Update on the 2nd draft NOx/SOx Secondary NAAQS Risk and Exposure Assessment

Presentation to CASAC
July 22, 2009

Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Quality Analysis Division
Office of Air Programs
Clean Air Markets Division

Purpose

Solicit feedback on EPA's 2nd draft Risk and Exposure Assessment for the NOx/SOx Secondary NAAQS review

- Highlight changes between 1st and 2nd drafts
- Obtain feedback on the analyses and results
- Obtain guidance on finalizing Risk and Exposure Assessment

Overview

- Changes between 1st and 2nd drafts
- Conceptual model for an ecologically meaningful secondary NAAQS
- Highlights of Atmospheric and Ecological Analyses
- Next Steps

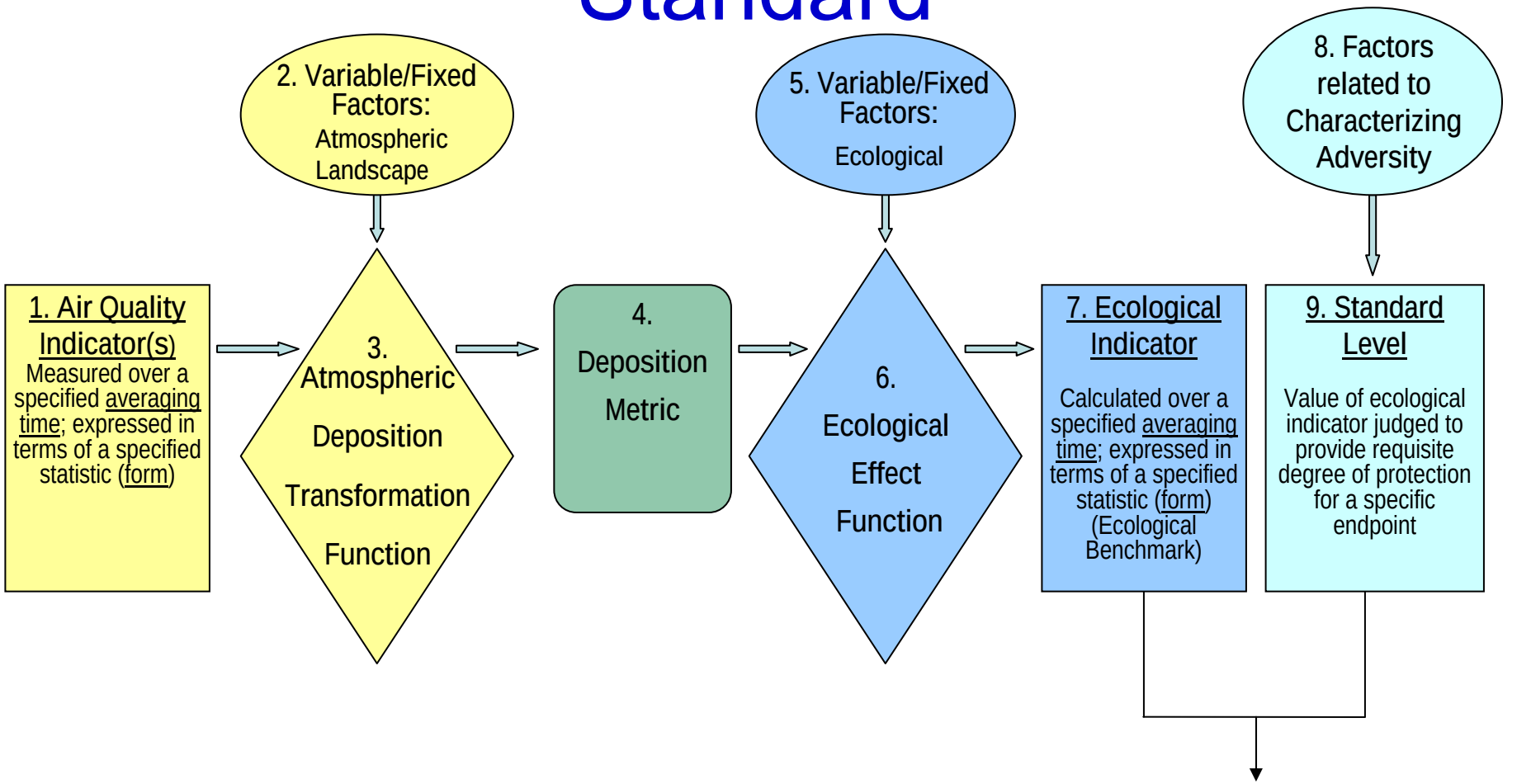
Changes in 2nd draft Risk and Exposure Assessment

