



# **Nitrogen Deposition Reduction Plan for Rocky Mountain National Park**

**Presentation to the  
Fall 2007 NADP Technical  
Meeting and Scientific  
Symposium**

**September 12, 2007**

# Air Quality Issues at Rocky

- For Rocky Mountain National Park, there is concern about:
  - Visibility degradation
  - Increasing tropospheric ozone concentrations
  - Nitrogen deposition
- CDPHE, NPS and EPA began a process for addressing these concerns
  - The "RMNP Initiative" began
  - Nitrogen deposition is the focus of the Initiative

# RMNP Initiative - History

- The agencies worked collaboratively from 2004 through 2007 to develop technical information and options for addressing the issues
  - The science and policy issues were publicly discussed throughout this period
- This process led to the development of a nitrogen deposition reduction plan



# Ecosystem Impacts



RMNP Nitrogen  
Deposition Reduction  
Plan

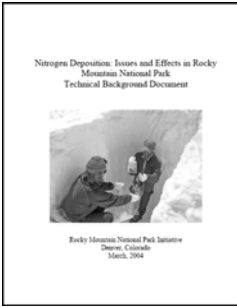
Journal article  
estimates “critical  
load”(April 2006)

Resource  
management goal  
established &  
endorsed (June 2006)

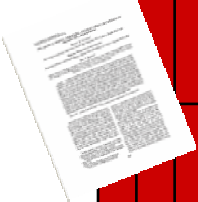
CDPHE, NPS, EPA MOU  
(Dec 2005)

AQCC Subcomm formed  
(Sept 2005)

**Nitrogen Deposition Issues and Effects Technical Background Document”**  
(CDPHE, NPS & EPA – March 2004) -based on 60 peer-reviewed papers



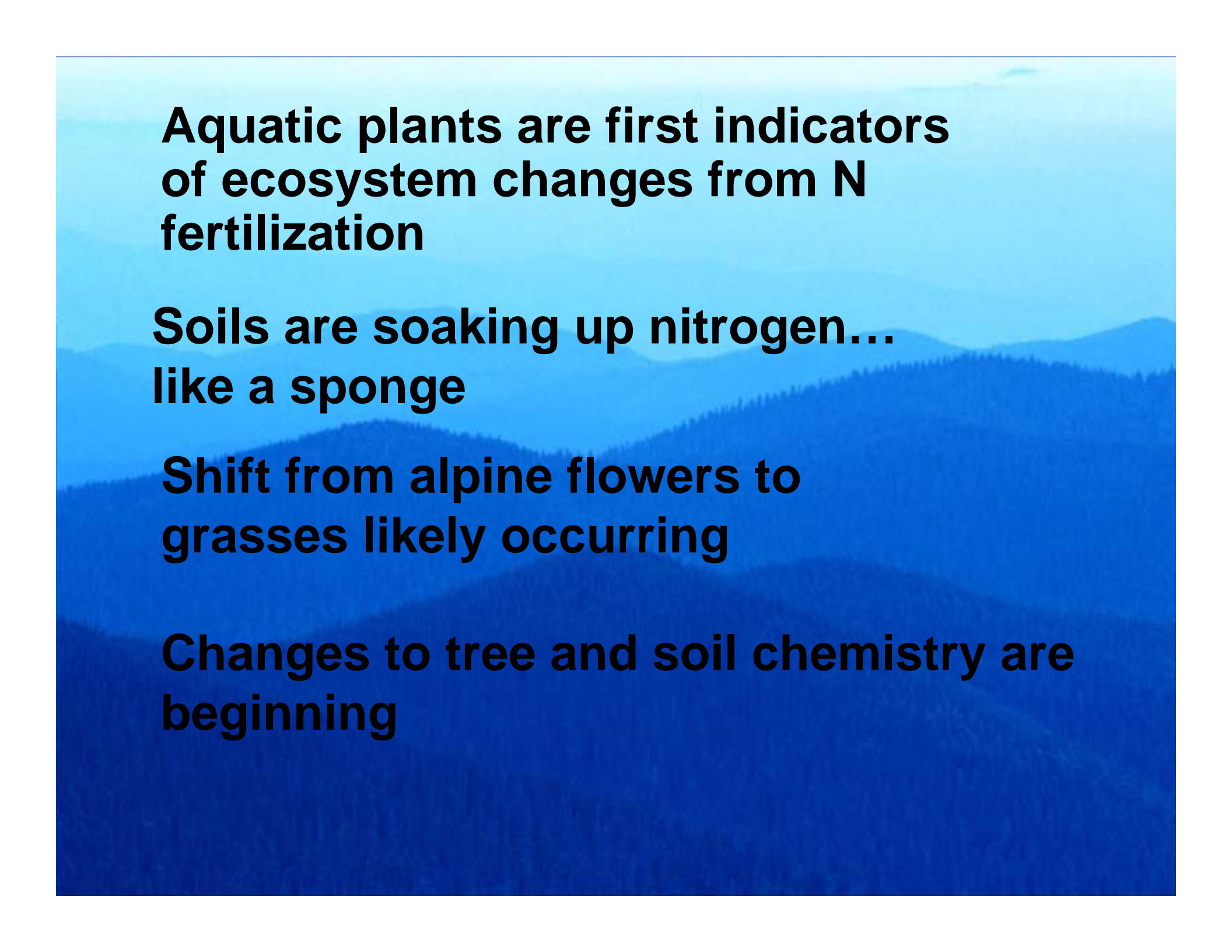
**>80 peer-reviewed publications form the basis for assessing nitrogen deposition and impacts at RMNP**



