Critical Loads as a Policy Tool: Highlights of the NO_x/SO_x Secondary NAAQS Review

Anne Rea[1] and Jason Lynch[2]

Randy Waite[1], Ginger Tennant[1], Jen Phelan[3] and Norm Possiel[1]

[1]EPA/OAR/Office of Air Quality Planning and Standards;
[2]EPA/OAR/Office of Atmospheric Programs; [3]RTI, International

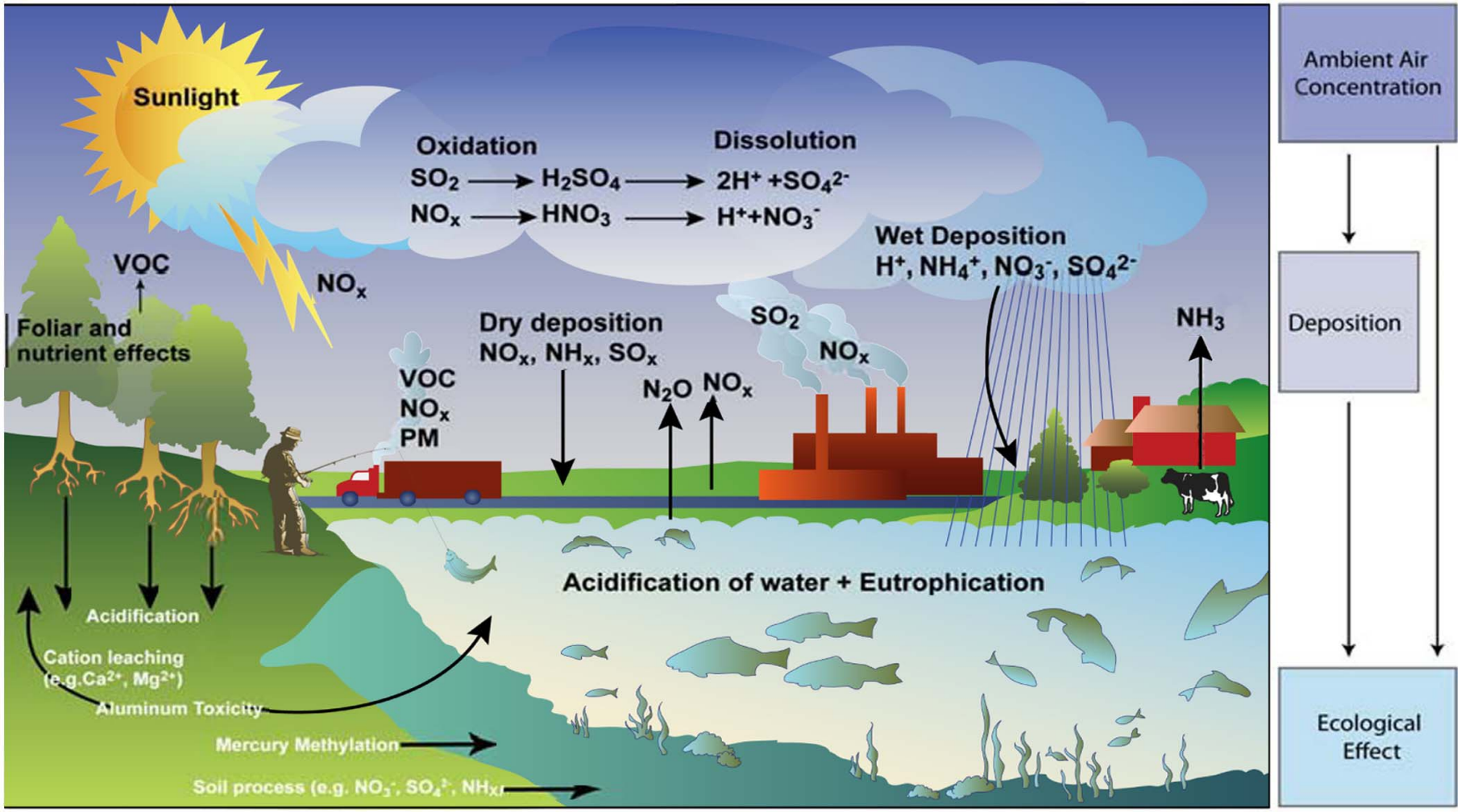
Presentation Overview

- Secondary NAAQS for NOx/SOx
  - Overview of Review
  - Targeted Ecological Effects
  - Conceptual Model of a Standard
  - Current Status
- Critical Loads for Acidity
  - Aquatic
  - Terrestrial (poster)
- Research Needs