- Added an Executive Summary
- Highlighted impact of reduced N throughout
  - Policy-relevant questions
  - Air quality and ecological analyses
- Air Quality Analyses
  - Updated maps on Emissions, Concentrations, and Deposition of NOx, NHx and SOx
  - Analysis of inter-annual variability and longer-term spatial deposition patterns
  - Replaced RSM with CMAQ-based simulations
  - Description of CMAQ applications and model performance

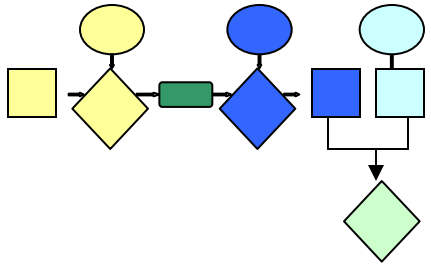
Changes in 2nd draft Risk and Exposure Assessment

- Ecological Analyses
  - Completed modeling and analyses for all 4 targeted effect areas
  - Scaled up to larger areas where possible
  - Added ecosystem services analyses
- Added material to Additional Effects chapter
  - Climate, visibility, and materials
  - Nitrogen addition effects on primary productivity (C-sequestration) and biogenic greenhouse gas fluxes
  - Phytotoxic effects on plants

Structure of an Ecologically-based Standard

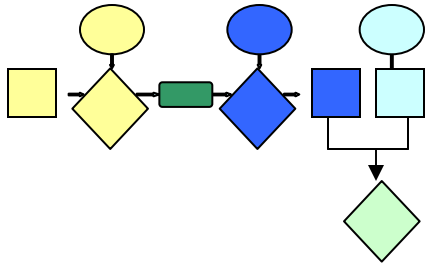


Scope of 2nd Draft REA



- Air Quality Analyses
  - Characterize current conditions (based on 2002 model year)
  - Quantify relationships between concentration and deposition
- Ecological Analyses
  - Characterize current conditions (2002) using deposition estimates from air quality analysis
  - Quantify linkages between atmospheric deposition and ecological effects based on an ecological indicator
- Additional Effects
  - Influence of SO_x deposition on methylmercury production, N_20 effects on climate, primary productivity, phytotoxic effects on plants

Findings from 2nd Draft REA

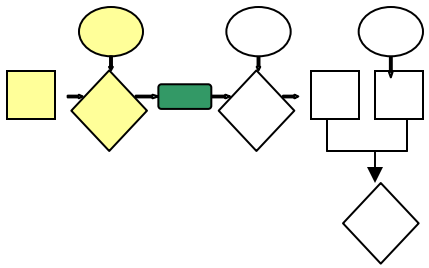


Known or anticipated adverse effects are occurring under current ambient loadings of N and/or S in sensitive ecosystems:

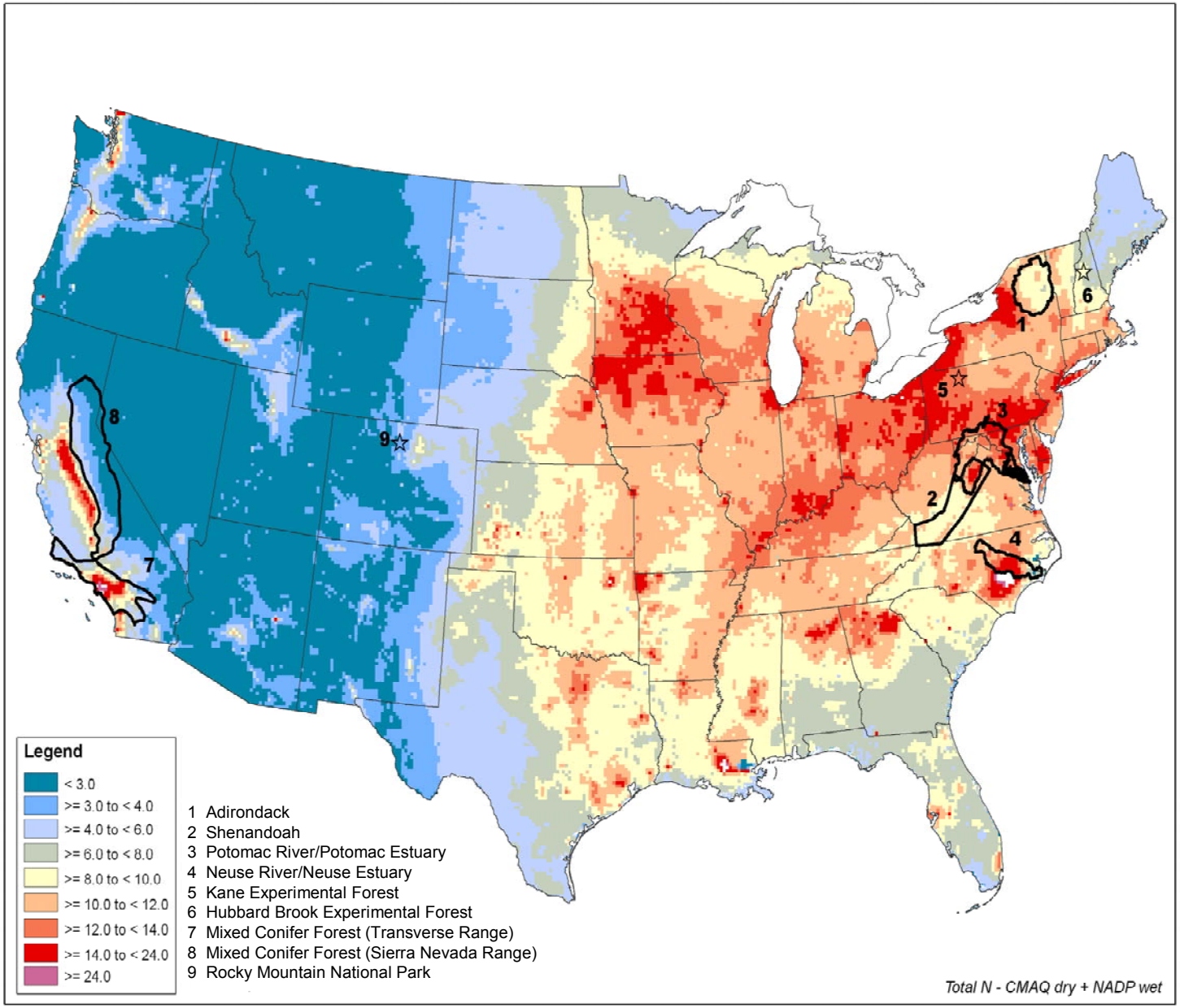
- Most confidence: aquatic acidification
- Fairly confident: terrestrial acidification
- Mixed confidence: aquatic nutrient enrichment (due to non-atmospheric sources)
  - Strong relationship with N deposition in high alpine lakes in RMNP
- Strong qualitative evidence: terrestrial nutrient enrichment