**>140 Peer-Reviewed Publications on the Effect of Nitrogen on Natural Resources and Systems**







**Aquatic plants are first indicators  
of ecosystem changes from N  
fertilization**

**Soils are soaking up nitrogen...  
like a sponge**

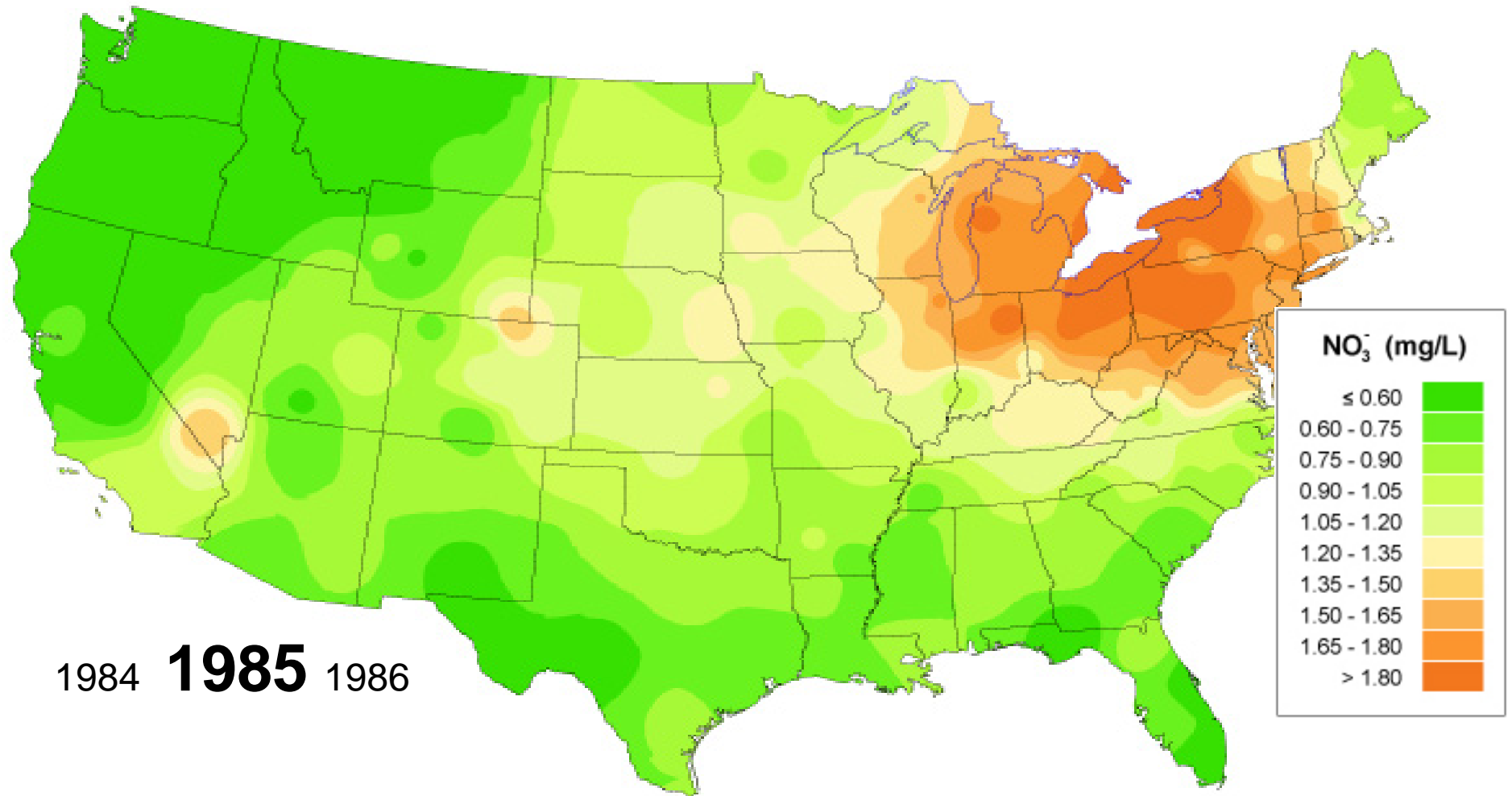
**Shift from alpine flowers to  
grasses likely occurring**