Secondary NO_x/SO_x NAAQS Review

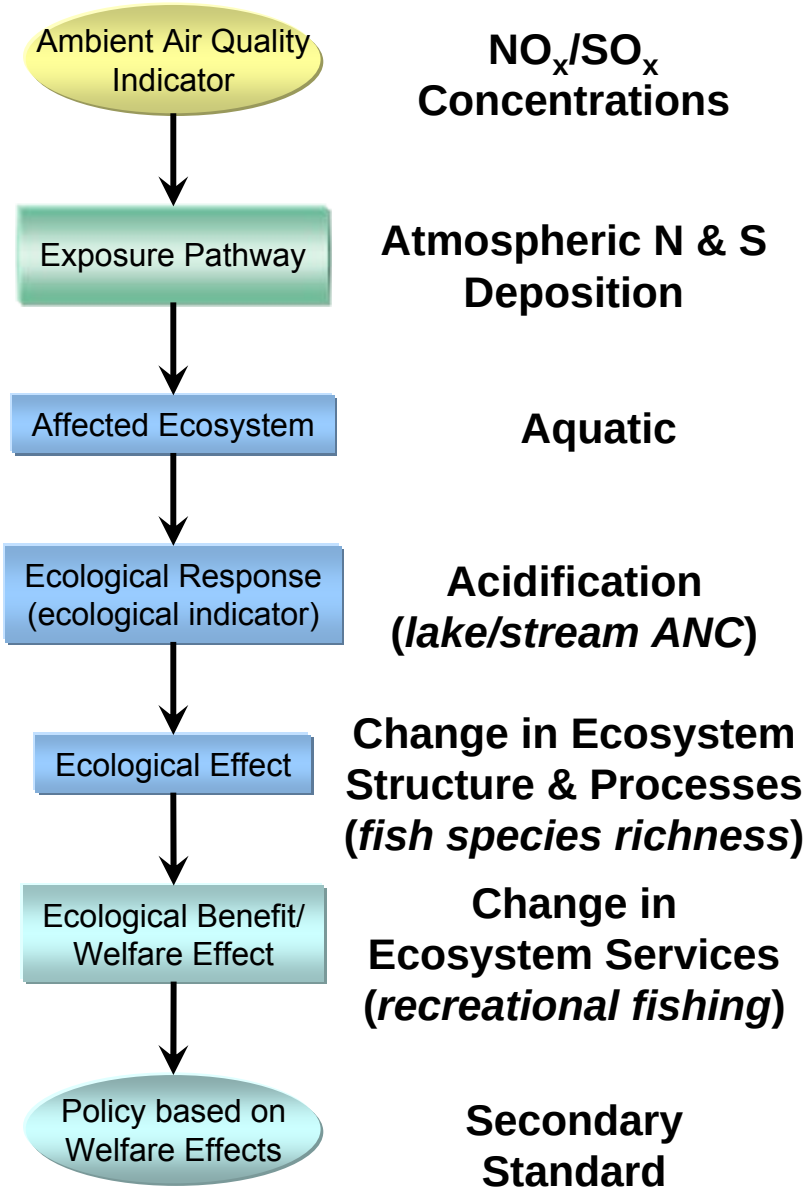
- Some Agency "firsts"
  - Independent Secondary Standard Review
  - Multi-pollutant Review
- NO_2 & SO_2 Secondary Standards – first set in 1971:
  - NO_2 reviewed in 1985, 1995
  - SO_2 reviewed in 1982
- Current Schedule
  - Notice of Proposed Rulemaking: Feb 2010
  - Final Rulemaking: Oct 2010