Air Quality Analyses

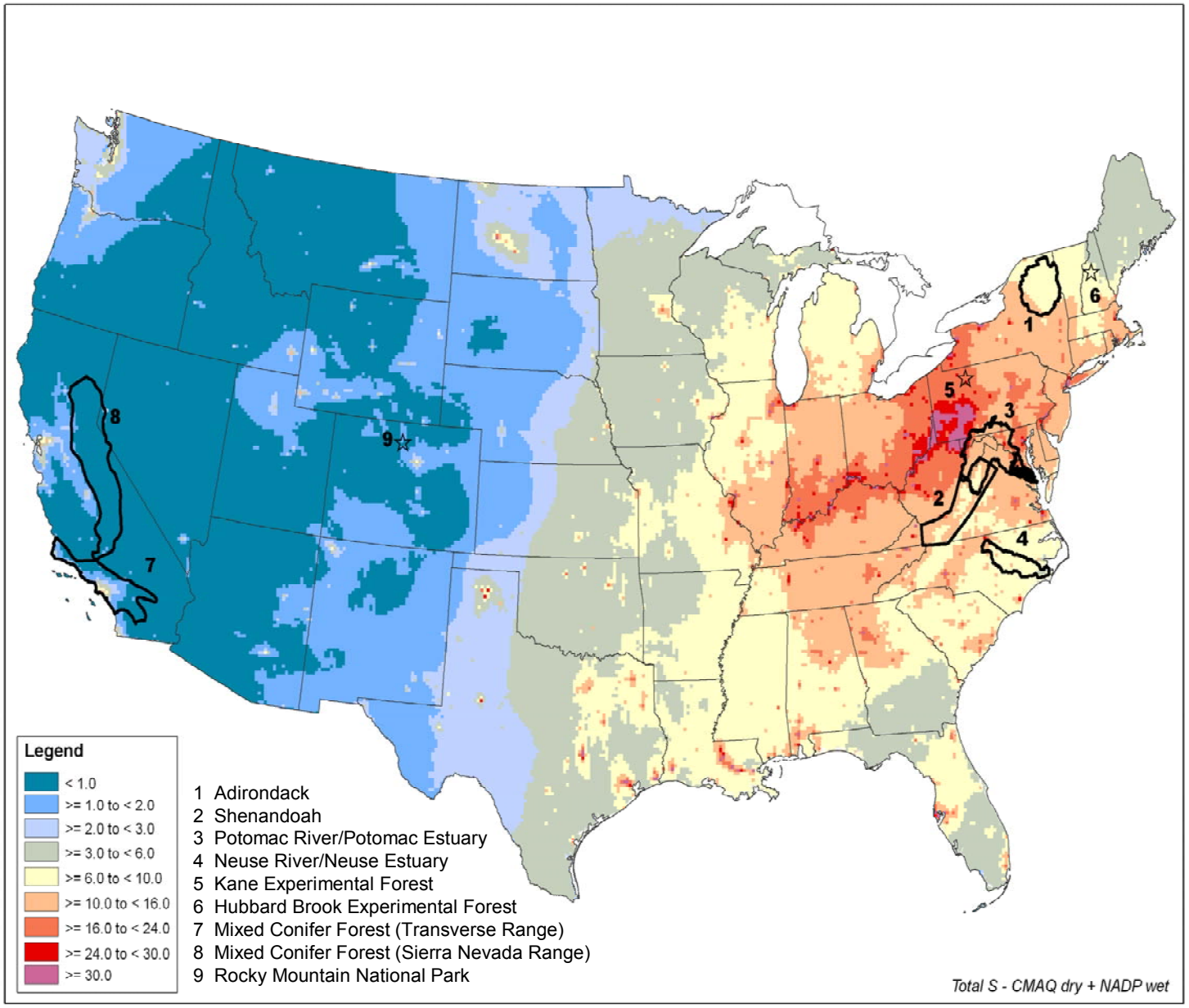
- Nationwide deposition maps
- Nitrogen deposition in case study areas
  - Wet vs. dry
  - Oxidized vs. reduced



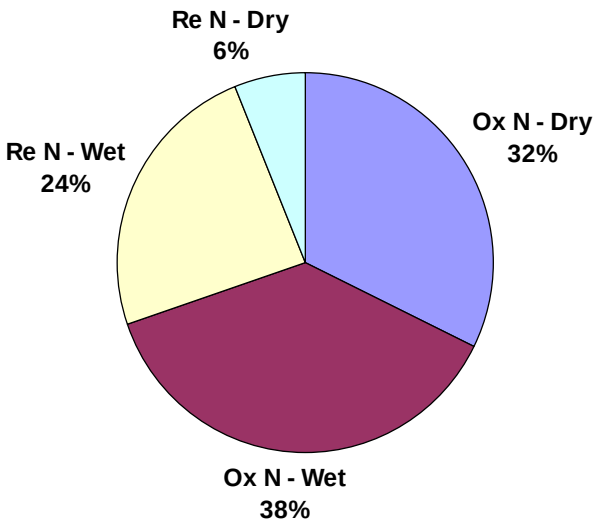
Nationwide Total Reactive Nitrogen Deposition for 2002