**Changes to tree and soil chemistry are  
beginning**



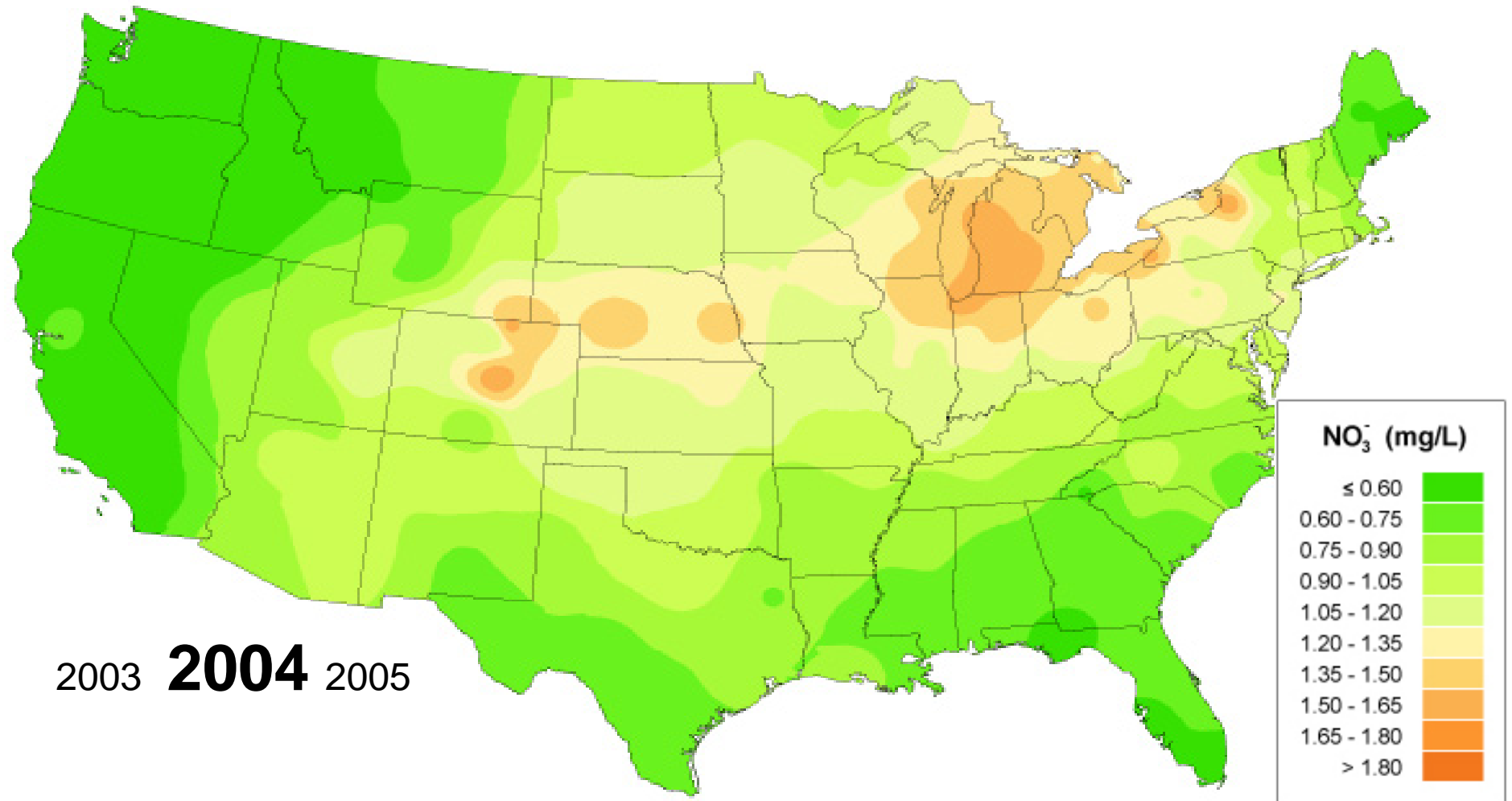
# Deposition Values/Trends

# Nitrate Ion Concentrations 1985-2004

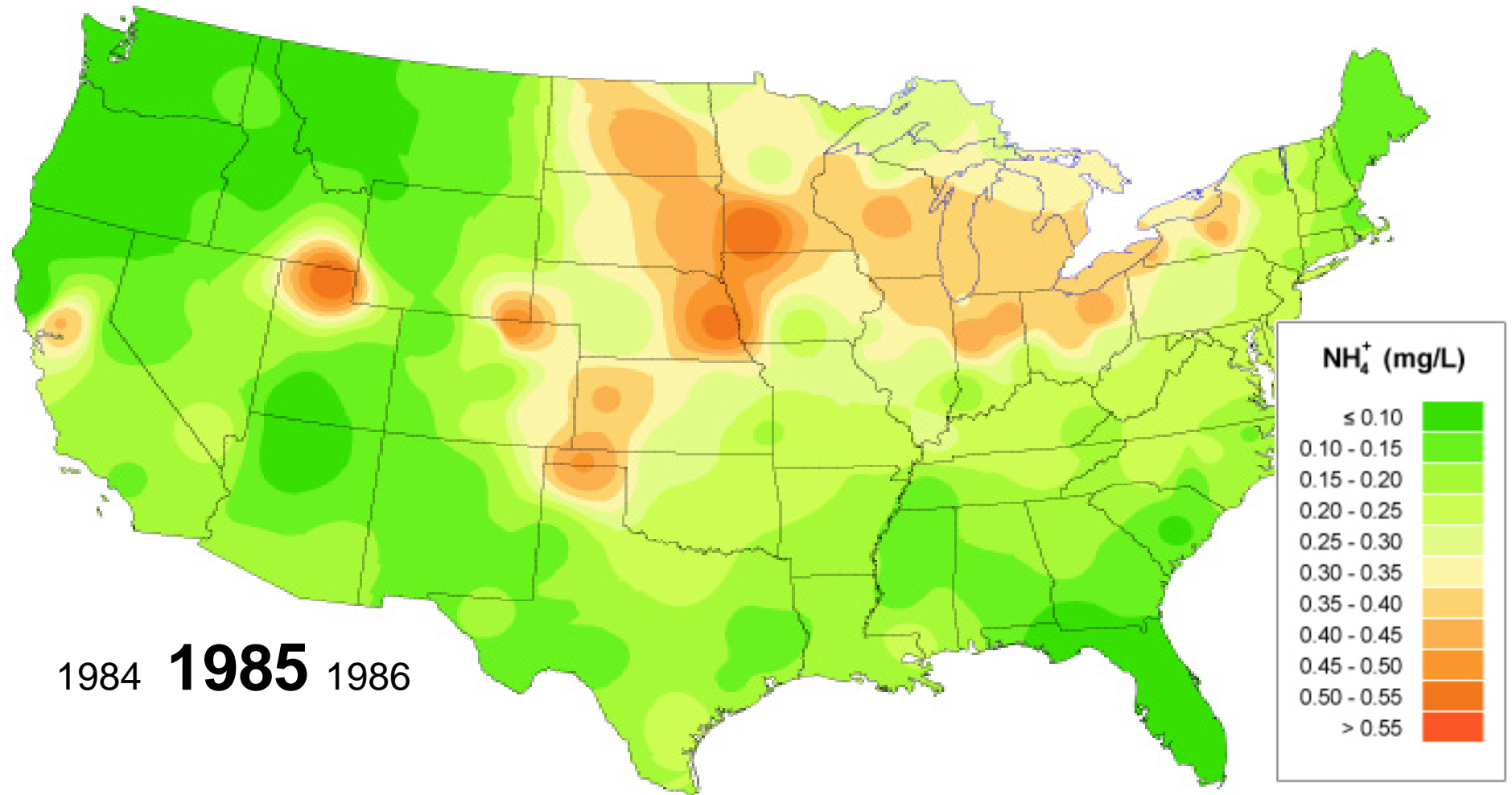




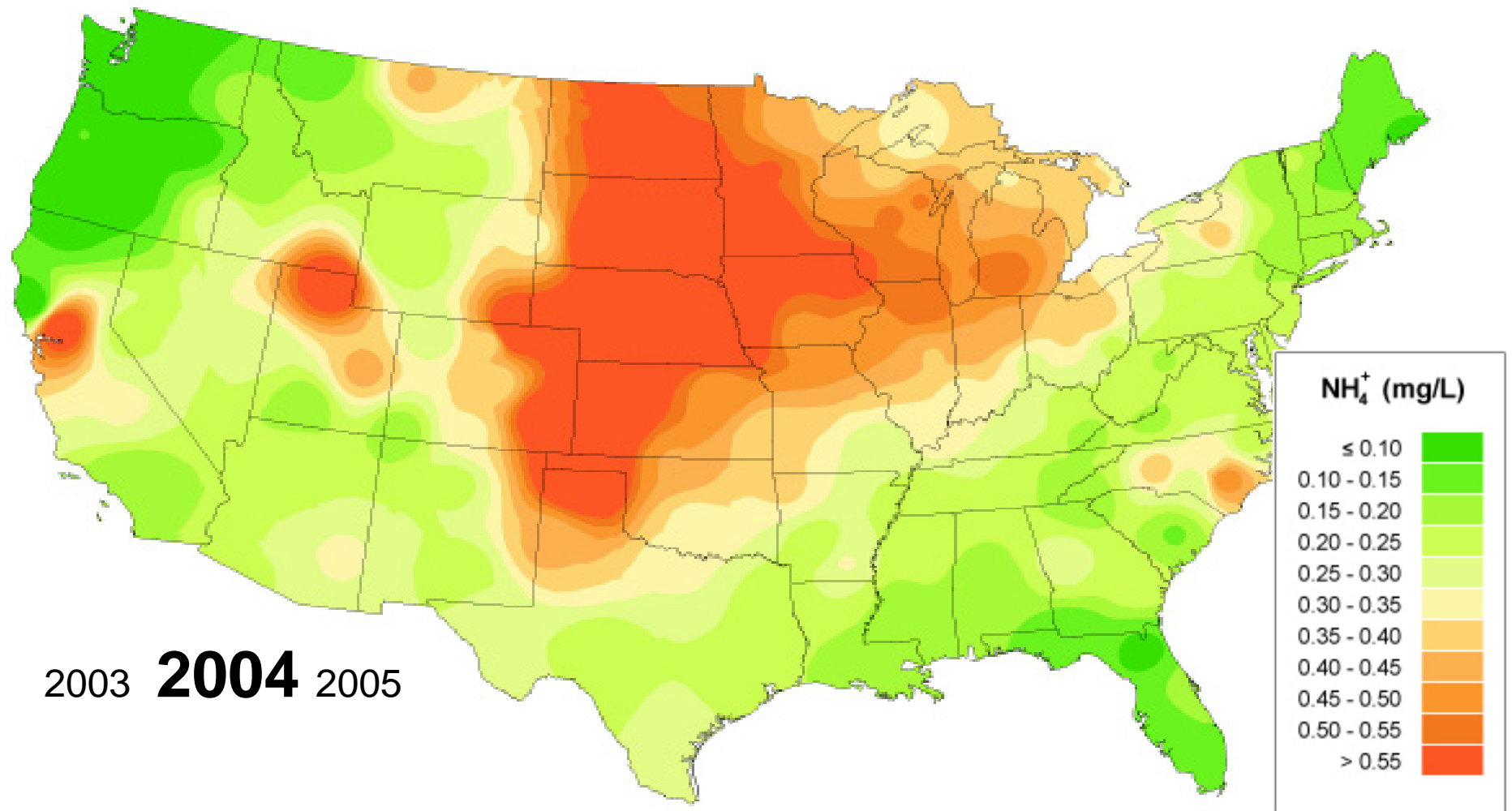
# Nitrate Ion Concentrations 1985-2004



# Ammonium Ion Concentrations 1985-2004



# Ammonium Ion Concentrations 1985-2004



# Nitrogen Deposition Monitoring in the Park



**National Atmospheric Deposition Program (NADP)  
Precipitation Collector and Rain Gage**



**USGS Divide-wide  
Snowpack Survey**



**Clean Air Status  
and Trends Network  
(CASTNet)**



# Deposition of Nitrogen at RMNP

- Current wet and dry nitrogen deposition averages 4.0 kilograms per hectare per year
  - Wet nitrogen deposition averages 3.1 kg/ha/yr
  - The pre-industrial or “natural” levels of nitrogen deposition are estimated to be around 0.2 kg N/ha/yr
  - Current deposition is about 20 times higher than pre-industrial levels
- Wet deposition of nitrates has increased 23% between 1985 and 2004
- Wet deposition of ammonium has increased 57% between 1985 and 2004
- This increased nitrogen loading is unnaturally changing high elevation ecosystems at RMNP





Critical Load for N

