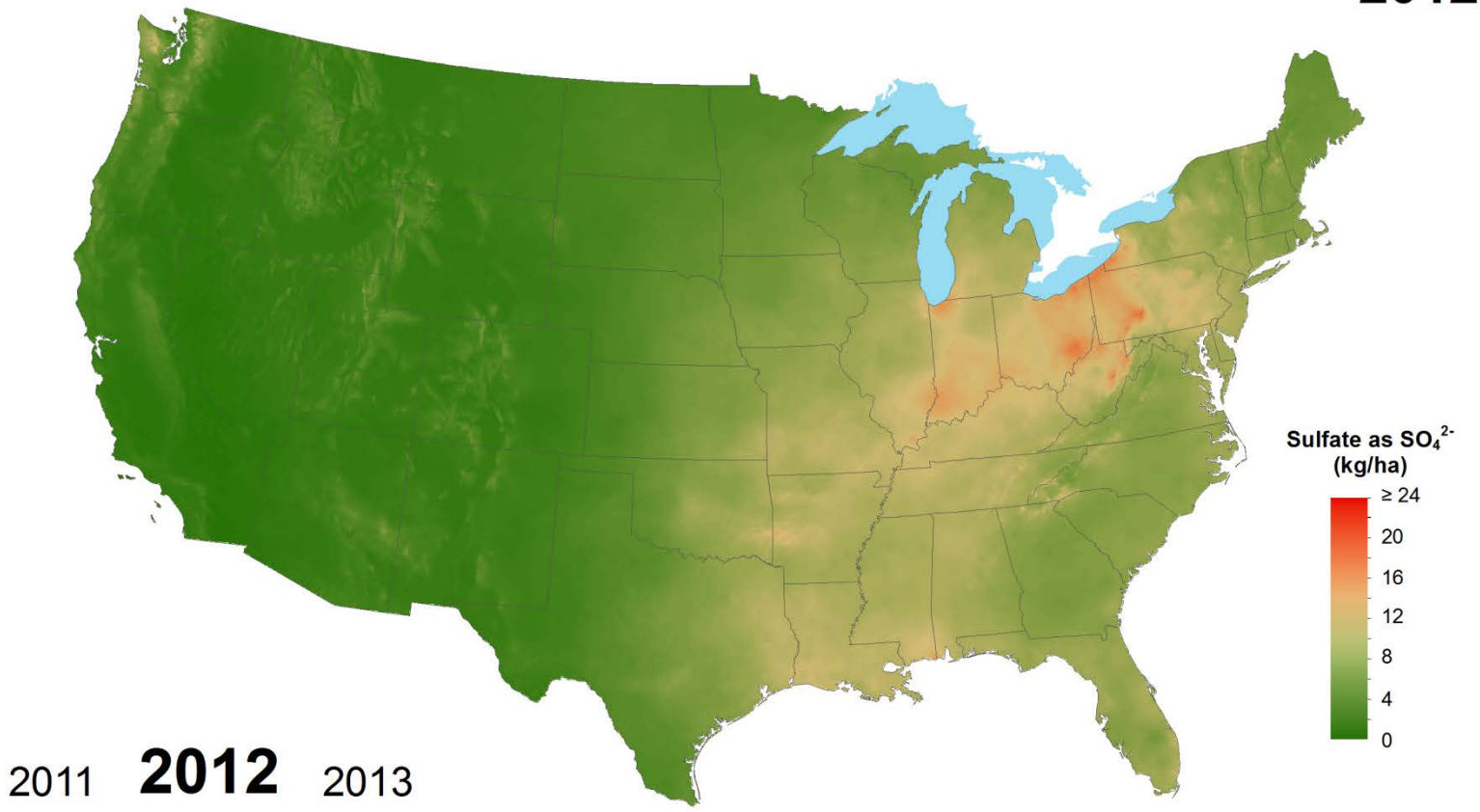
Sulfate ion wet deposition
1986



1985 **1986** 1987

National Atmospheric Deposition Program/National Trends Network
http://nadp.isws.illinois.edu

Sulfate ion wet deposition 2012



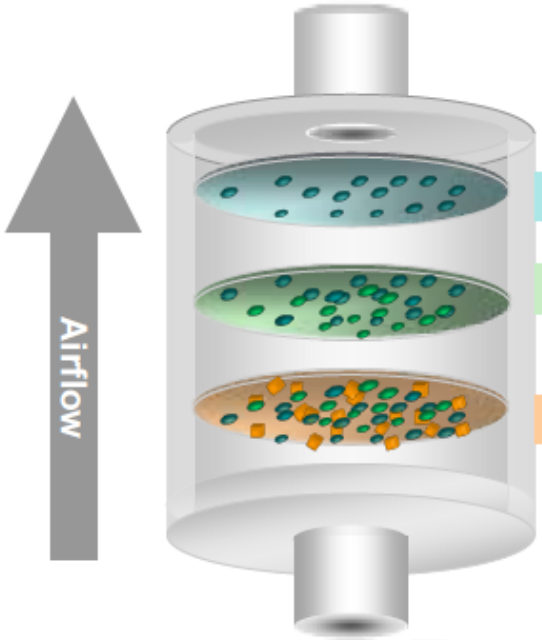
2011 **2012** 2013

National Atmospheric Deposition Program/National Trends Network
http://nadp.isws.illinois.edu

Dry Deposition Sampling (CASTNet)

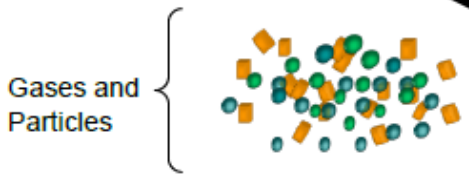
- 83 U.S. CASTNet monitoring sites (25 NPs)

Three air filters collect the pollutants over 1-week



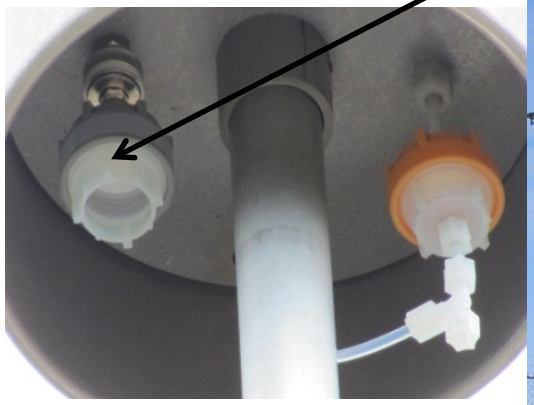
Gas and particle concentrations in air are measured by filter packs and then used to estimate daily dry deposition

Whatman	Gaseous • SO_2
Nylon	Gaseous • HNO_3 • SO_2
Teflon	Particulate • SO_4^{2-} • NO_3^- • NH_4^+ • Ca, Na, Mg • Cl



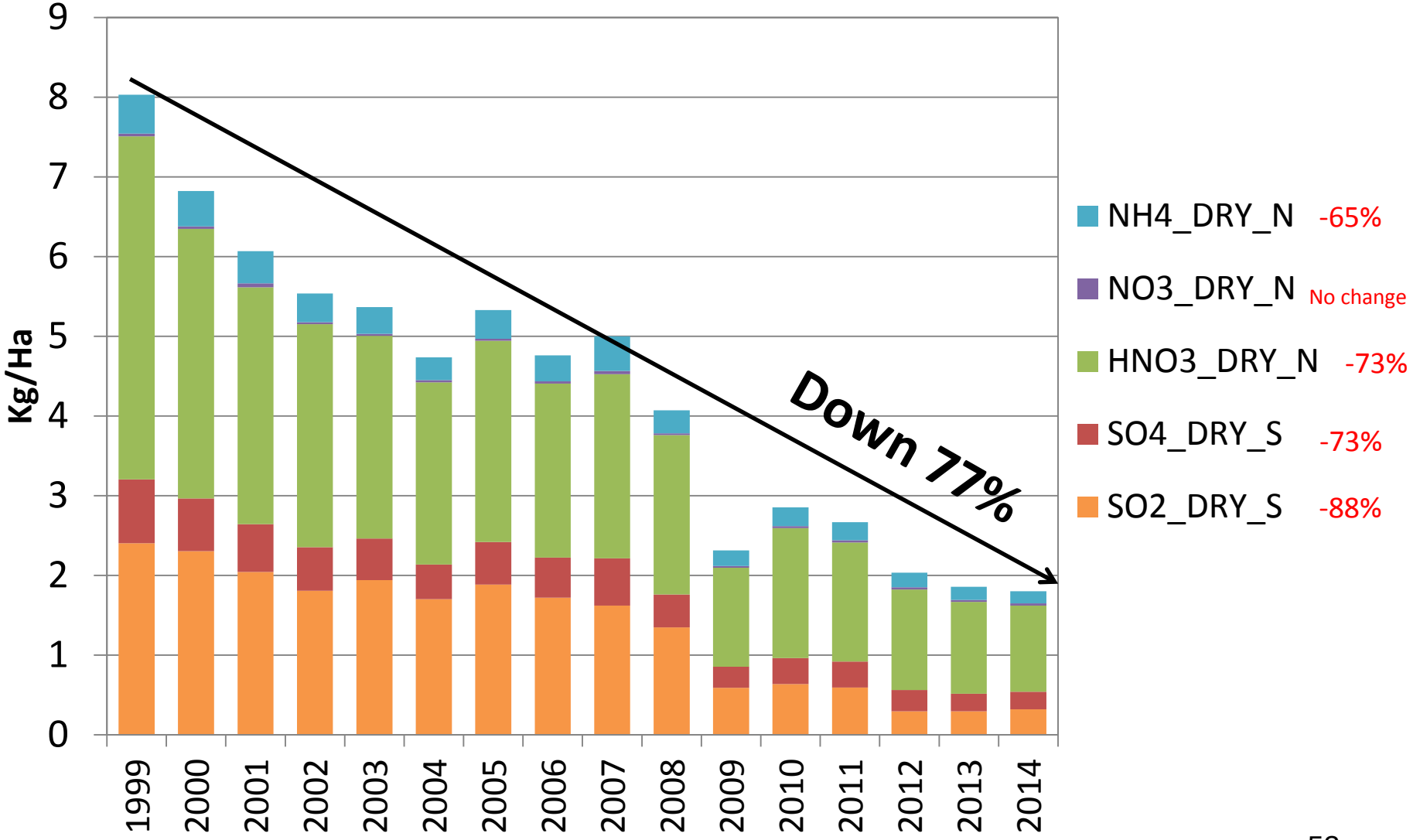
Filter packs are open-faced, with no size exclusion

- 20% of S and N deposition can be from coarse particles
- HNO_3 reacts with inlets