Nationwide Sulfur Deposition for 2002

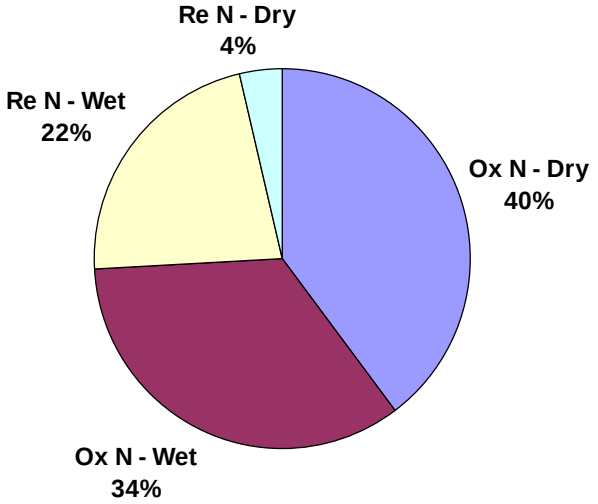


Relative Amount of Nitrogen Deposition (2002)

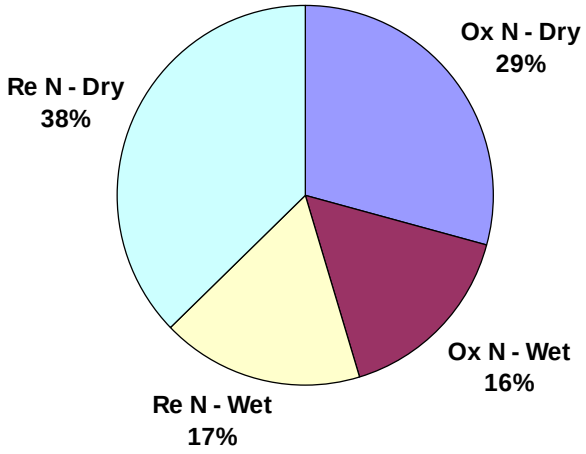


Adirondacks

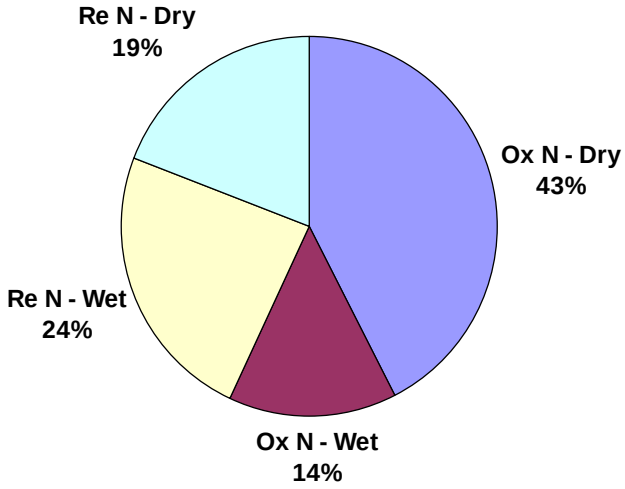
Examples



Kane Forest



Neuse River

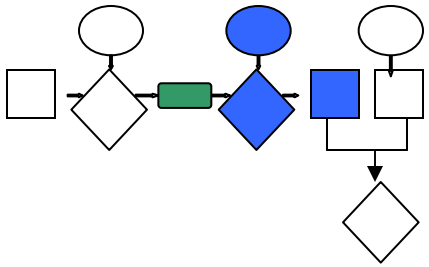


Sierra Nevada

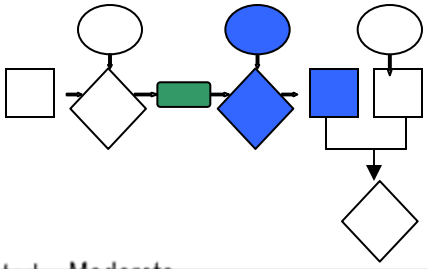
Ecological Analyses

Four targeted effect areas:

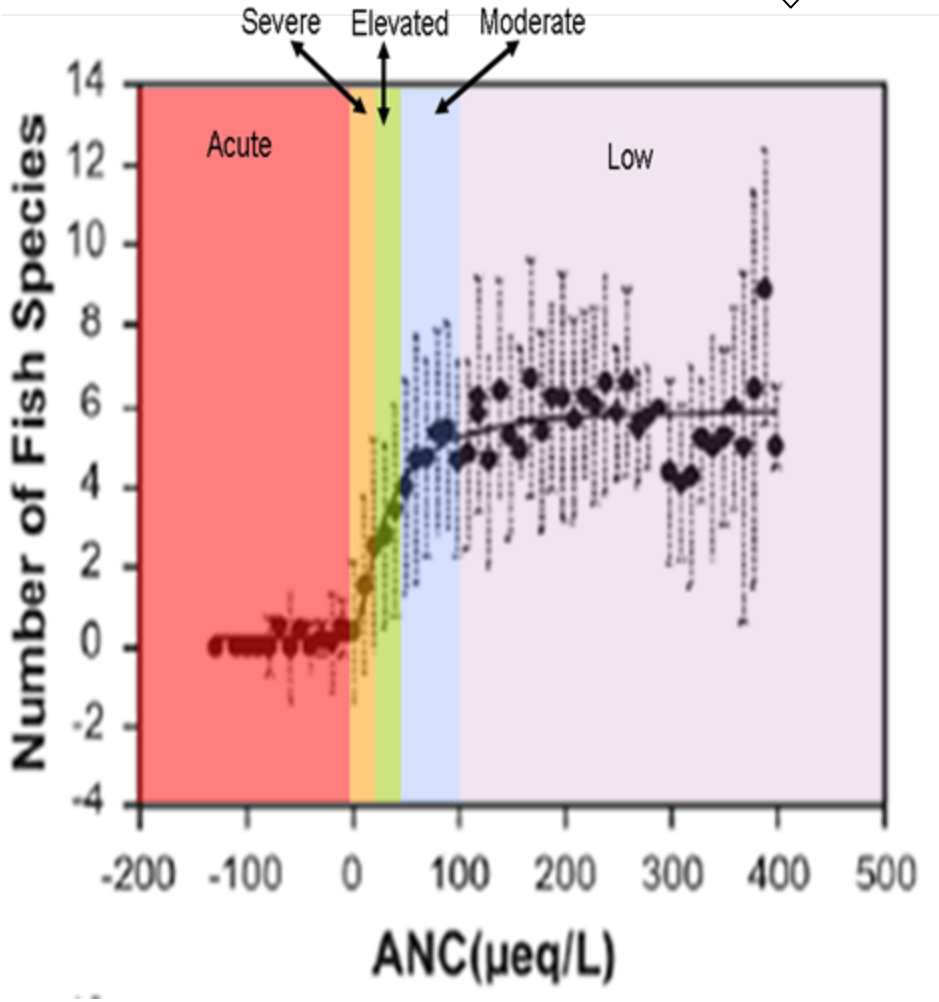
- Aquatic Acidification
- Terrestrial Acidification
- Aquatic Nutrient Enrichment
- Terrestrial Nutrient Enrichment



Aquatic Acidification

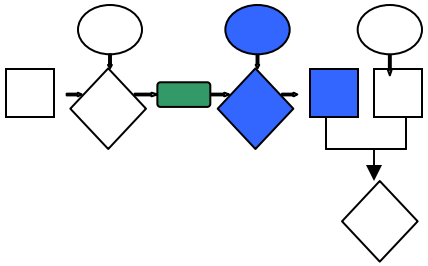


- Ecological Indicator
  - Acid Neutralizing Capacity (ANC) of surface waters
  - Best single indicator of biological response and health of aquatic communities in acid-sensitive systems
- Ecosystem Services Affected
  - Recreational fishing
  - Biodiversity



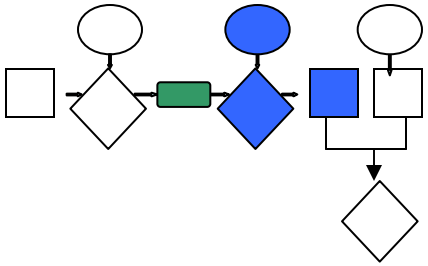
Source: Sullivan et al., 2006

Aquatic Acidification



- Ecologically Relevant Background
  - Accounts for naturally acidic lakes and streams
  - Gauge what a realistic ANC might have been before acidifying deposition
- Current Conditions (vs. pre-industrial 1860):
  - **Adirondacks:**
    - NO_3^- – 5-fold higher today
    - SO_4^{-2} 17-fold higher today
    - lowered ANC an avg of 54 µeq/L
  - **Shenandoahs:**
    - NO_3^- – 60-fold higher today
    - SO_4^{-2} 32-fold higher today
    - lowered ANC an avg of 43 µeq/L