# Critical Load at Rocky Mountain National Park

- Large body of evidence indicates nitrogen deposition has affected and continues to affect ecosystems within the park.
- Current wet deposition is monitored at 3.1 kg/ha/yr (total—wet and dry—estimated at 4 kg/ha/yr). Natural background is estimated at 0.2 kg/ha/yr.
- Specific, published (peer-reviewed) research has shown that wet deposition levels at the time the biological changes started to occur was 1.5 kg/ha/yr.



# Critical Load and the Resource Management Goal

- The quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge
- RMNP Superintendent identified 1.5 kg/ha/yr wet deposition as the critical load for eutrophication (N fertilization), and as a park resource management goal
- RMNP has adopted a wet nitrogen deposition resource management goal of 1.5 kg N/ha/yr
- CDPHE, the Colorado Air Quality Control Commission, and EPA have endorsed this goal

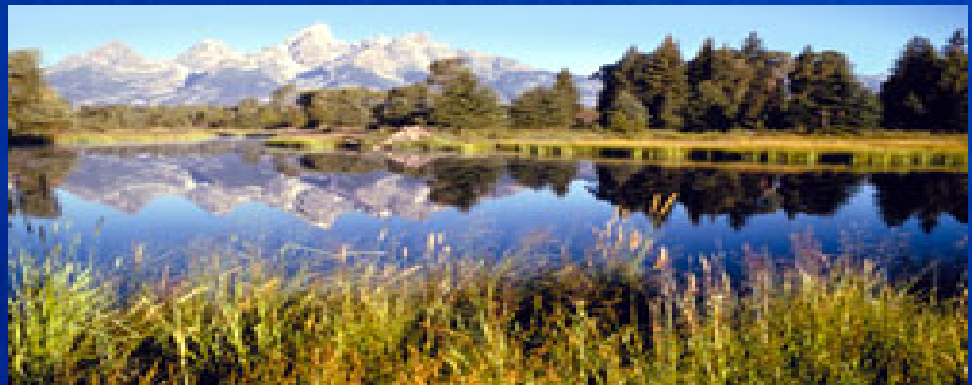


The background of the slide is a monochromatic blue-tinted photograph of a landscape. It features several layers of rolling hills and mountains, creating a sense of depth and perspective. The sky is a lighter shade of blue, and the overall atmosphere is serene and expansive. The text is overlaid on the middle of the image.