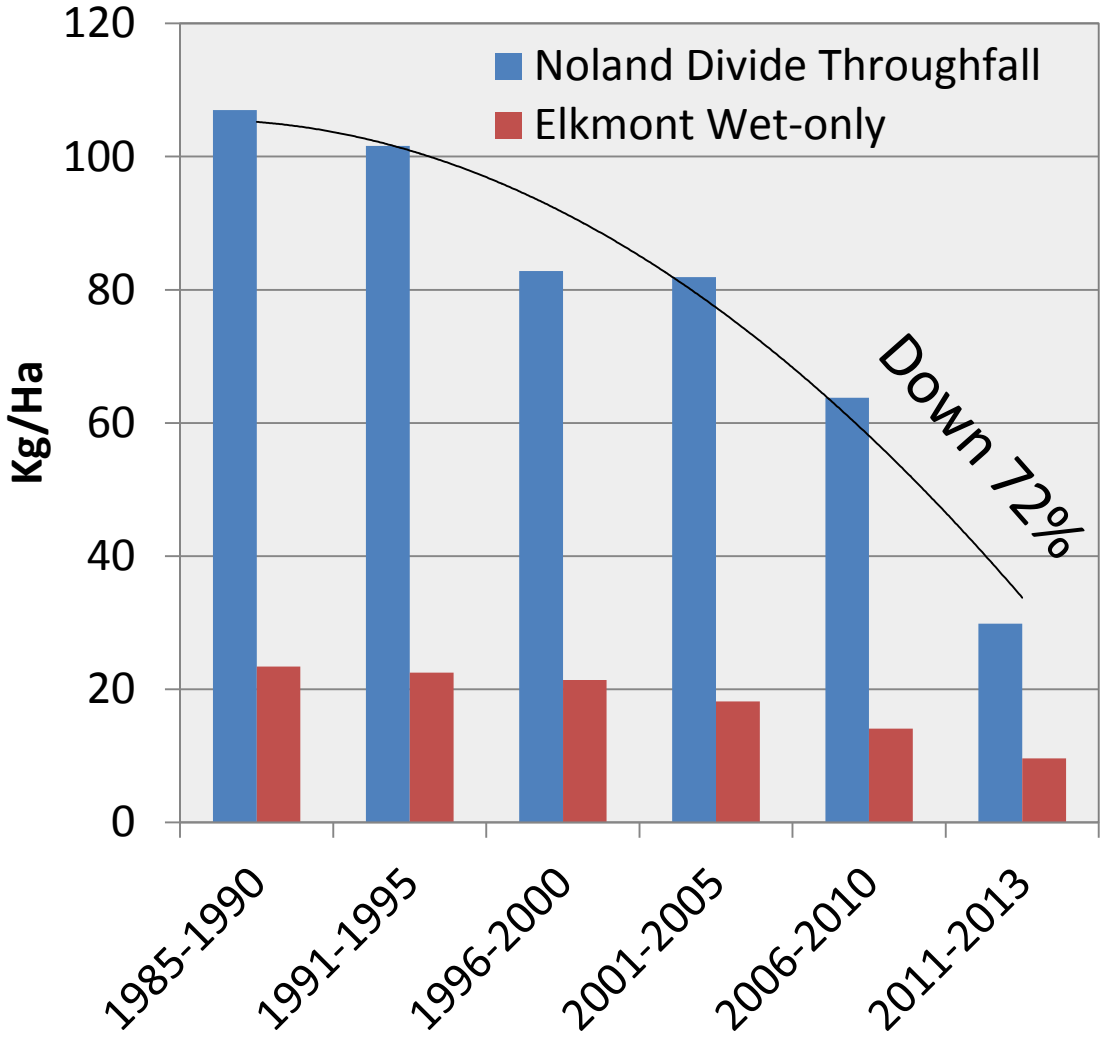
Annual Dry Deposition of Nitrogen and Sulfur

GRSM -Look Rock (Source: CASTNet)



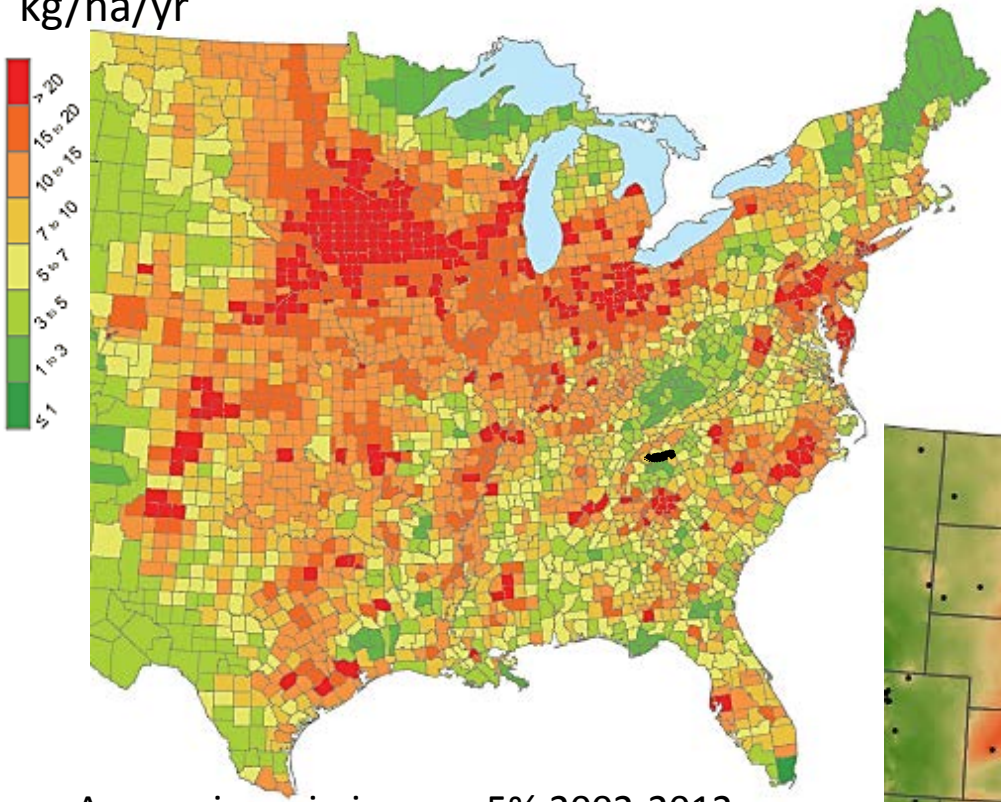
Trend in "Total" Sulfate Deposition

(via "Throughfall collector")

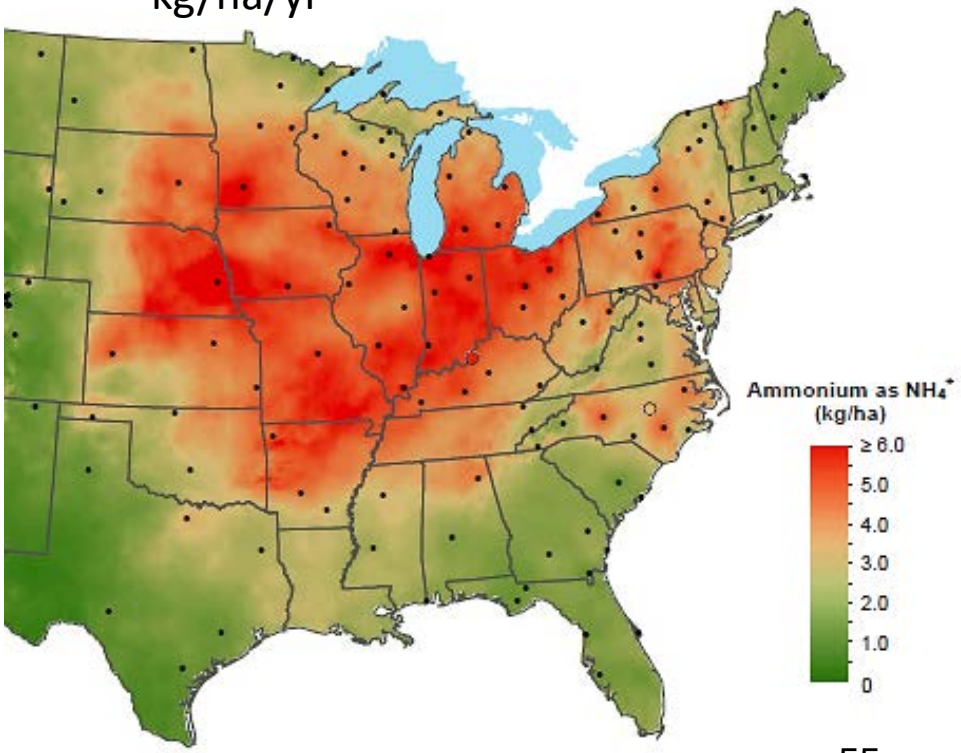


Annual Ammonia (NH3) Emissions and Ammonium (NH4) Deposition

Ammonia Air Emissions
kg/ha/yr



Ammonium Wet Deposition
kg/ha/yr



- Ammonia emissions up 5% 2002-2012
- Emitted primarily from agriculture (volatilization of manure/urine from cattle, swine, poultry operations and fertilizer app).
- Contributes to N deposition, acidification of soils/streams, particle formation, and haze.
- Not directly regulated, expected to increase.
- Park is part of the National Ammonia Monitoring Network (NADP-AMoN)

Source: NADP

Ammonia (NH_3) Concentrations at Look Rock

Ammonia Monitoring Network (AMoN) - Look Rock TN01 (Bi-weekly avg, 2011-2014)

Radiello Diffusion-Type Passive Sampler Phosphoric acid impregnated cartridge, then removed w/ DI H2O