Targeted Ecological Effects

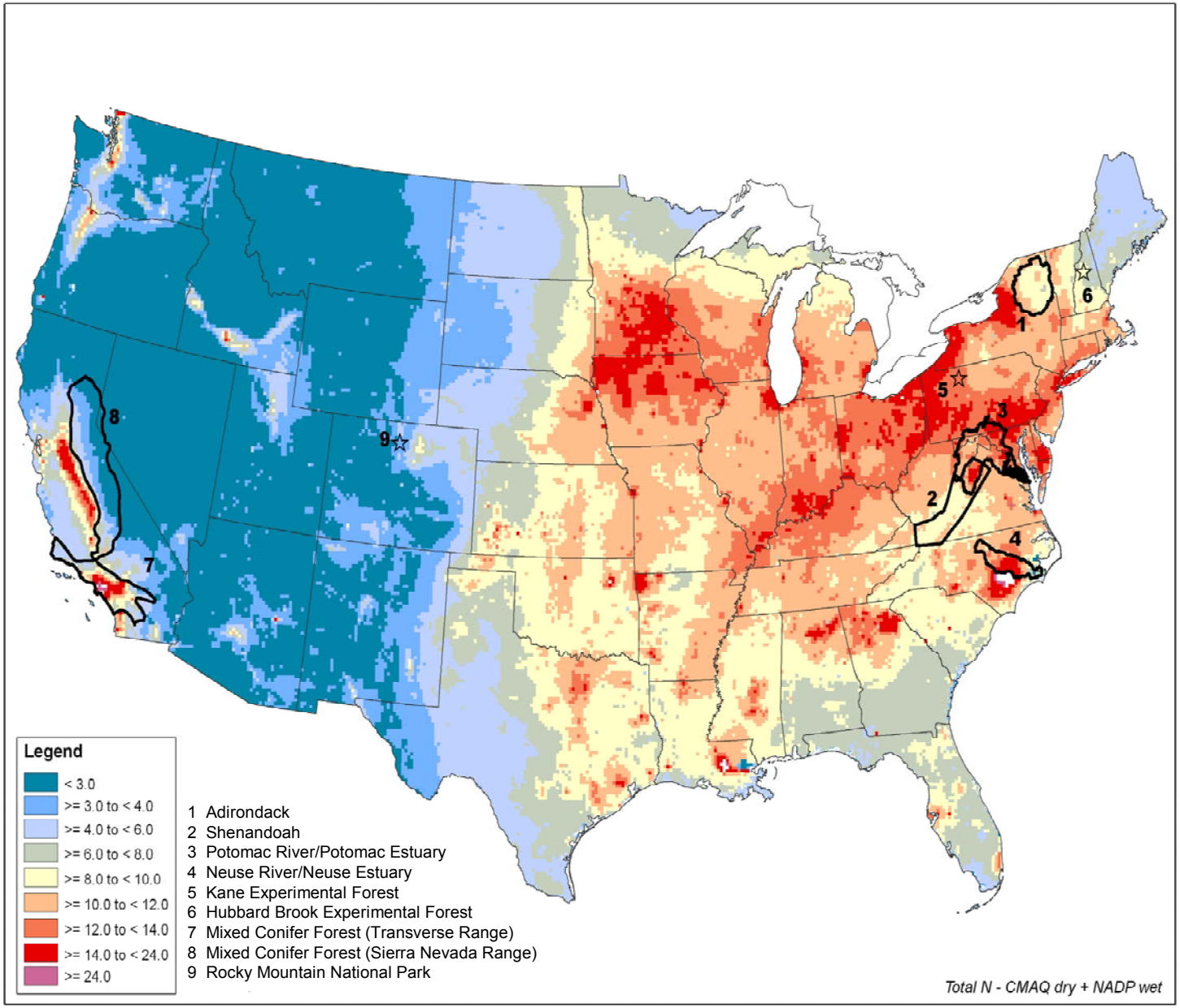


Source: U.S. EPA/NCEA Integrated Science Assessment for Oxides of Nitrogen and Oxides of Sulfur: Ecological Criteria (2008)

Conceptual Model for a Secondary Standard



Nationwide Total Reactive Nitrogen Deposition (2002)



Current Status of Review

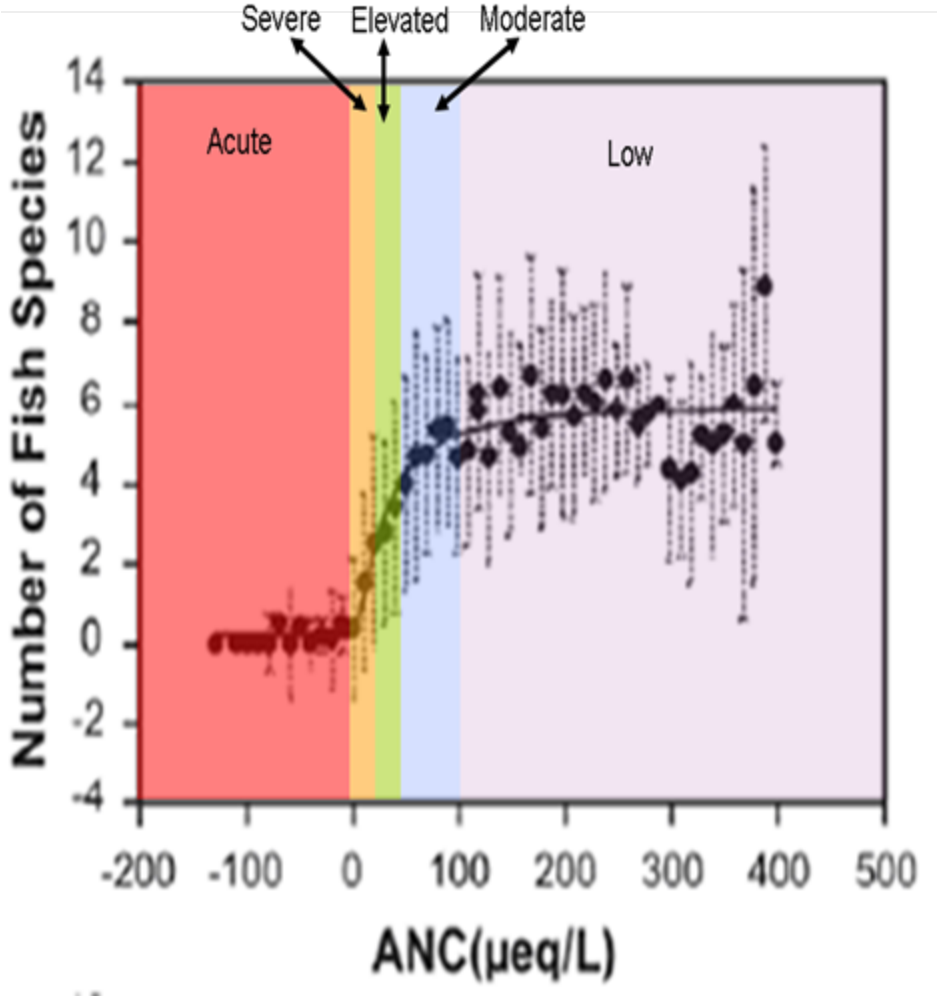
- Known or anticipated adverse effects are occurring under current ambient loadings of N and S in sensitive ecosystems
  - Aquatic acidification – high confidence
  - Terrestrial acidification – high confidence
  - Aquatic nutrient enrichment (non-atmospheric sources) – mixed confidence (strong relationship with N deposition in high alpine lakes in RMNP)
  - Terrestrial nutrient enrichment – strong qualitative evidence
- Clean Air Scientific Advisory Committee view:
  - Sufficient information to set separate standards; necessary to do so to protect against aquatic and terrestrial acidification and terrestrial nutrient enrichment effects
- Currently in discussions with the plaintiff's regarding the schedule for the review