# Collaborative Process and Plan Development

# Collaborative process to address air quality concerns at Rocky Mountain National Park

- **MOU (2005) between NPS, EPA Region 8 and Colorado's Air Pollution Control Division: to develop "air quality management policies and programs to address harmful impacts to air quality and other natural resources occurring in Rocky Mountain National Park."**
- **Colorado Air Quality Control Commission subcommittee**
- **Participants and stakeholders have reviewed the research, identified information needs and have begun to discuss options for improving conditions**
- **"Weight of the evidence" approach to consider reductions**
  - **Monitoring/trends**
  - **Attribution studies**
  - **Planned reductions**
- **A Plan has been developed**



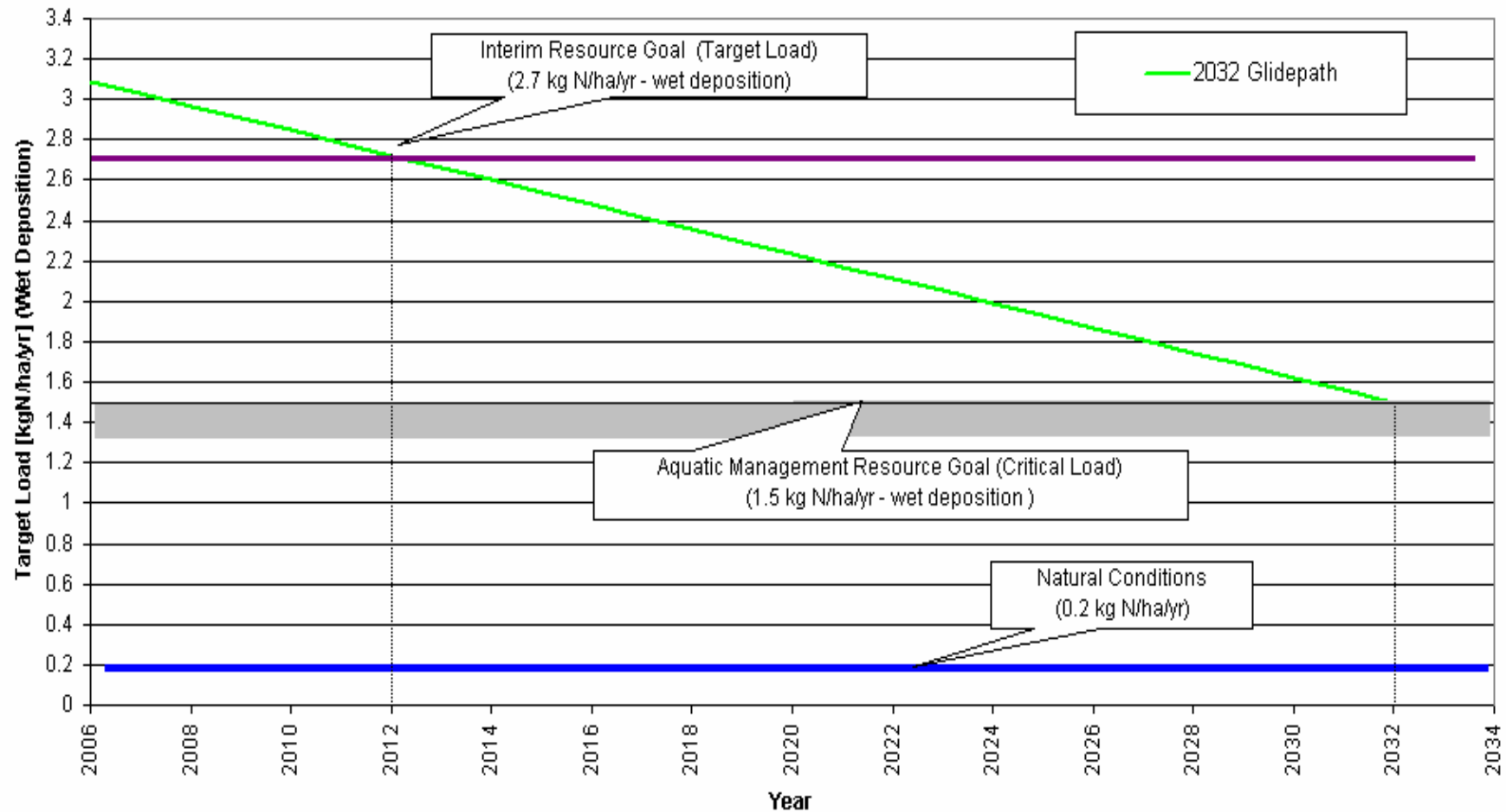




# Highlights of the RMNP Nitrogen Deposition Reduction Plan

# Rocky Mountain National Park

## 2032 Glidepath for Nitrogen Deposition Reduction



# NOx Control Options

- A list of possible control options to reduce NOx emissions are provided for numerous source types
  - Stationary sources
  - Mobile sources
  - Area sources
- A general overview of each with emission reductions and cost estimates are provided

# Ammonia Reduction Options

- A list of possible best management practices to reduce ammonia emissions are discussed
  - BMPs for crop production
    - Tillage and fertilizer management
  - BMPs for livestock production
    - Feed, livestock, facility, wastewater, manure management
- A general overview of each with emission reduction potential and implementation issues are provided
- Research needs and plans are also presented
- BMPs for domestic fertilizer and controls for stationary sources will be investigated