2011 2012 2013 2014

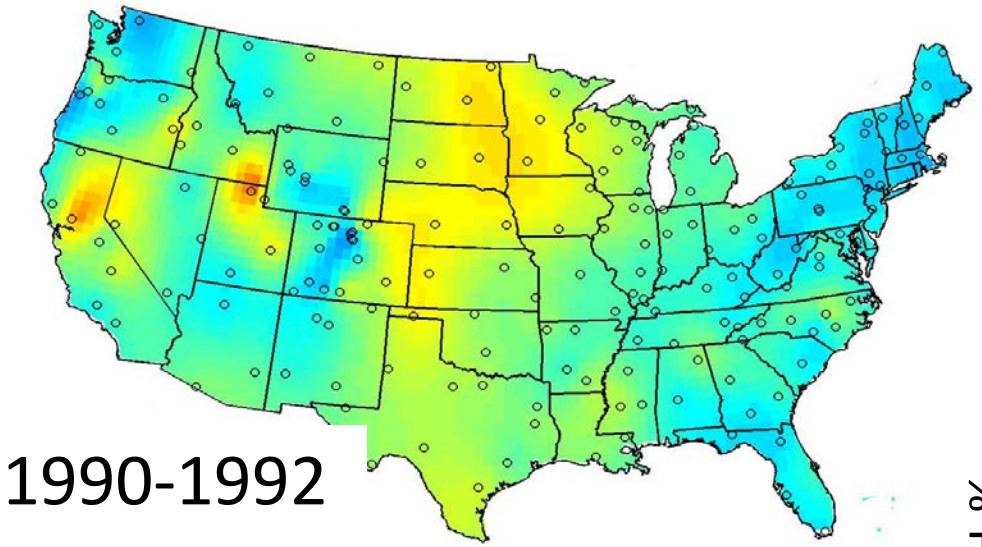
Up 33%

NH_3, µg/m3

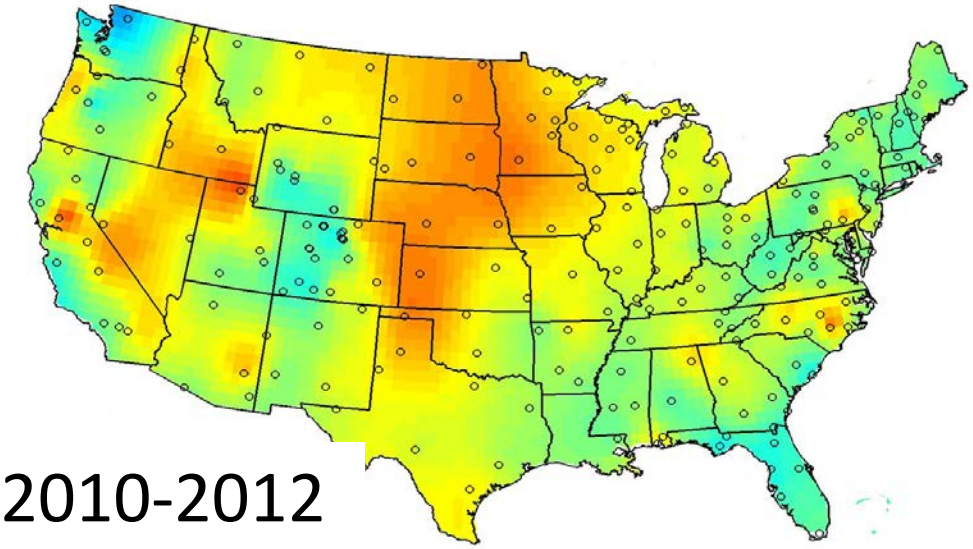
1.2
1.0
0.8
0.6
0.4
0.2
0.0

4/26 - 5/10
6/21 - 7/5
8/16 - 8/30
10/11-10/25
12/6-12/20
1/31-2/14
3/27-4/10
5/22-6/5
7/17-7/31
9/11-9/25
11/6-11/20
12/31-01/08
2/26-3/12
4/23-5/7
6/18-7/2
8/13-8/27
10/22-11/5
12/17-12/31
2/11-2/25
4/8-4/22
6/3-6/17
7/29-8/14
9/23-10/7
11/18-12/2
1/13-1/27

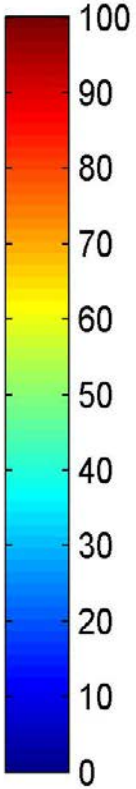
20-Year Change in the Average NH_4^+ fraction of Wet Inorganic Nitrogen Deposition at NADP Sites

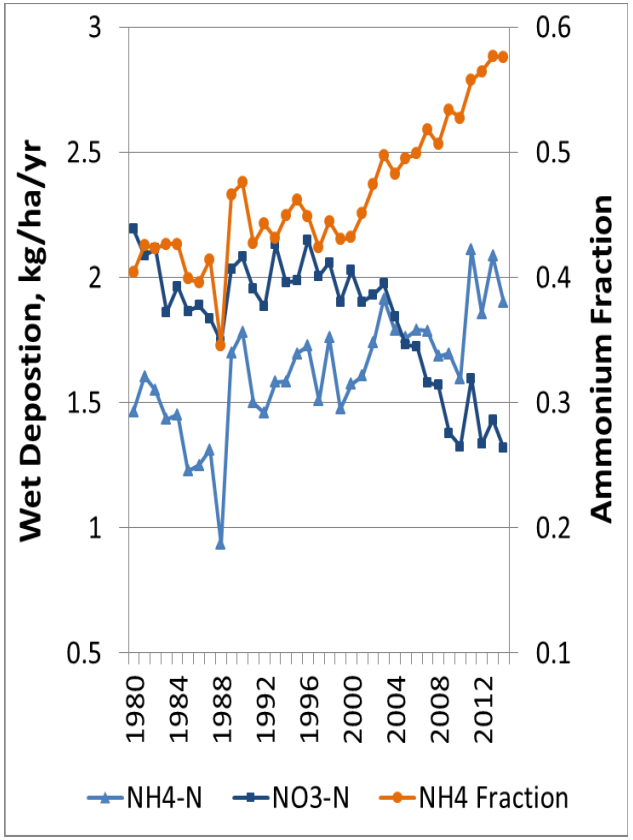


1990-1992



2010-2012



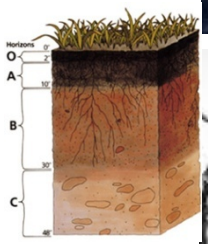


Too Much Nitrogen Leads to Nitrogen Saturation Effects

"Overloaded with too much of a good thing"

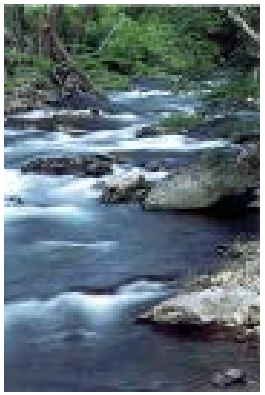
Terrestrial Effects:

- Alters soil chemistry and fertility;
- Depletes soil nutrients (soil calcium loss into streams);
- Soil aluminum toxicity in soils (Al:BC/Ca ratios);
- Forest health concerns (growth and composition).

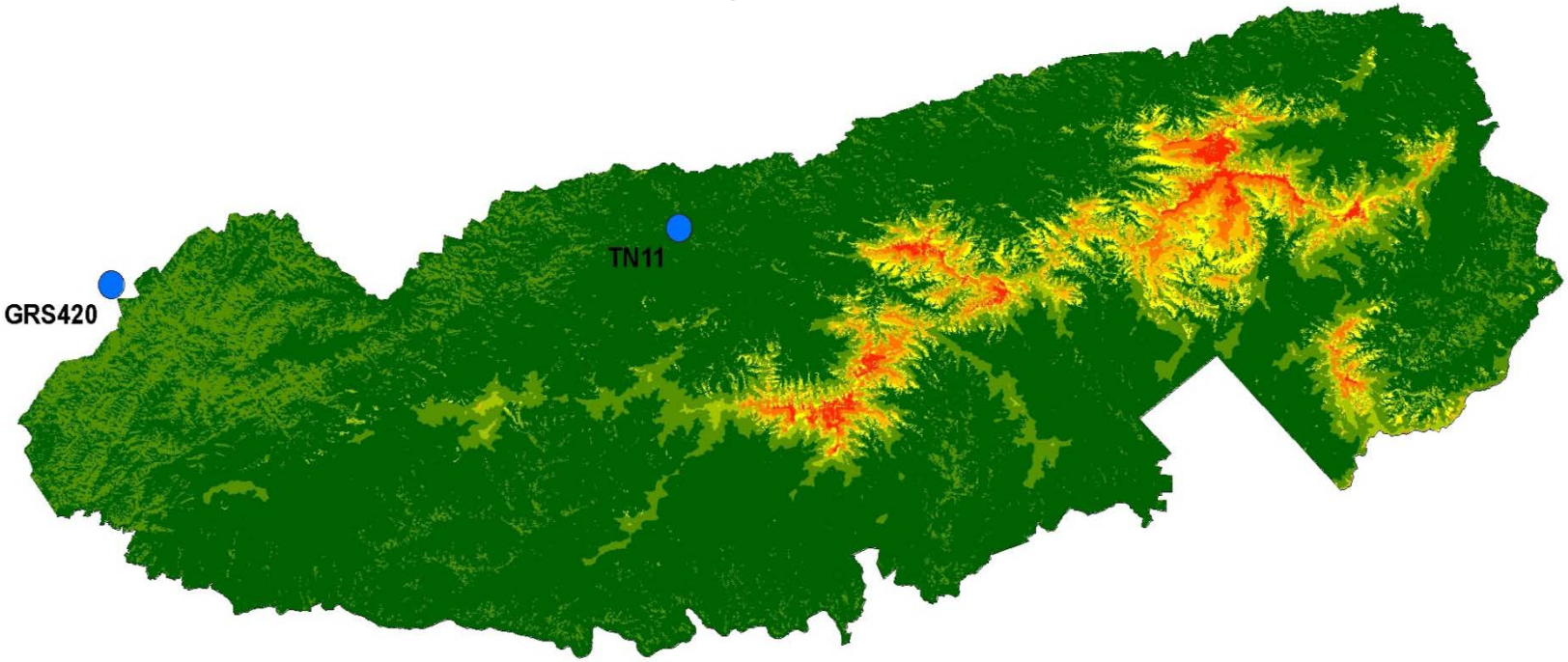


Aquatic Effects:

- Excess nitrate "leaks" into streams;
- Lowers stream acid "buffering" capacity (ANC) and pH;
- Leads to chronic and episodic acidification;
- Release of toxic aluminum into surface waters;
- Loss of aquatic diversity & trout range and survival;
- Violation of Clean Water Act, 303(d) impairment, TMDL



Total SO_4^{2-}, NO_3^- and NH_4^+ deposition in 2011 at GRSM (calculated by Weathers et al 2006)



Total SO4 deposition in 2011
(kg S/ ha/ yr)

- 5.8 - 6.8
- 6.9 - 8.3
- 8.4 - 9.9
- 10 - 12
- 13 - 14
- 15 - 16
- 17 - 21

Total NO3 deposition in 2011
(kg N/ ha/ yr)