Aquatic Acidification

- Critical Loads Approach
  - Critical load approach gives us a tool to evaluate whether a waterbody and biota are impacted from acid deposition
  - Has air pollution reached a tipping point (threshold) for causing harmful effects to plants, animals, soils, or ecosystems?
  - A critical load indicates the amount of acidic input of sulfur and nitrogen deposition that a given lake or stream can neutralize and still maintain a specified level of ANC (e.g., 20, 50, 100 µeq/L)

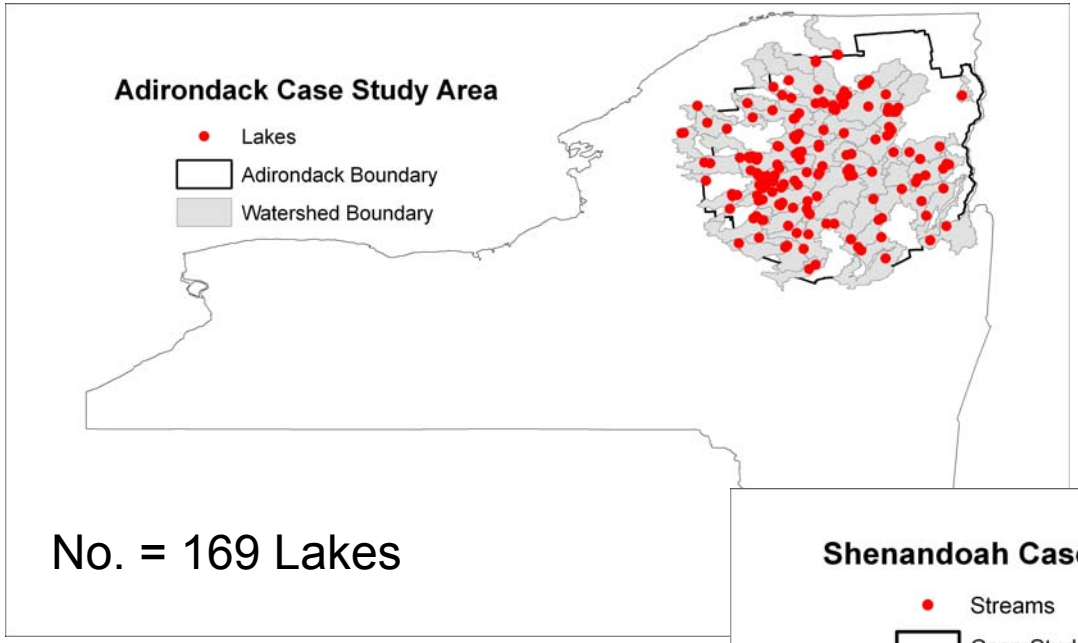
Aquatic Acidification

- Ecological indicator
  - Acid Neutralizing Capacity (ANC) of surface waters
  - Chemical criteria of 20, 50, 100 µeq/L
  - Ecosystem effects
- Ecosystem services affected
  - Recreational fishing
  - Fish species richness
  - Biodiversity