# Mandatory Emission Reduction Measures are not being Proposed at this Time

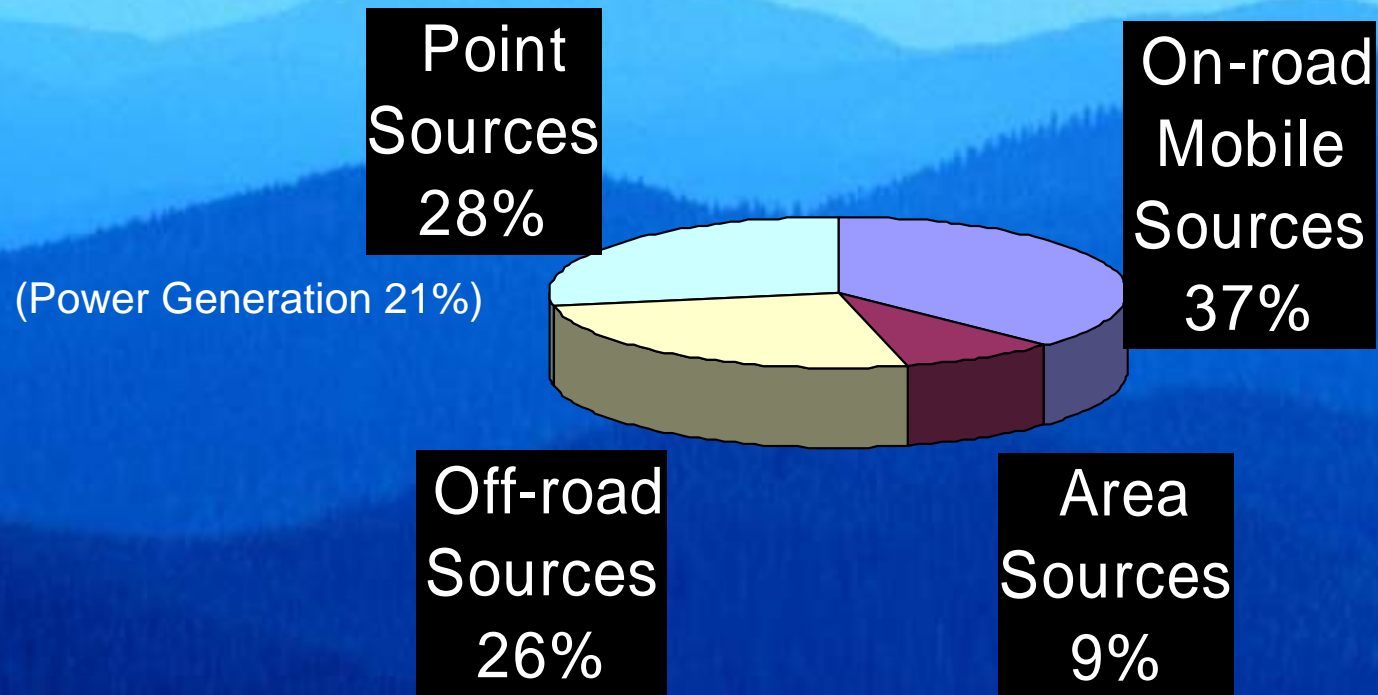
- Voluntary reductions, best management practices, and benefits from current programs will be emphasized
- Future air quality regulatory efforts are anticipated
  - MOU agencies commit to develop NO<sub>x</sub> reduction measures for consideration during the Regional Haze SIP process
  - Contingency plan measures will be developed by 2010 through a public process
- For water quality, restoration of waters using a collaborative, community-based approach will be utilized