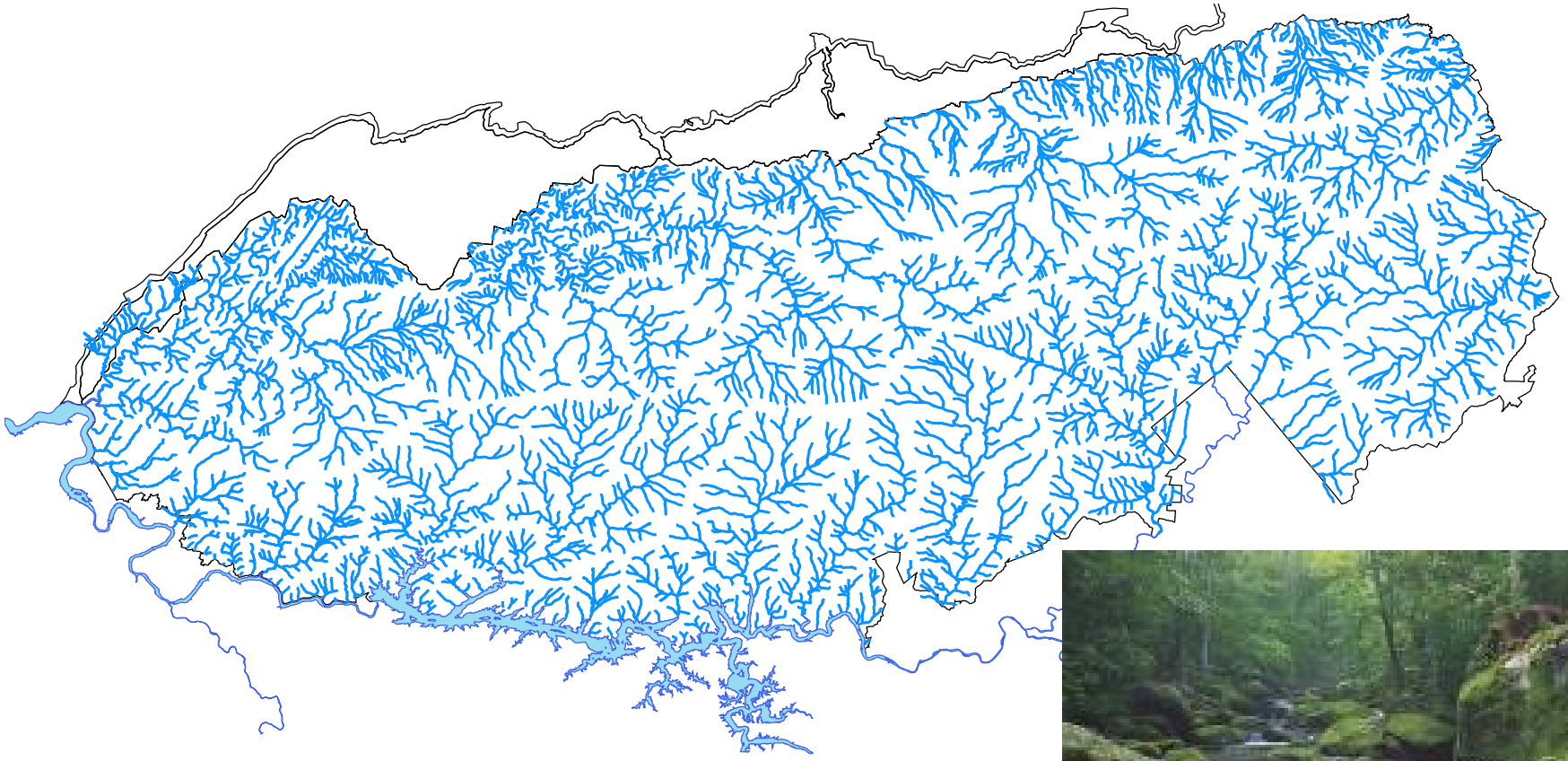
- 4.7 - 5.5
- 5.6 - 6.7
- 6.8 - 8
- 8.1 - 9.5
- 9.6 - 11
- 12 - 13
- 14 - 17

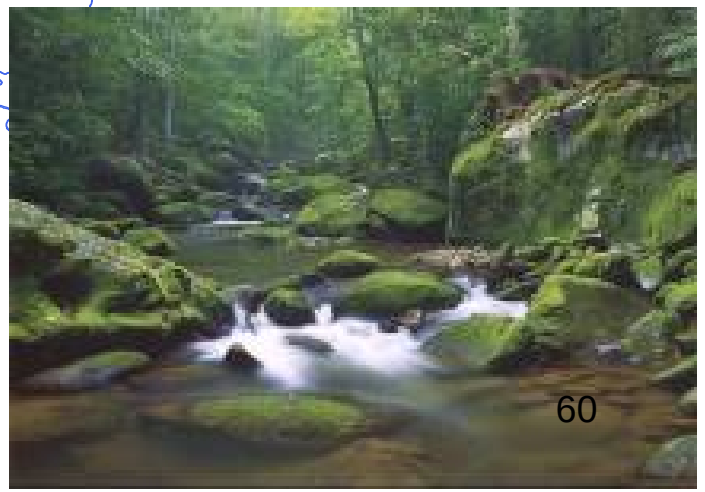
Total NH4 deposition in 2011
(kg N/ ha/ yr)

- 3 - 3.6
- 3.7 - 4.4
- 4.5 - 5.2
- 5.3 - 6.2
- 6.3 - 7.1
- 7.2 - 8.3
- 8.4 - 11

GRSM Water Resources

- 2,116 miles of streams, 1st-6th order, 5 Outstanding National Resource Waters ONRWs, and 100's of wetlands and springs