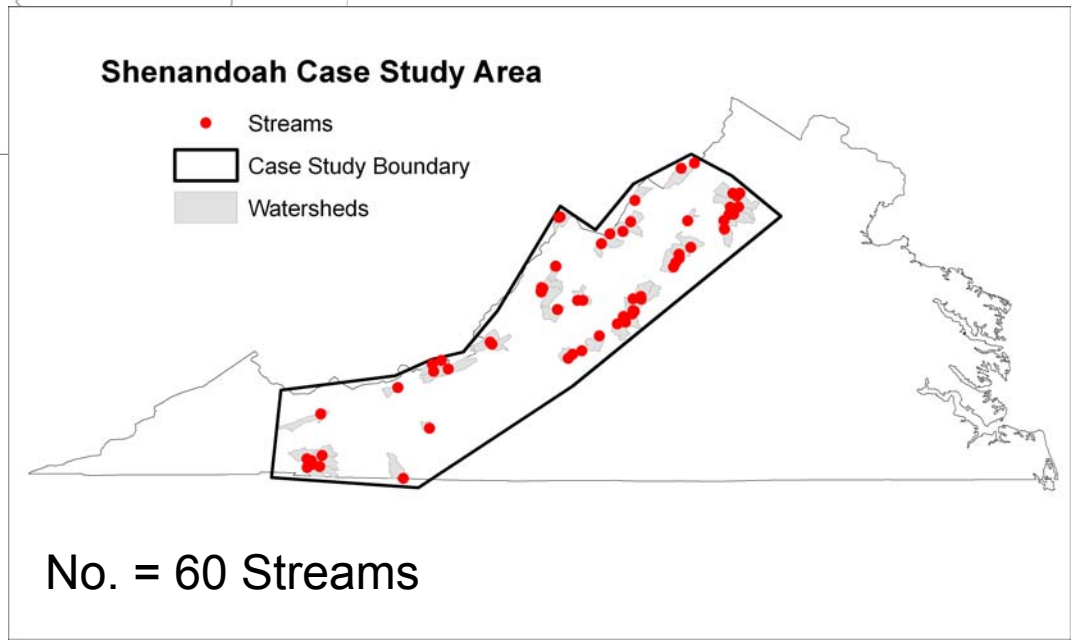


Source: Sullivan et al. (2006)

Aquatic Acidification Case Studies



No. = 169 Lakes



No. = 60 Streams

Critical Loads Calculations

- Steady State Critical Loads
  - Calculated critical loads for both the steady-State Water Chemistry (SSWC) and the First-order Acidity (FAB)
  - SSWC model results are presented
  - F-Factor or MAGIC to estimate weathering rates (DuPont et. al 2005)
- Surface water chemistry
  - EMAP, TIME and ALTM/LTM programs
  - SWAS-VTSSS-LTM programs
  - Single sample to weekly monitoring data
  - Base flow
- Critical load exceedances for acidity
  - Combined NADP Wet and CMAQ dry deposition
  - Year of 2002
  - N leaching flux (concentration of nitrate in runoff)

Critical Loads Calculations

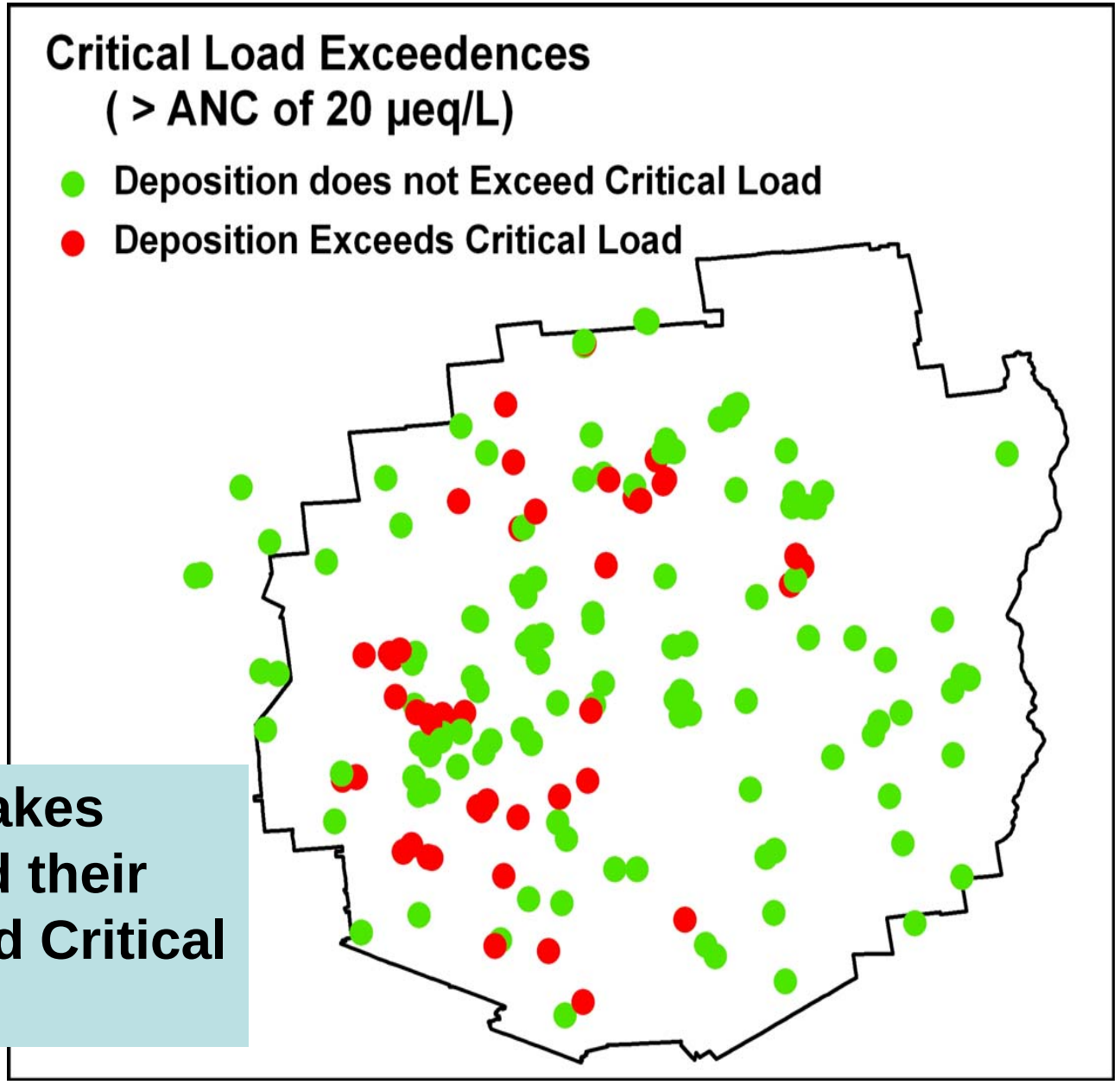
$$CL(A) = ([BC^{*}]_{o} - [ANC]_{limit}) * Q$$