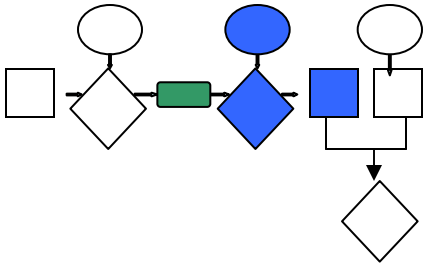
Modeling Results: Critical Loads



- 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)
- **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

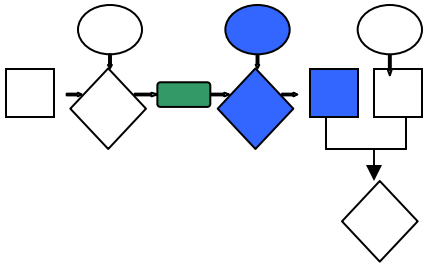
  → Scaled up to 1842 lakes: 13-51%
- **Shenandoahs:** 72 to 92% of modeled streams cannot maintain and ANC ranging from 20 to100 µeq/L, respectively (n=60 streams) under current N and S deposition levels

Terrestrial Acidification



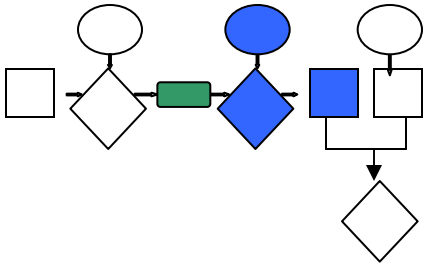
- Ecological Indicator:
  - Base cation to Aluminum ratio in soils (e.g., 0.6, 1.2, 10)
  - Effects on tree growth (sugar maple, red spruce)
- Case Study Locations:
  - Hubbard Brook Experimental Forest (NH)
  - Kane Experimental Forest (PA)
  - Scaled up to 24 states and correlated with Forest Service Forest Inventory Analysis database
- Current Conditions:
  - Used Critical Load analysis on tree plots
  - Sugar maple: 3-75% of plots cannot maintain a BC:Al ranging from 0.6 to 10 (n=4,992 plots, 24 states)
  - Red spruce: 3-36% of plots cannot maintain a BC:Al ranging from 0.6 to 10 (n=763 plots, 8 states)
- Ecosystem Services Affected:
  - Wood products, maple syrup production
  - Recreation, threatened and endangered species habitat

Aquatic Nutrient Enrichment



- Ecological Indicator:
  - Change in NOAA's Eutrophication Index: Bad/Poor/Moderate/Good/High
  - Based on chlorophyll a, macroalgae, dissolved oxygen, toxic algal blooms, submerged aquatic vegetation
- Case Study Locations:
  - Potomac River & Neuse River
- Current Conditions:
  - Ecological modeling to change score from "Bad" to "Poor"
  - reductions in atmospheric deposition alone would not solve coastal eutrophication problems due to multiple non-atmospheric inputs
- Ecosystem Services Affected:
  - Commercial and recreational fishing
  - Recreation (boating & beach use) and housing prices
- Rocky Mountain National Park
  - Studies show a strong relationship between atmospheric deposition (sole source of N) and algal shifts in high alpine lakes

Terrestrial Nutrient Enrichment



- Ecological Indicator:
  - Data limited; benchmark values for ecological effects attributed to N deposition for coastal sage scrub and mixed conifer forest communities
- Case Study Locations:
  - Sierra Nevada & San Bernardino Mountains
- Current Conditions:
  - Observational evidence, no modeled continuum of response
  - Coastal Sage Scrub: 3.3-10 kg N/ha/yr
    - N no longer limiting, changes in fungal root species, declines in coastal sage scrub as outcompeted by grasses; loss of habitat, increased wildfire risk
  - Mixed Conifer Forest: 3.1-17 kg N/ha/yr
    - Shifts from N-sensitive to N-tolerant lichen to complete loss of lichen, leaching of nitrate into streams
- Ecosystem Services Affected:
  - Recreation, aesthetic, and cultural services
  - Water quality, habitat loss, increase risk of wildfires

Next Steps…

To Finalize Risk and Exposure Assessment

- Feedback and Guidance from CASAC
- Consider Public Comments
- Plan to release Final Risk and Exposure Assessment in September