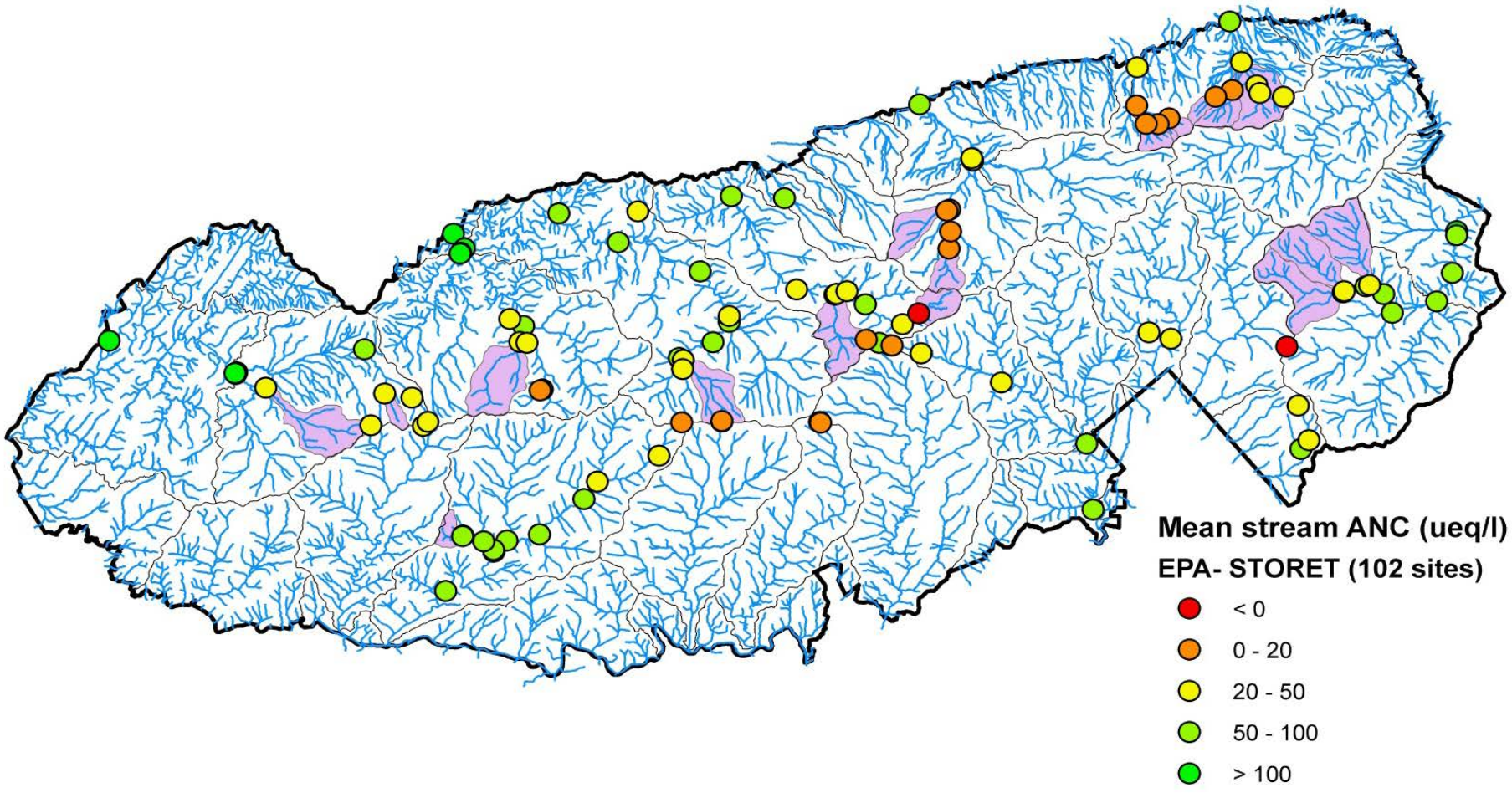


Stream ANC Toxicity Thresholds for Brook Trout

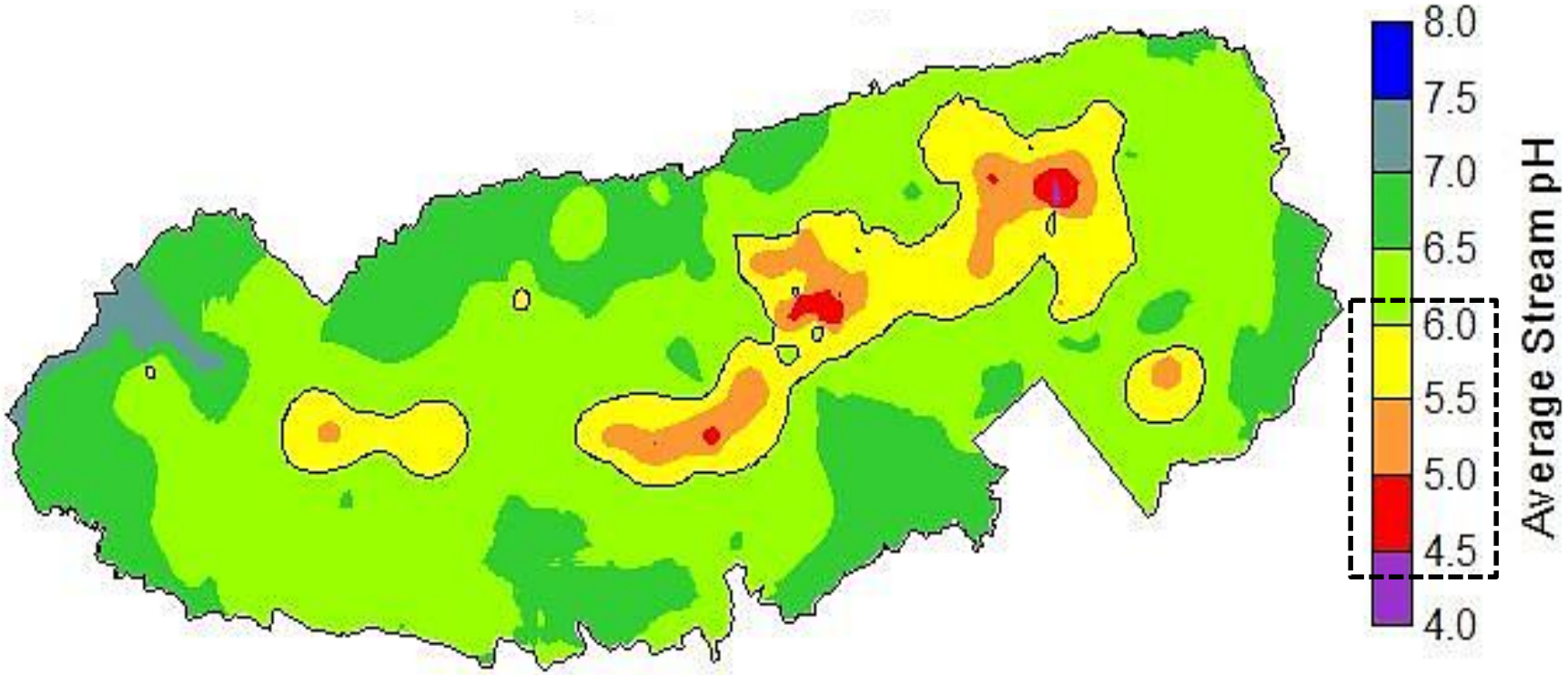
Brook Trout Category	ANC Class	ANC Range (ueq/L)	Brook Trout Response
Suitable	Adequate buffering	> 50	Reproducing brook trout populations expected where the habitat is suitable
Indeterminate	Potentially sensitive	20-50	Extremely sensitive to acidification; brook trout response variable
Marginal	Episodically acidic	0-20	Sub-lethal and/or lethal effects on brook trout possible
Unsuitable	Chronically acidic	< 0	Lethal effects on brook trout probable

ANC = acid neutralizing capacity

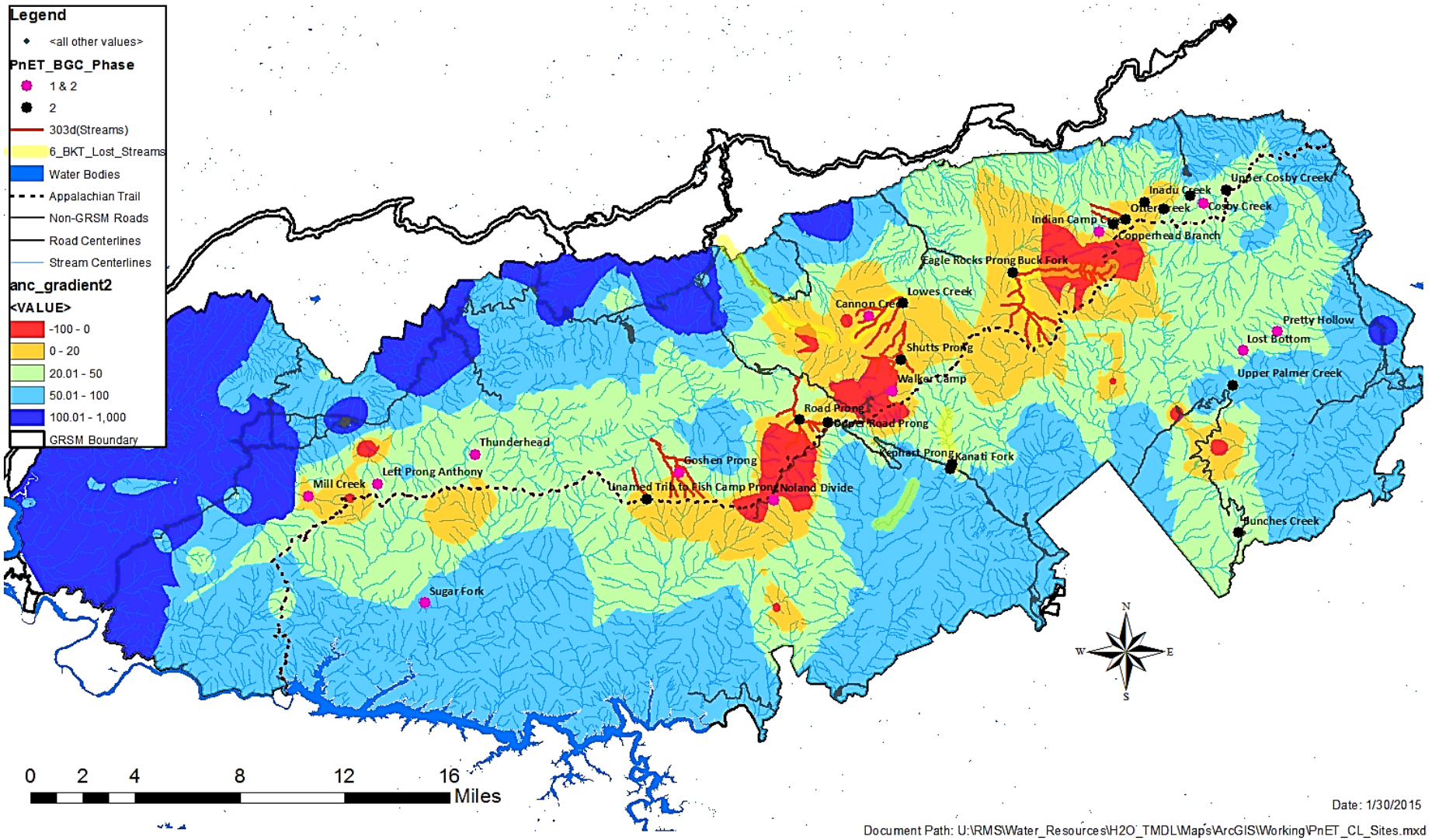
Mean Acid Neutralizing Capacity (ANC) for Measured Streams in GRSM (1991-2013)



Average Stream pH



Map Created by: Terry Flum February 11, 1997



Date: 1/30/2015

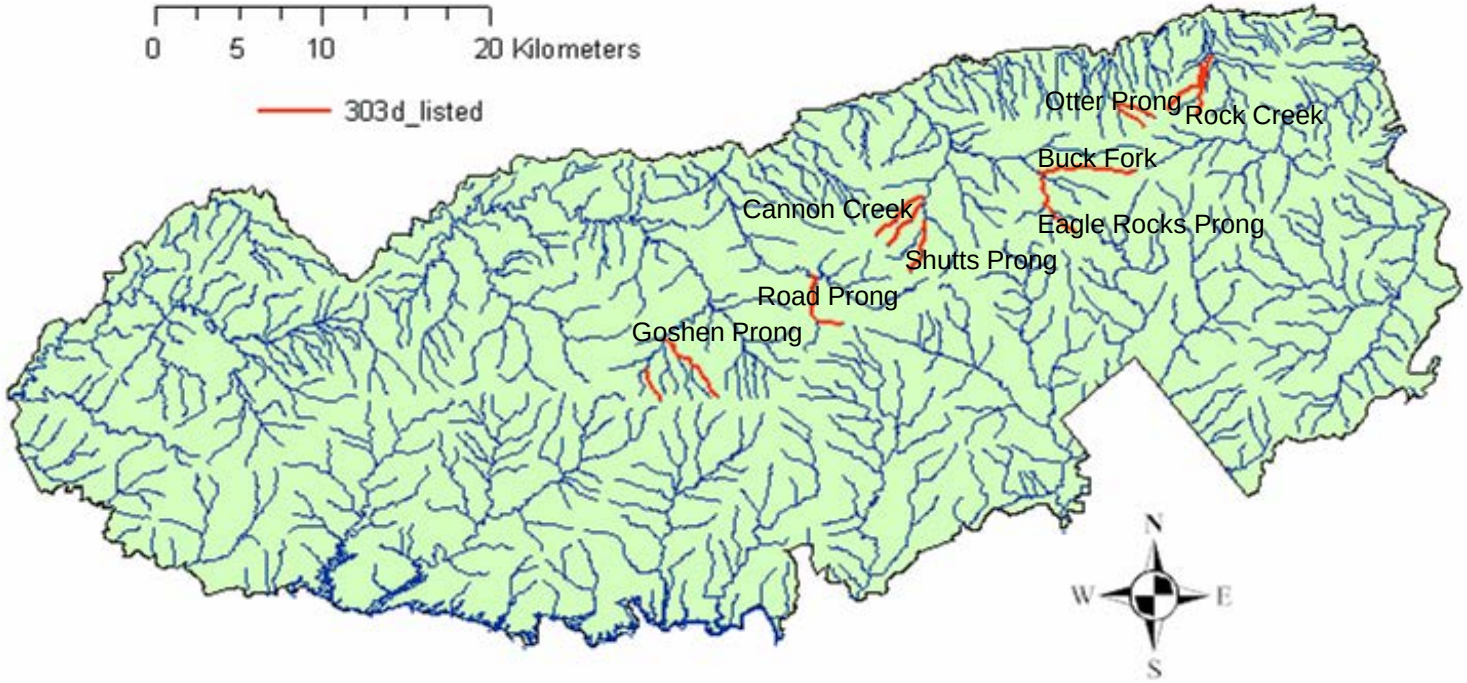
Document Path: U:\RMS\Water_Resources\H2O_TMDL\Maps\ArcGIS\Working\PnET_CL_Sites.mxd

Clean Water Act - 303(d) Stream Impairment from Low pH due to Acid Deposition

In 2006, TDEC listed 12 Park streams in TN (67km) on EPA's 303d list due to low stream pH (<6.0) from acid deposition.

In 2010, Total maximum daily loads (TMDLs) for pH/ANC were established by TDEC. (TMDL is the total amount of a pollutant that can be assimilated by a receiving water body while achieving water quality standards). Clean Water Act is weak to address non-point sources of pollution causing the violation.

Critical loads for acid deposition for park streams are being developed by Syracuse Univ, EPA, and NPS. Critical load is the level of deposition above which resource impairment or harmful effects occur.

