THE ROCKY MOUNTAIN NATIONAL PARK
AIR QUALITY INITIATIVE:
AIR QUALITY CONTROL COMMISSION
ANNUAL BRIEFING

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RMNP AQ Initiative Annual AQCC Update
RMNP AQ INITIATIVE: BACKGROUND

- Interagency effort addresses air pollution issues in RMNP
  - Focus on nitrogen deposition
- “Weight of the evidence” approach considers:
  - Monitoring/trends
  - Attribution studies
  - Planned reductions
- Nitrogen Deposition Reduction Plan (2007)
- Contingency Plan (2010)
Alpine more susceptible to effects from Nitrogen deposition

precipitation + high NO\textsubscript{x} + high NH\textsubscript{x} = higher deposition rates

thin soils

low rates of plant growth

vegetation & soils have limited capacity to buffer the chemical effects of N deposition
CRITICAL LOAD

- Large body of evidence indicates nitrogen deposition has affected and continues to cause harmful effects on sensitive ecosystems within the park.
- Current wet deposition monitored at ~3.2 kg N/hectare/year (rolling 5-year average - 2011-2015)
- Natural background estimated at 0.2 kg N/hectare/year

- Specific, published (peer-reviewed) research has shown that wet deposition levels at the time harmful effects started to occur was ~1.5 kg N/ha/yr.
Rocky Mountain National Park: Continuum of Impacts to Ecological Health

N Load (kg/ha/yr)

- Current N deposition in Rocky Mtn. NP: 3.2/4.9
- Target Load: Park Natural Resource Goal: 1.5/2.3
- Natural background N deposition: 0.2/0.5

Solid line text box = observed effects; Dotted line text box = potential effects

- Change in alpine plant species
  \[ \text{CL} = 3.0 \text{ kg/ha/yr total N} \]
- Change in aquatic plant species composition
  \[ \text{CL} = 1.5 \text{ kg/ha/yr wet N} \]
- Increases in “weedy” lichen species
  \[ \text{CL} = 3.1 \text{ kg/ha/yr total N} \]
- Soil N saturation/leaching
  \[ 4.0 \text{ kg/ha/yr total N} \]
- Forest decline (acidification effects on trees)
  \[ \text{CL} = 8.0 \text{ kg/ha/yr total N} \]
- Effects on aquatic animals (episodic acidification) begins
  \[ \text{CL} = 4.0 \text{ kg/ha/yr total N} \]

Potential future ecosystem impacts if N deposition increases

“Weight of evidence” of ecosystem health decline on east side of park
NITROGEN DEPOSITION REDUCTION PLAN & CONTINGENCY PLAN

• Original NDRP endorsed by NPS, EPA and CDPHE and the Colorado Air Quality Control Commission on August 16, 2007
  1) Management approach based on collaborative process
  2) Voluntary approach, no mandatory requirements or standards
  3) Sets long-term (25-year) resource management goal
  4) Sets timeline and interim (5-year) milestone goals intervals to achieve nitrogen reduction goal by 2032
  5) Strategies to achieve goal
  6) Identifies options that can be implemented on a voluntary basis

• Contingency Plan endorsed by NPS, EPA and CDPHE and the Colorado Air Quality Control Commission on June 22, 2010
  ❖ Adaptive management approach consisting of 5 elements
    1) Data Tracking Plan
    2) Triggering Mechanism
    3) Recommending & Implementing Contingency Measures
    4) List of Potential Contingency Measures
    5) Public Outreach & Participation
DEPOSITION TRENDS THROUGH 2015
MONITORING & TRACKING

- Wet nitrogen deposition has stabilized in both the long- and short-term

- Long-Term Statistical Trend (1984-2015*):
  - Wet nitrogen deposition increased at RMNP Loch Vale until 2010 and is now stable, although it continues to increase at RMNP Beaver Meadows
  - Ammonium is increasing at all 5 sites
  - Nitrate is decreasing at 2 sites

- Short-Term 5 or 7 year Statistical Trends (2011-2015 or 2009-2015):
  - Wet nitrogen deposition is stable at all sites
  - Ammonium is increasing at 3 sites
  - Nitrate is decreasing at 1 sites

- Loch Vale Co-located site (2009 - 2013)
  - Provided QA/QC support for trends
  - Basis for confidence intervals

*Site records vary between 1980 and 1987
alpha = 0.10
When the measured value = the glidepath, 90% confident that N deposition will exceed the lower bound. 10% chance that the true deposition is greater than the upper bound.
NITROGEN SOURCE AREAS & TRANSPORT PATTERNS

• During spring and fall upslope weather events, high concentrations of both types of nitrogen move from eastern urban & agricultural areas of Front Range to RMNP

• Regular summer upslope transport from mountain valley convection

• Substantial portion of deposited nitrogen originates in Colorado
  • More than 40% of ammonia from CO, about 70% from Front Range (Denver to state line), Morgan, and Weld counties
  • Less than 50% nitrogen oxides (NO$_x$) from Colorado
  • Reducing NH$_x$ emissions in closer proximity to park have greater positive effect (not all emissions are equal)