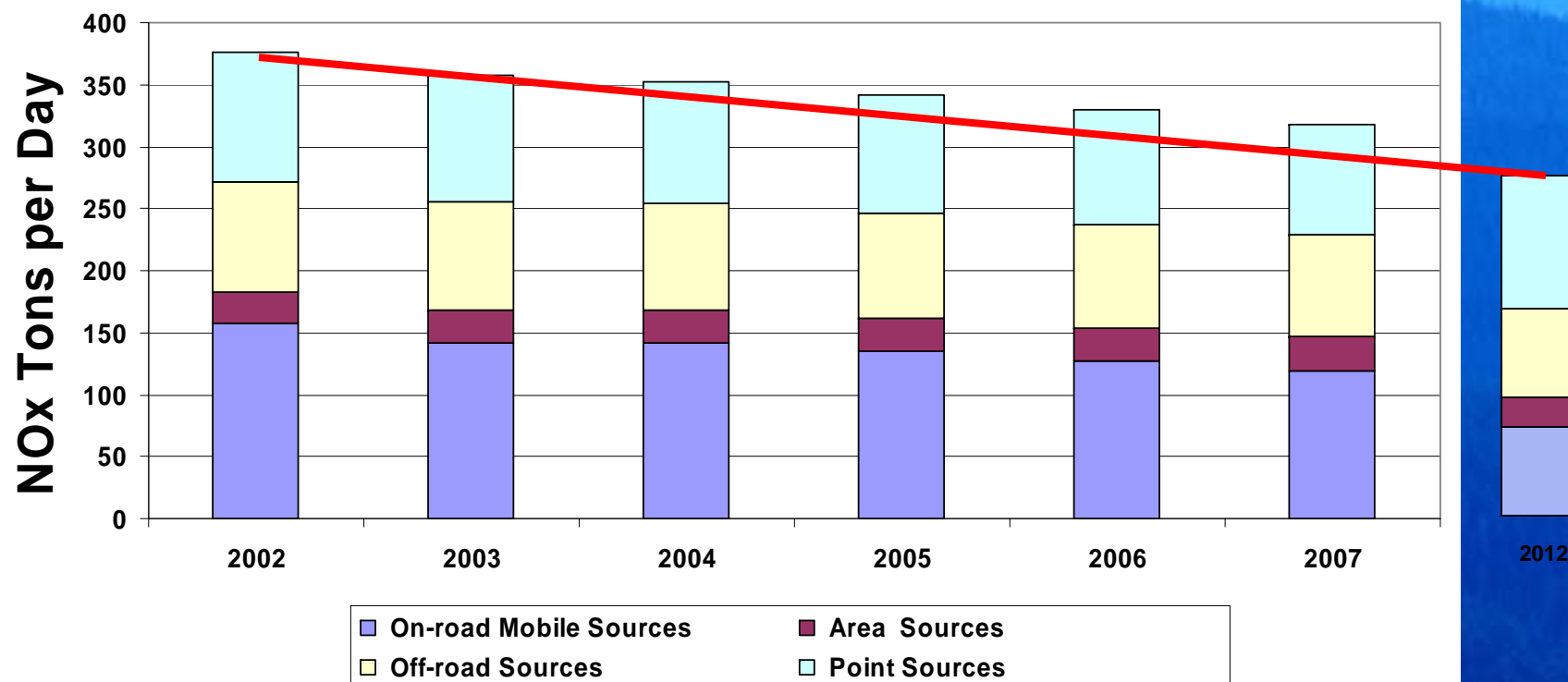
# Trends in Emissions

- **Ammonia**
  - Current and 2018 emissions have been estimated and continue to be refined
- **NOx reductions have been estimated**
  - 23% reduction 2012 along the Front Range
    - Fueled by 50% reduction from mobile sources
  - 28% reduction by 2022 for metro Denver
    - Fueled by 71% reduction from mobile sources
  - 30% reduction by 2018 for the Western U.S.