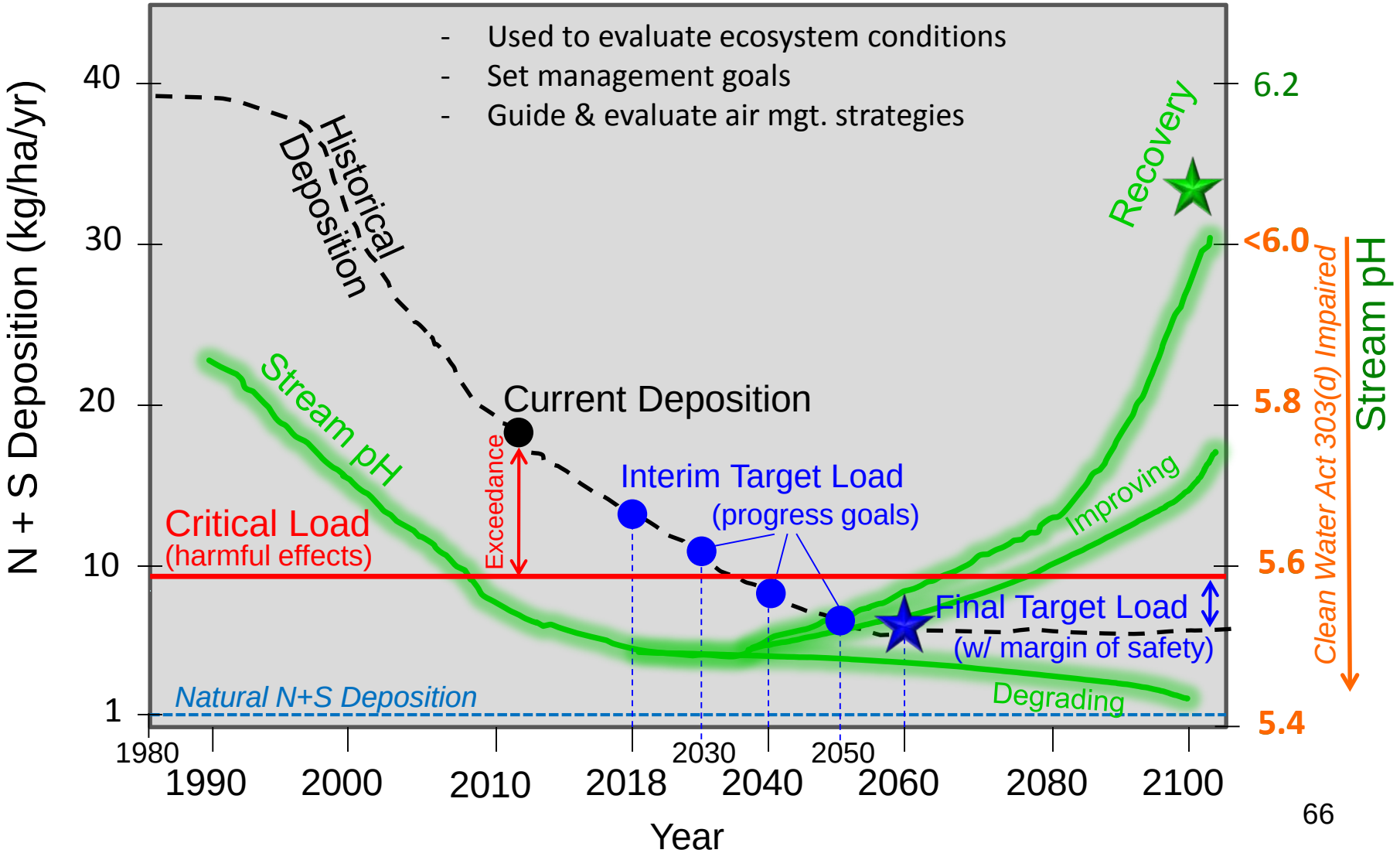


Next Steps: Complete critical load modeling with Syracuse Univ. and EPA and share information with key stakeholders (EPA, States, policy-makers, enviro. groups.)

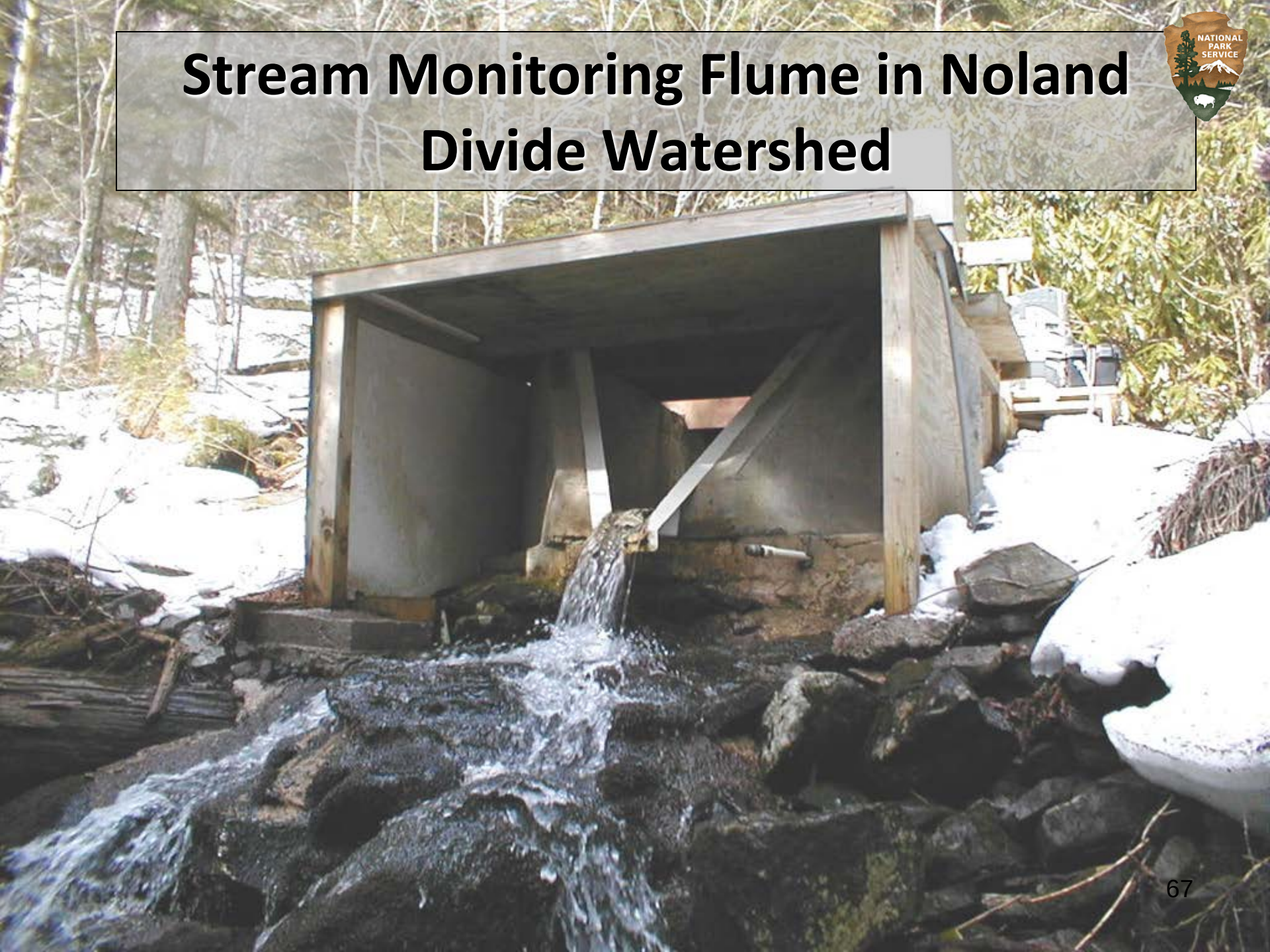
Conceptual Example of Critical Load and Target Loads for Acid Deposition to Protect Stream pH at Great Smoky Mountains NP

Critical Load: Level of deposition above which resource impairment or harmful effects occur.

Target Load(s): Policy-based acceptable intermittent level of deposition along path to final deposition goal.