- $CL(A)$: Harmful Deposition
- $[BC^{*}]_{o}$: Base cation supply
- $[ANC]_{limit}$: Biological Criteria
- Q: Runoff

$$Ex(A) = S_{dep} + N_{leach} - CL(A)$$

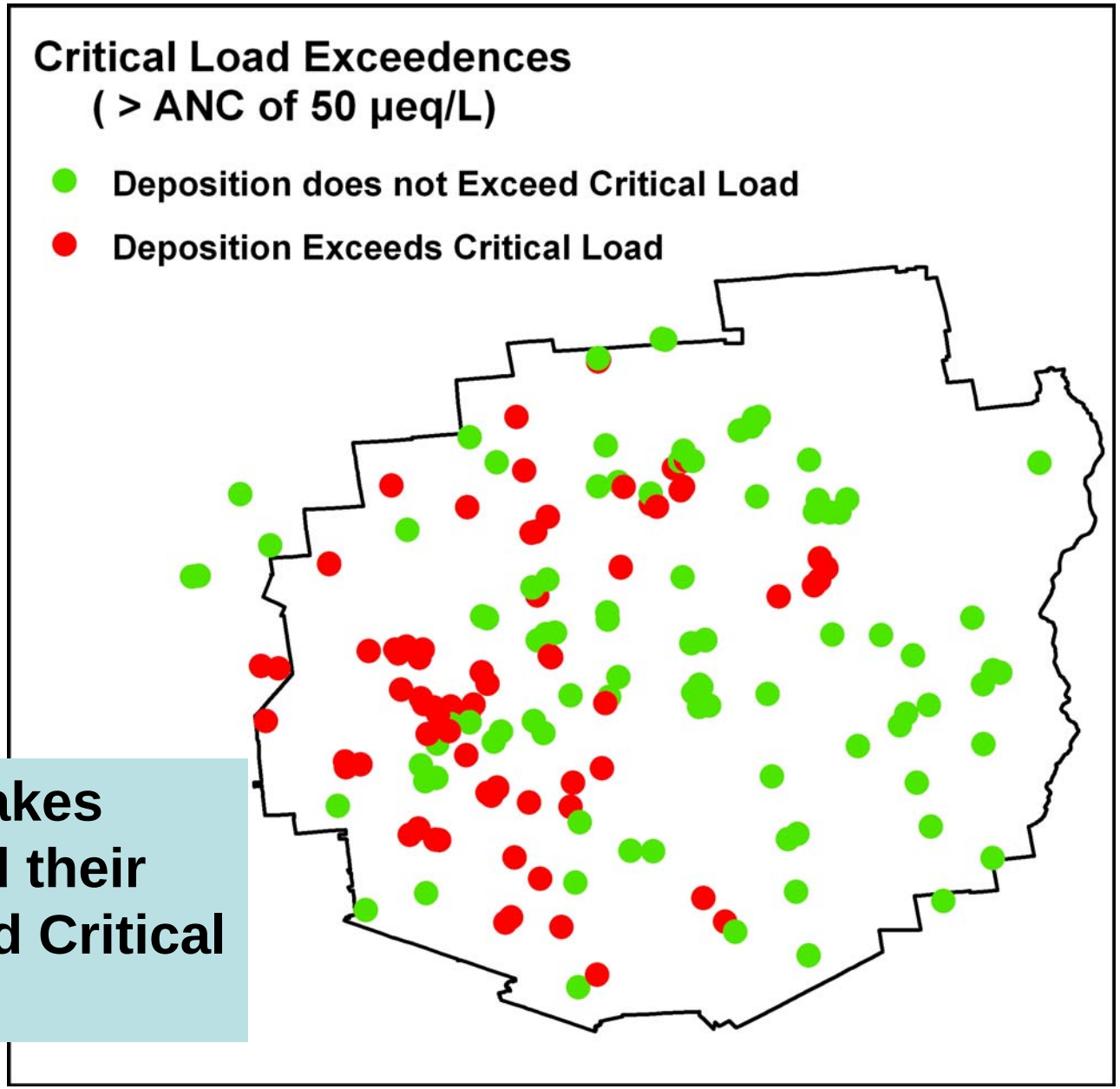
- $Ex(A)$: Exceedence
- S_{dep}: Deposition
- N_{leach}: Nitrate leaching
- $CL(A)$: Critical Load