• In-park/nearby sources of ammonia not considered significant contributors to deposition in RMNP
Agricultural Best Management Practices:
Helping to Reduce Nitrogen Impacts at Rocky Mountain National Park
AGENCY EFFORTS WITH COLORADO AGRICULTURE

• What does success look like with CO Agriculture?
  • reduced nitrogen deposition contributions
  • ongoing collaboration
  • filling data gaps
  • demonstrated implementation of BMPs
  • Increasing participating producers
  • Early Warning System implementation
COLORADO AGRICULTURE DISCUSSIONS

• Focus our efforts on what matters most geographically, by industry, or size of operation.
  • Improve understanding of the agricultural community's role to help inform reduction strategies and the next milestone decision.
  • Establish “S.M.A.R.T” indicator(s) of ammonia emissions (specific, measurable, achievable, relevant, time-bound). (e.g., beef production vs manure), and key data sources.
  • Use “S.M.A.R.T” indicator(s) to determine trends in agricultural ammonia emissions.
  • Evaluate efficacy of the Early Warning System followed by roll-out as warranted.
EARLY WARNING SYSTEM/AGRICULTURAL POLLUTION PREVENTION PROJECT

• Goal: demonstrate effectiveness of pilot-scale “early warning system” that alerts agricultural producers in advance of upslope weather event likely to transport ammonia & reactive nitrogen into RMNP
  • Producers alter or delay farm or manure management practices until weather event elapsed

• Agricultural producer participants: 60
• Non-producer participants tracking warnings: 33
• Number of meteorological warnings April 2014 - Dec 2015
  • 2014: 10 warnings total (majority in July/Sept) (20 days total)
  • 2015: 15 warnings so far (majority in April/Oct) (31 total days)
• Affected producers provided 21±5 responses per warning
  • 75% of respondents changed practices for full warning period
  • Additional 10% changed for portion of warning period
• Number of fact sheets developed/distributed: 3
• Early Warning System paper (Piña et al.) will be submitted by April 2017

• Additional monitor in RMNP (July 2014 March-Oct 2015, 2016, beginning again March 2017) (NPS/EPA)
  • Continuous ammonia
  • Daily ammonia, nitric acid, PM2.5 nitrate and ammonium
  • 3x/week wet dep of oxidized, reduced, and organic N

• USDA funded summertime ammonia network (March – October; 2017 will include several Denver area sites)

• Transect of High-Time Resolution Ammonia (NRCS/Weld County/CLA/Dairy Board/CDPHE)
2016 SUMMER AVERAGE MAP

RMNP Avg 0.5 ppb

Kersey not to scale 60 ppb

Credit: Katie Benedict, CSU
MONITORING & RESEARCH PROJECTS

- Mobile ammonia measurements in NE Colorado (June 2016) (CDPHE)
- Analysis of real-time data for evaluation of Early Warning System and source analysis (CSU)
- Comparison with Satellite Observations (CSU)
- Comparison with CAMx Model Simulations (CSU)
NO\textsubscript{X} PROJECTS

• Case study for EPA’s Policy Assessment for Review of Secondary NAAQS for NO\textsubscript{x}
  • Notes that nitrogen deposition can alter species composition and cause eutrophication, drawing initial conclusions that existing standard does not protect such ecosystems and resulting services from impairment

• MOU agencies developing NO\textsubscript{x} Emissions Reductions Fact Sheet for stakeholders
  • Issue and who’s involved
  • Sources and regulations
  • Where do we want to be? (emissions)
  • What is being done about it for the future?
MOU AGENCY PLANS

• Planning for 2017 Milestone
  • Fill information gaps to inform the decision in 2018
• Focused effort with Agriculture Subcommittee to understand ammonia emissions, trends, and reduction efforts
• Supporting higher resolution ammonia monitoring in Front Range and Park
• Studies to further understanding of deposition factors and source apportionment
• Working to understand current and future oil and gas contributions
• Request next AQCC update shortly after 2017 Milestone Report release
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RMNP Website: www.colorado.gov/cdphe/rmnpinitiative
MILESTONE REPORTS:
WEIGHT OF THE EVIDENCE
APPROACH & CONCLUSIONS

• Assessment of multiple evidence types

• Two identified questions:
  • 20xx Nitrogen Deposition Interim Milestone met?
  • Will the RMNP Nitrogen Deposition Contingency Plan be triggered?

• Quantitative and Qualitative Factors

• Therefore, the MOU agencies concluded that the 2012 interim milestone had not been achieved. However, the RMNP Nitrogen Deposition Contingency Plan was not triggered at this time.
WEIGHT OF THE EVIDENCE SUMMARY (AS OF 2012)

• Demographic trends show Front Range population and vehicle miles increasing while agricultural counts steady

• NOₓ emissions decreasing nationally and locally while ammonia emissions remain stable

• Efforts continue to improve Colorado’s nitrogen emission inventories

• Significant NOₓ reductions on the horizon expected to contribute to reduced nitrogen deposition in RMNP

• Ag Subcommittee and multiple ammonia-related research efforts promising
  • 5-year adaptive plan & Early Warning System pilot

• In-Park emission strategies in place
  • Vehicle transportation systems
  • Increases in fleet efficiency
  • Environmental Management System