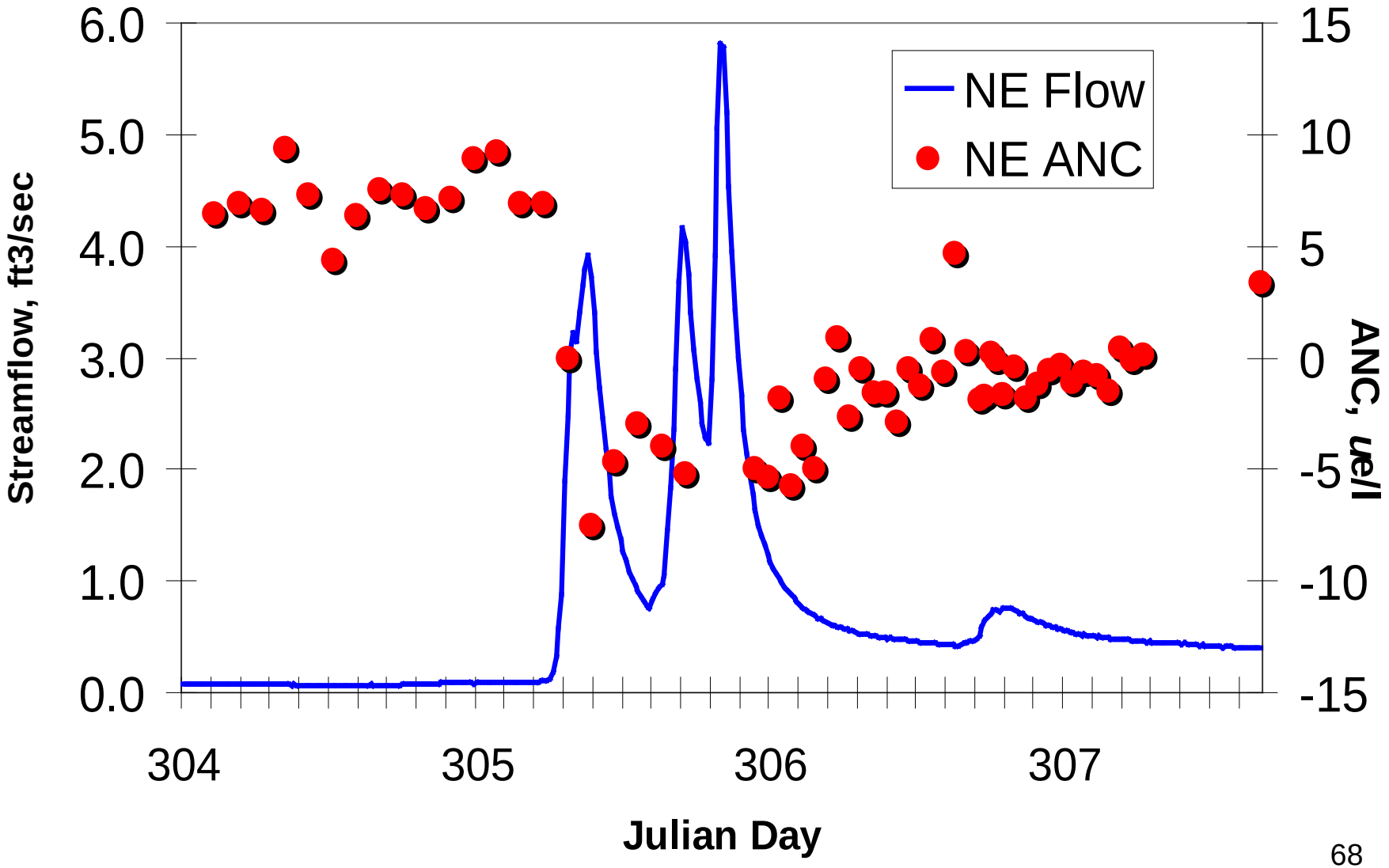


Stream Monitoring Flume in Noland Divide Watershed

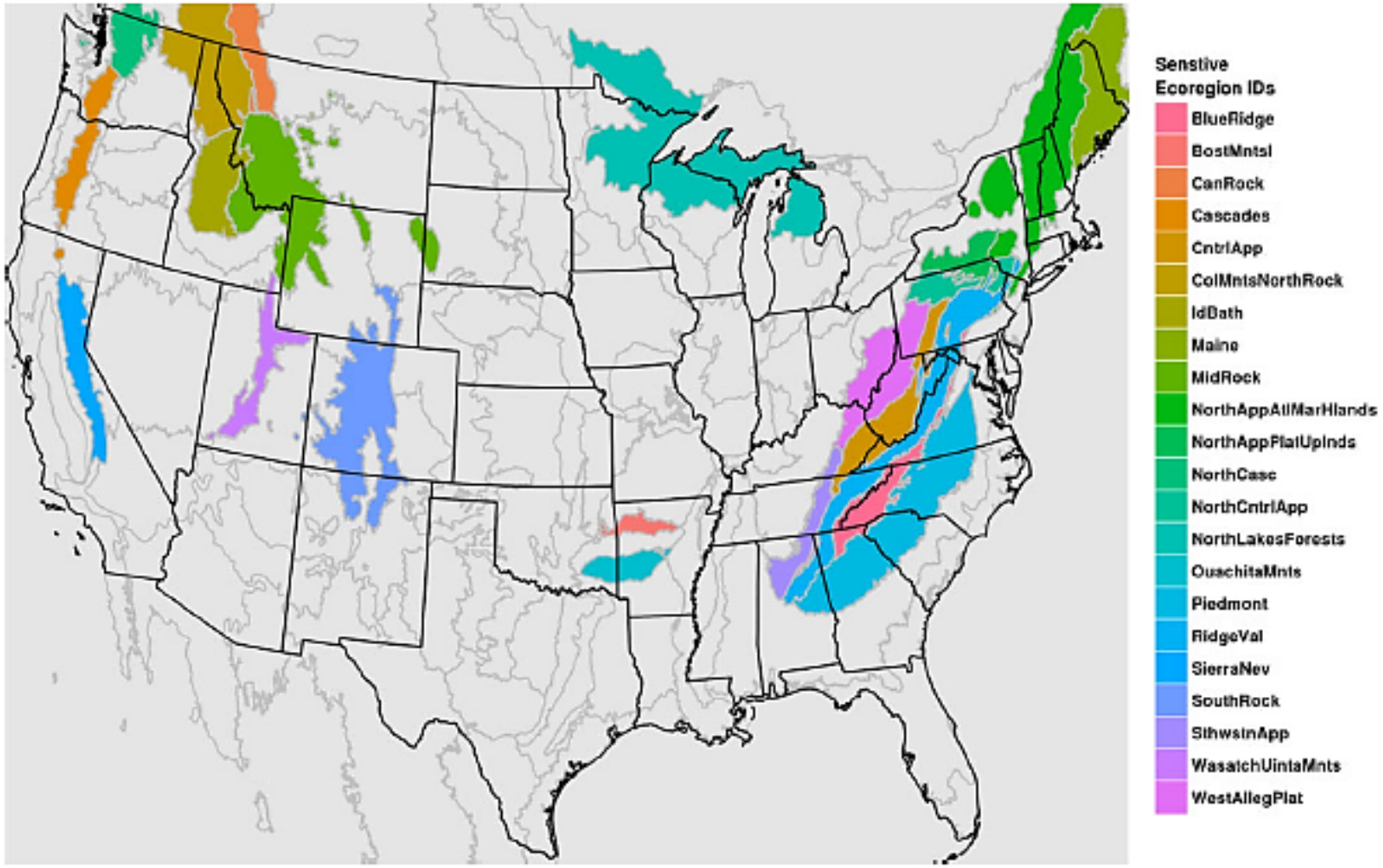


Storm Events and Episodic Acidification:

Acid Neutralizing Capacity (ANC) at Noland Divide Watershed



Acid-Sensitive Ecoregions from Scheffe et al. 2014

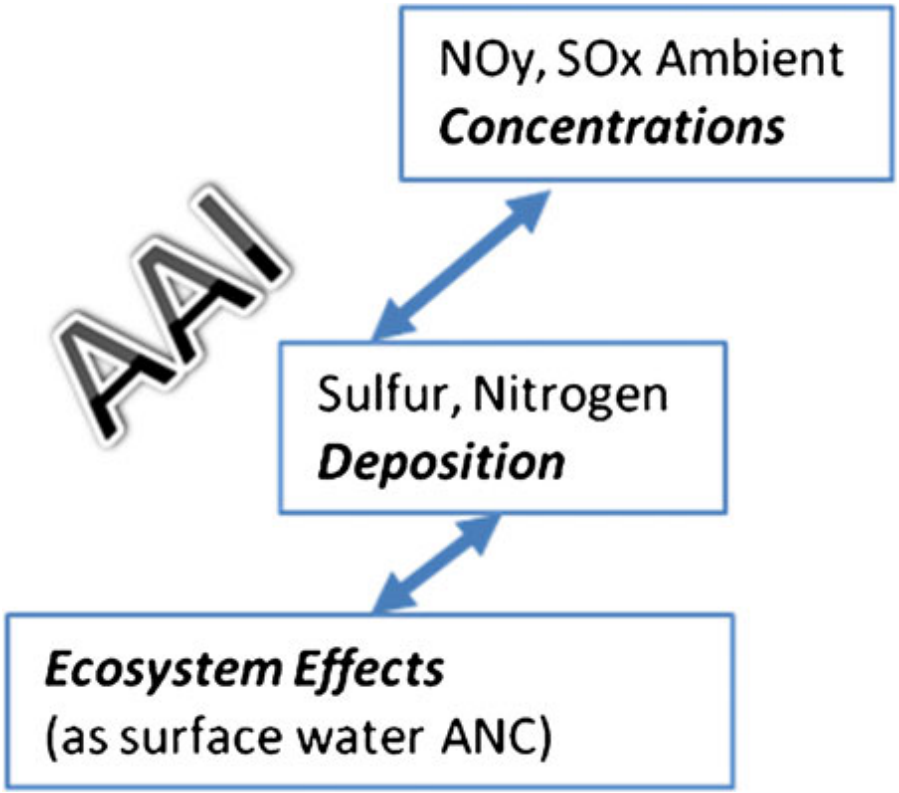


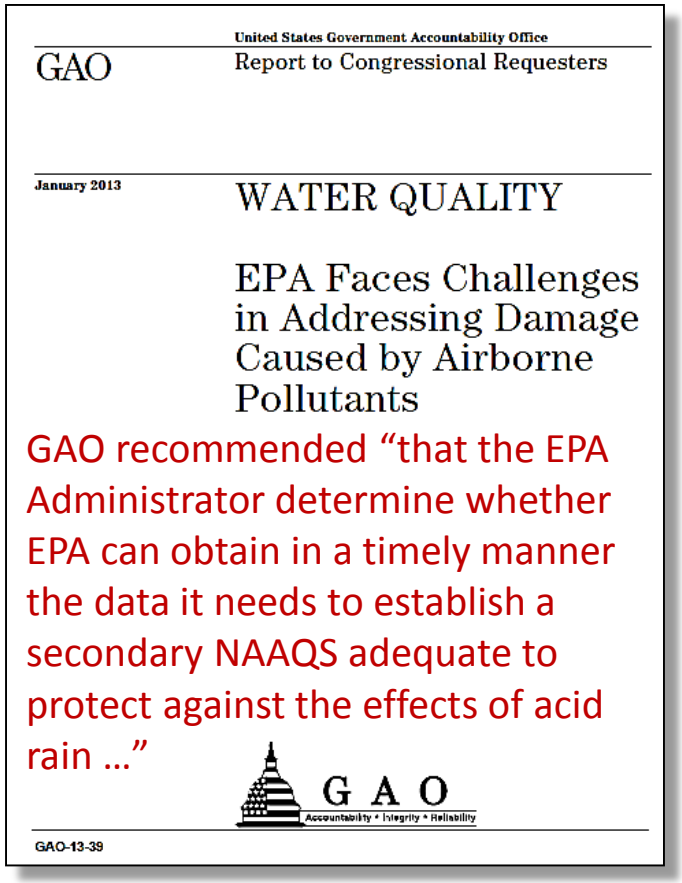
EPA's Atmospheric Acidification Index (AAI)

A New Regulatory Metric Linking Atmospheric and Biogeochemical Models to Assess Potential Aquatic Ecosystem Recovery

A Potential Approach for the NOx/SOx Secondary National Ambient Air Quality Standard to protect Water Quality/Stream Chemistry (Acid Neutralizing Capacity)

Considered by EPA in 2010, but dropped, not promulgated, needed further study.