Results



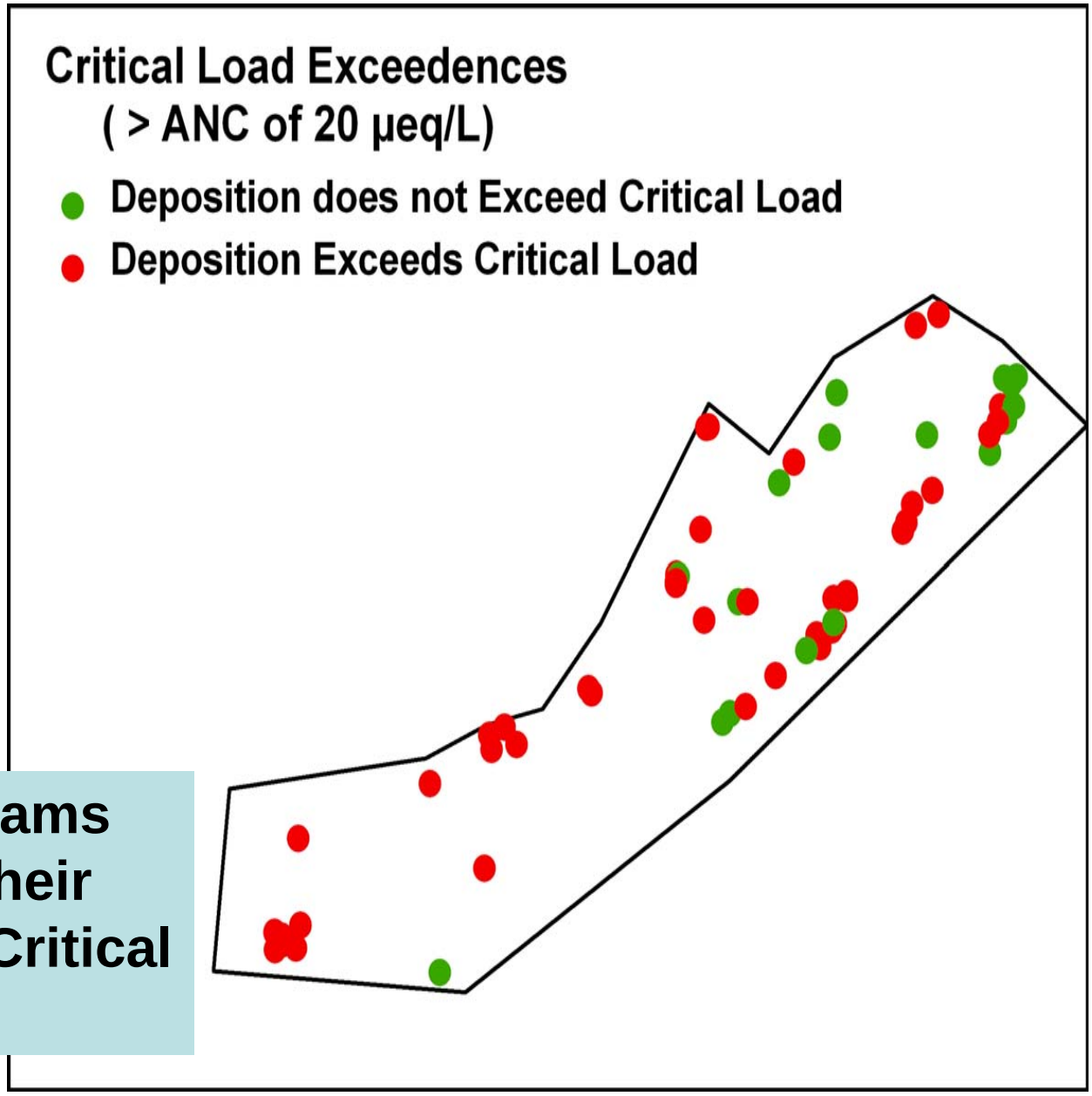
28% of Lakes Exceeded their calculated Critical Load