# NOx Source Categories - 2007

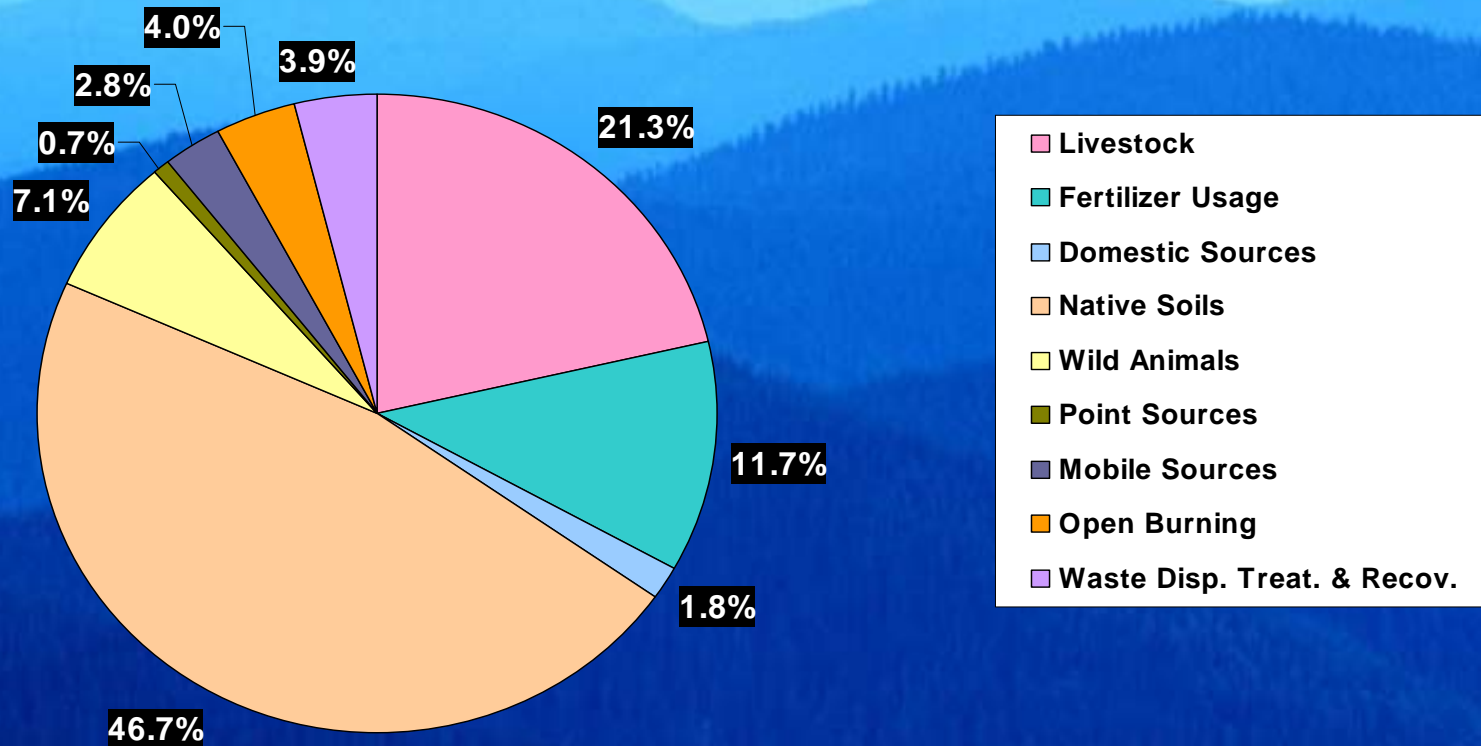


# Nitrogen Oxides Emissions Trend

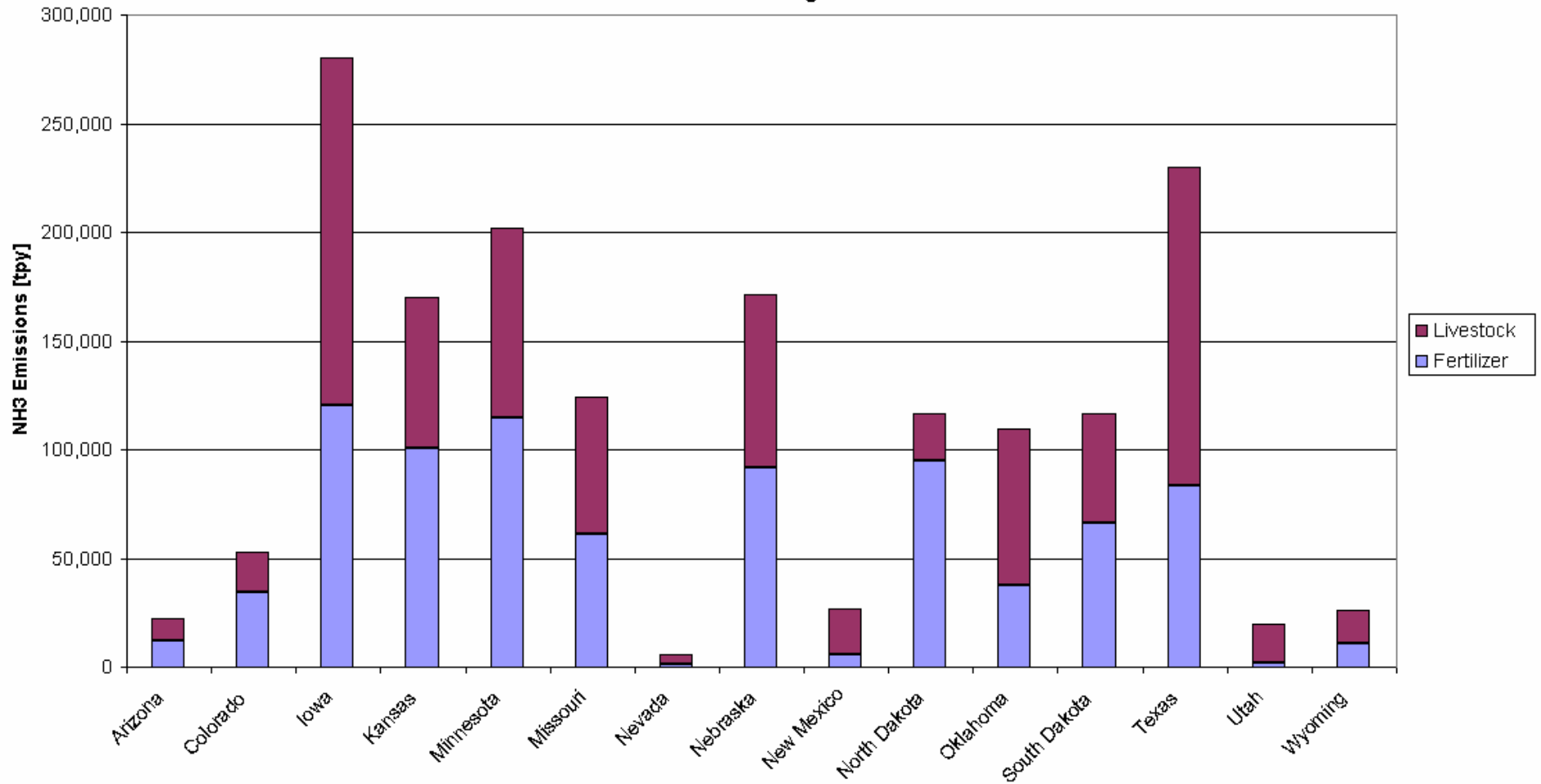


# Colorado Ammonia Emission Estimates

**2002 Statewide NH<sub>3</sub> Emissions**  
*by Source Category*



## Agriculture Ammonia Emissions from Surrounding States





# Deposition, Emissions and Transport and Attribution

- Deposition monitoring and trends data are presented
  - Current deposition is well above the resource management goals
  - N deposition has increased over the last 25 years
- Colorado emissions of N from NO<sub>x</sub> and ammonia are estimated
  - 34% mobile sources
  - 23% agriculture
  - 24% area sources
  - 19% point sources
  - Trends in activities and emissions are presented
- Anticipated NO<sub>x</sub> reductions may result in achieving the 2012 target load of 2.7 kg N/ha/yr *if* ammonia emissions remain constant

# Deposition, Emissions and Transport and Attribution

- Further research will better help determine source regions and emission reduction benefits
  - Regional Haze visibility modeling work
  - ROMANS study over the next 1-2 years
- Metro-area, in-Park, in-State and out-of-State culpability will be better defined
- Attribution of N deposition by source category will be possible
- The ozone/N deposition interplay will be examined

# Implementation Strategy and Continuing Evaluation

- **Near term:**
  - Existing and planned NO<sub>x</sub> reduction measures will be implemented
  - NO<sub>x</sub> strategies will be developed
  - Agricultural BMPs accepted by the industry will be broadly implemented in Colorado
  - Ammonia emissions will be better characterized
  - Modeling and assessment activities will proceed



# Implementation Strategy and Continuing Evaluation

- **Longer term:**
  - **Ammonia-reducing agricultural BMPs will be researched, field tested**
    - MOU agencies will work with producers to implement BMPs that are shown to be cost-effective
  - **Ammonia-reducing BMPs and emission reduction programs for urban sources and water treatment facilities will be researched and implemented**
    - Urban fertilizer usage research began this Spring
  - **Education/outreach to the agricultural sector, industrial groups and the public will occur**
  - **Additional NOx strategies, voluntary and regulatory, will be considered**

# Agency Endorsements

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## Rocky Mountain National Park Nitrogen Deposition Reduction Plan

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### Memorandum of Understanding Agencies

*Vaughn Baker*

Vaughn Baker, Superintendent, Rocky Mountain National Park

*Michael D. Snyder*

Michael Snyder, Acting Director, National Park Service, Intermountain Region

*for Robert E. Roberts*

Robert E. Roberts, Regional Administrator, Environmental Protection Agency, Region 8

*James B. Martin*

James B. Martin, Executive Director, Colorado Department of Public Health & Environment

**August 16, 2007**



<http://www.cdphe.state.co.us/ap/rmnp.html>

**The Website for this presentation, the Nitrogen Deposition Reduction Plan, the Options and Technical Papers, and additional information about the RMNP Initiative**



A photograph of a tundra field in Loch Vale, Rocky Mountain National Park. The foreground is dominated by numerous bright pink geraniums with five petals and dark centers. Interspersed among them are several bright yellow buttercups. The background is a dense field of similar flowers, creating a vibrant, colorful landscape. The text "Questions or Comments?" is overlaid in the center in a large, white, sans-serif font.

Questions or Comments?

Rocky Mountain National Park – Tundra Flowers in Loch Vale