United States Government Accountability Office

GAO

Report to Congressional Requesters

January 2013

WATER QUALITY

EPA Faces Challenges in Addressing Damage Caused by Airborne Pollutants

GAO recommended "that the EPA Administrator determine whether EPA can obtain in a timely manner the data it needs to establish a secondary NAAQS adequate to protect against the effects of acid rain …"

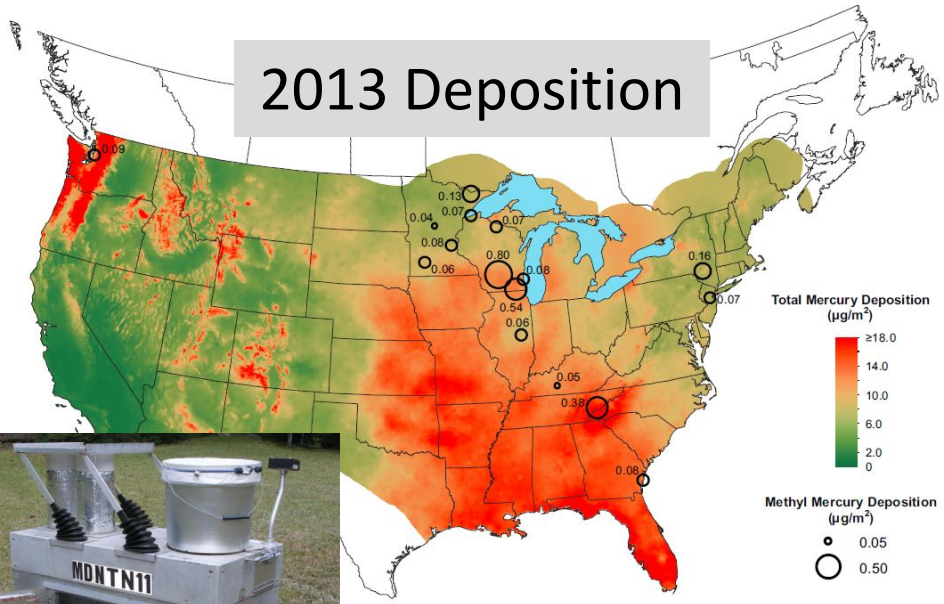
GAO

Accountability • Integrity • Reliability

GAO-13-39

Mercury Deposition and Bioaccumulation

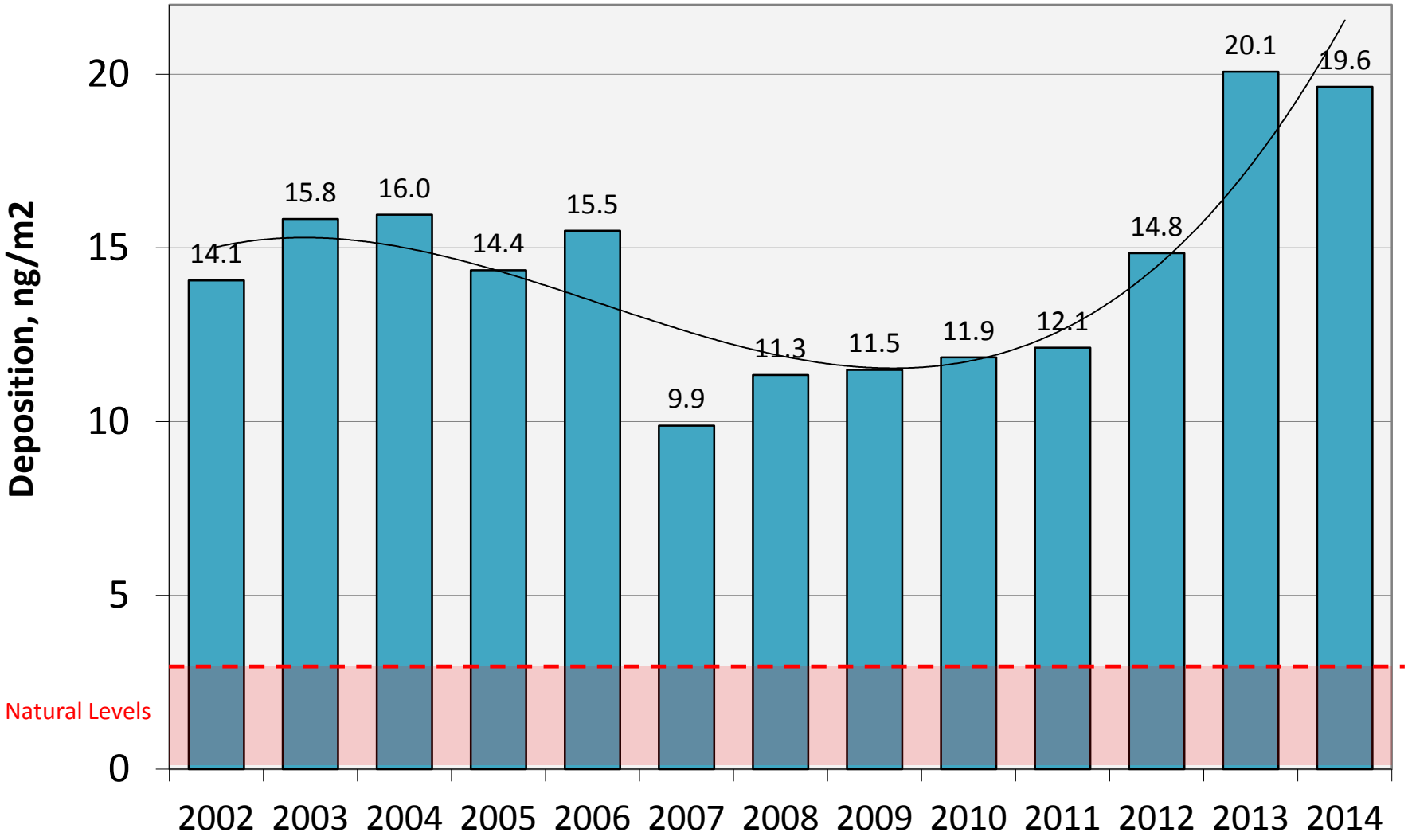
- GRSM monitors high deposition of mercury (inorganic non-harmful), especially at higher elevations
- Most mercury deposited at park comes from coal-fired power plants air emissions.



- Bioaccumulation of the harmful form (organic methyl-mercury) in the food web is of concern.
- Methylating trophic pathways exist in park showing up in terrestrial organisms (e.g. birds, salamanders, insects, spiders)
- Further study needed to determine pathways & risk.

Annual Total Wet Mercury Deposition

(Source: Mercury Deposition Network)



Overall Improving Air Quality Trends

- Nearby TVA Emissions.. down 95%
  - Eastern U.S. emissions down 76%
- Ozone pollution……..down 36%
  - Growing-season exposures down 64%
- Particle pollution…….down 49%
- Haziness (worst days)..down 130%
- Haziness (best days)…..down 69%
- Sulfate wet deposition…down 57%
- Nitrate wet deposition...down 23%
- S & N dry deposition…….down 77%
- S throughfall deposition…down 72%
- Ammonium wet deposition…. no change
- Mercury deposition no change (but increasing since 2007)

Thank You

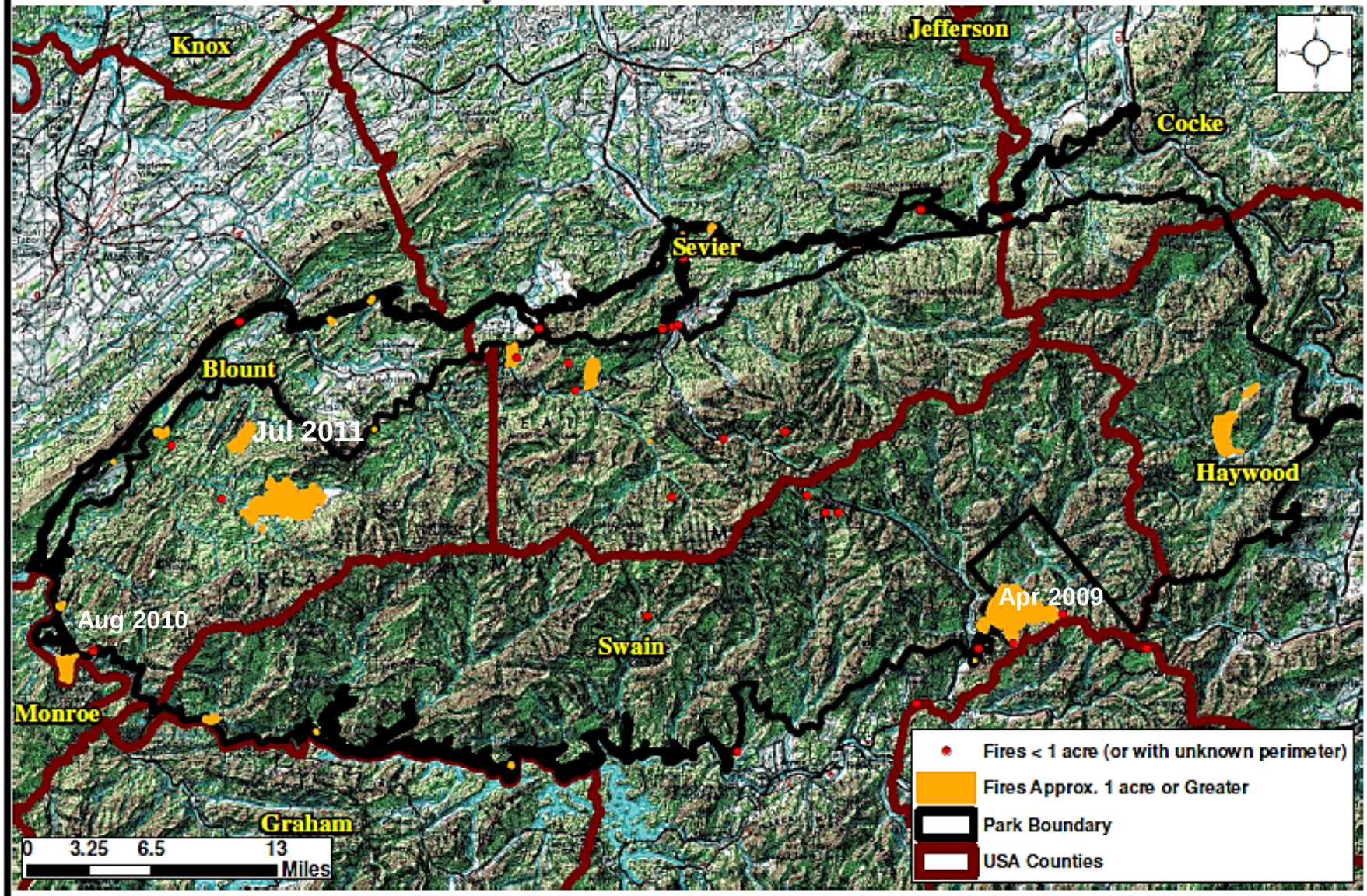
Email: jim_renfro@nps.gov Phone: (865)436-1708

National Park Service
U.S. Department of the Interior

Great Smoky Mountains National Park
Tennessee/North Carolina

National Park Service
U.S. Department of the Interior

Great Smoky Mountains Fires 2009 to 2013



Produced by GRSM Fire Management

Nov. 2013