Results



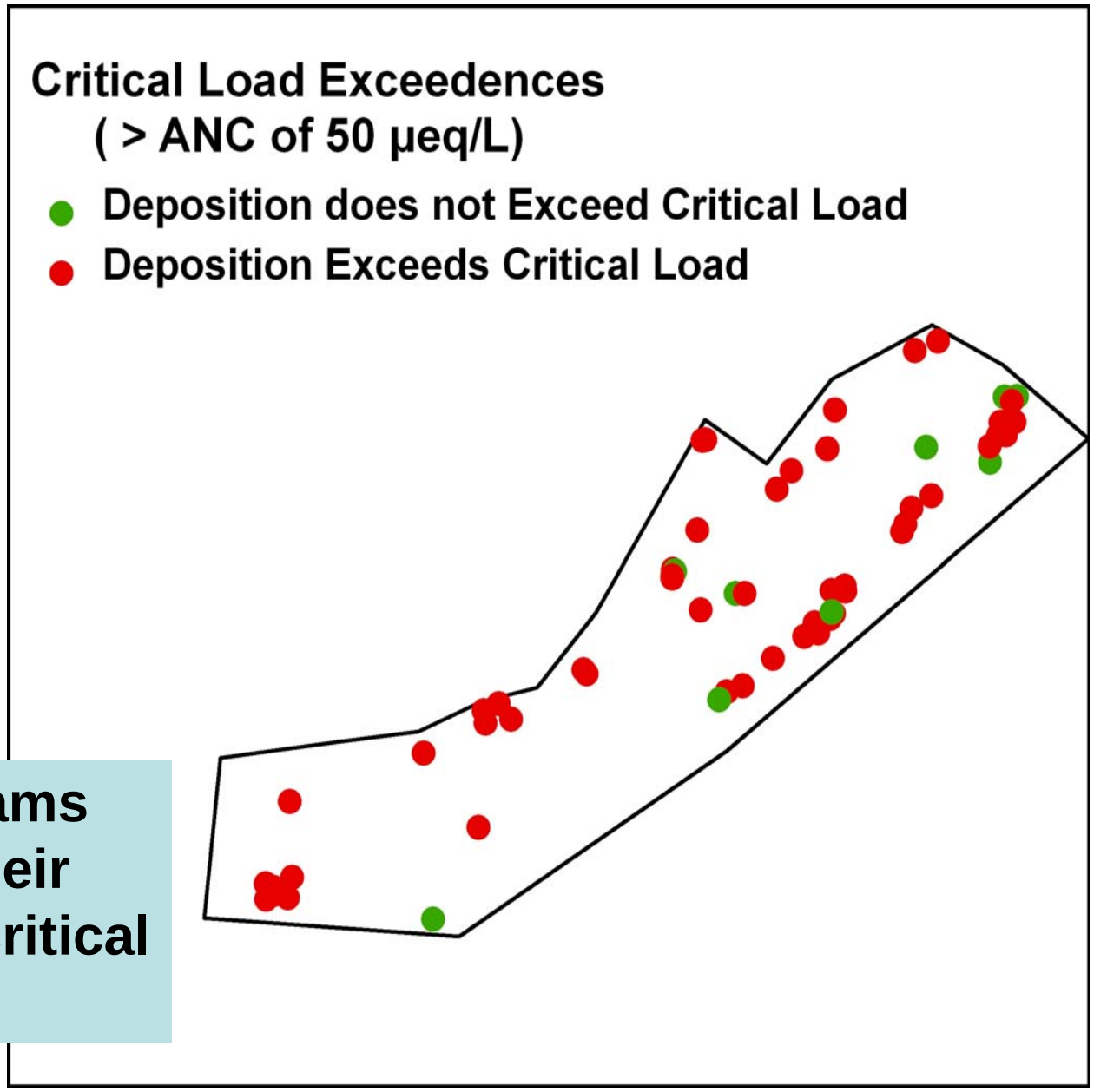
44% of Lakes Exceeded their calculated Critical Load

Results



72% of Streams Exceeded their calculated Critical Load

Results



85% of Streams Exceeded their calculated Critical Load

Result Summary

- **Adirondacks:** 28 to 48% of modeled lakes cannot maintain an ANC ranging from 20 to100 µeq/L, respectively (n=169 lakes) under current N and S deposition levels
  - Scaled up to 1842 lakes in the Adirondacks: 13-51%

- **Shenandoahs:** 72 to 92% of modeled streams cannot maintain and ANC ranging from 20 to100 µeq/L, respectively (n=60 streams) under current N and S deposition levels

Research Needs

- Relationships between critical loads for aquatic acidity and effects on ecosystem services, especially due to incremental changes in an ecological indicator such as ANC
- Developing nationwide weathering rates, or weathering rates for aquatic ecosystems sensitive to acidification
- Developing a better understanding of the uncertainty in critical loads for acidity and exceedance values
- Developing methods for calculating critical loads for surface water acidity when data are absent or of poor quality
- Evaluating ways to combine multiple critical load estimates for surface waters and soils on a national scale
- Estimating ways to determine critical load parameters across different media (e.g., surface waters, soils).

For More Information

www/epa.gov/ttn/naaqs

or

Anne Rea
rea.anne@epa.gov
(919) 541-0053

Jason Lynch
lynch.jason@epa.gov
(202) 343-9257