

# Critical Loads, Deposition, and Exceedances in the United States – *Transitions*

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Critical Loads of Atmospheric Deposition Science Committee

# Critical Load (CL) “Transitions” in the U.S.

1. NADP-CLAD CL Database →  
Management and Policy in U.S.
2. Transitions within NADP-CLAD



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# CL Database → Management and Policy in U.S.

## **NADP-CLAD National Critical Load Database (NCLD) v3.0:**

- CLs in NCLD:
  - Forest soil acidification
  - Surface water acidification
  - 5 Empirical CLs of N
- 2,989,920 geographically-referenced CLs
- Used by U.S. Federal Agencies to support policy development/review and natural resource management

The screenshot shows the NADP website with a focus on the CLAD National Critical Load Database (NCLD). The sidebar on the left lists NADP Committees, EROS, NOS, CLAD, TDEP, and AMSC. The CLAD section is highlighted. The main content area is titled "CLAD National Critical Load Database (NCLD), version 3.0". It describes the database as a compilation of empirical and calculated critical loads data and information from regional and national scale projects. It highlights critical loads of sulfur and nitrogen deposition and their effects on terrestrial and aquatic environments. A report is included in the download file with details on calculations and references for all critical loads. It also mentions that CLAD members submitted data to this cooperative effort as a productive and meaningful way to share information to improve methods for estimating, calculating, mapping, interpreting, and refining critical loads. The page invites users to use the data, share findings, and participate in updates. It encourages joining CLAD to receive notifications. A "CLAD Database Access Registration" section follows, with a note that users will receive a link to the database by email after submitting a form. The registration form includes fields for personal information (Name, Affiliation, Email) and planned use of data (Education, Research, Environmental Assessment, Policy Development, Other), with "Submit" and "Reset" buttons. At the bottom, there is a copyright notice for 2019 and links to Data Use Conditions, Comments, Contacts, Home, and social media icons for Facebook, Twitter, and LinkedIn.

<http://nadp.slh.wisc.edu/committees/clad/db/>



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# New studies for the NADP-CLAD NCLD

- **Herbaceous species richness (ecoregion-level):**
  - Simkin, S. M., et al. 2016. Conditional vulnerability of plant diversity to atmospheric nitrogen deposition across the United States. *Proceedings of the National Academy of Sciences USA* 113:4086–4091.
- **Surface Water Acidification:**
  - Four studies in eastern U.S.
- **Herbs species:**
  - Christopher M. Clark, Samuel M. Simkin, Edith B. Allen, William D. Bowman, Jayne Belnap, Matthew L. Brooks, Scott L. Collins, Linda H. Geiser, Frank S. Gilliam, Sarah E. Jovan, Linda H. Pardo, Bethany K. Schulz, Carly J. Stevens, Katharine N. Suding, Heather L. Throop, and Donald M. Waller. Potential vulnerability of 348 herbaceous species to atmospheric deposition of nitrogen and sulfur in the U.S. In review, *Nature Plants*.
- **Trees species:**
  - Horn KJ, Thomas RQ, Clark CM, Pardo LH, Fenn ME, Lawrence GB, et al. (2018) Growth and survival relationships of 71 tree species with nitrogen and sulfur deposition across the conterminous U.S. *PLoS ONE* 13(10): e0205296.
- **Lichens community:**
  - Geiser, LH; Heather Root, HT; Jovan, SE; St. Clair, L; Dillman, K.L.; Schwede, D. In prep. Lichen community responses to atmospheric deposition and climate indicate protective air pollution thresholds for US Forests.
  - Geiser, LH; Nelson, PR; Jovan, SE; Root, HT; Clark, CM. (In review) Assessing ecological risks from atmospheric deposition of nitrogen and sulfur using epiphytic macrolichens. *Biodiversity* (Special Issue on Lichen Diversity and Biomonitoring) [https://www.mdpi.com/journal/diversity/special\\_issues/lichen\\_diversity\\_biomonitoring](https://www.mdpi.com/journal/diversity/special_issues/lichen_diversity_biomonitoring)



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# U.S. Federal Agencies that use CLs

- Environmental Protection Agency (EPA) – to support review of NOx and SOx National Ambient Air Quality Standards
- National Park Service (NPS) – to assess current risk to resources and support review new point sources of pollution
- Forest Service (USFS) – to support development of management plans and status and trends reports for national forests
- Bureau of Land Management (BLM) – to support review of new sources of pollution in protected areas



# CLAD Scientific Working Groups

- **WG-1:** National Critical Load Database (NCLD)
- **WG-2:** Critical Load Uncertainty
- **WG-3:** Critical Load Synthesis
- **WG-4:** Uncertainty in Deposition Estimates
- **WG-5:** Critical Loads Communication and Outreach



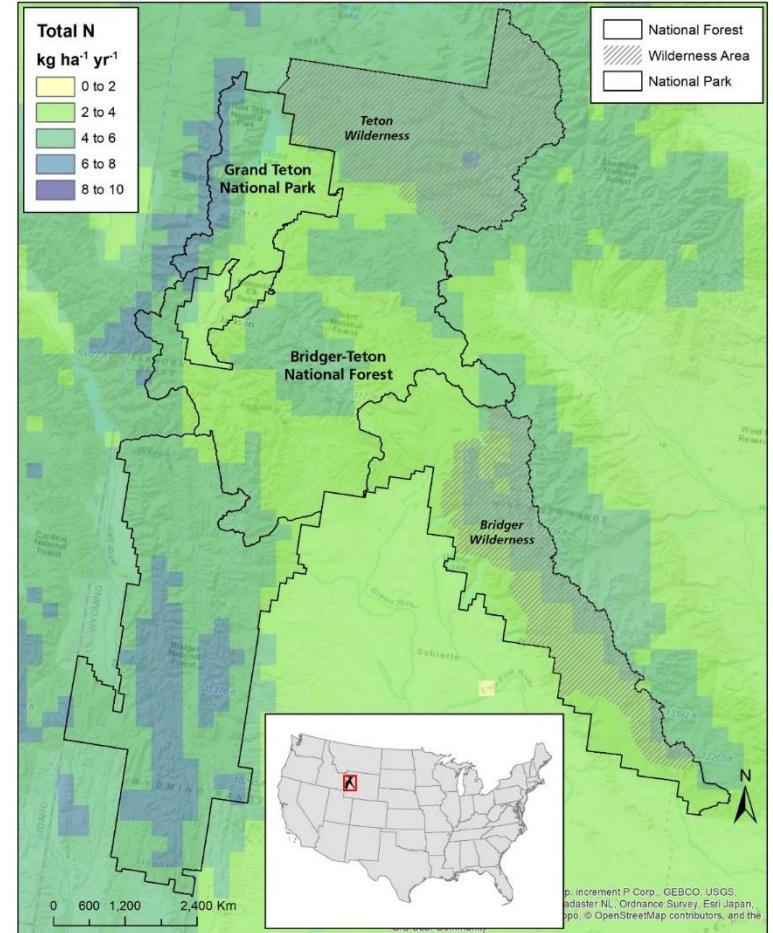
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# CLAD Scientific Working Groups

- **WG-3: Critical Load Synthesis:**
  - Objective: Develop standardized methods to represent individual and multiple critical load types in same geographic area.
  - Goal: Determine which CL to use in a given location.
  - Lead by: Linda Pardo (USFS), Chris Clark (EPA), and Mike Bell (NPS)

## Example: Bridger Teton National Forest

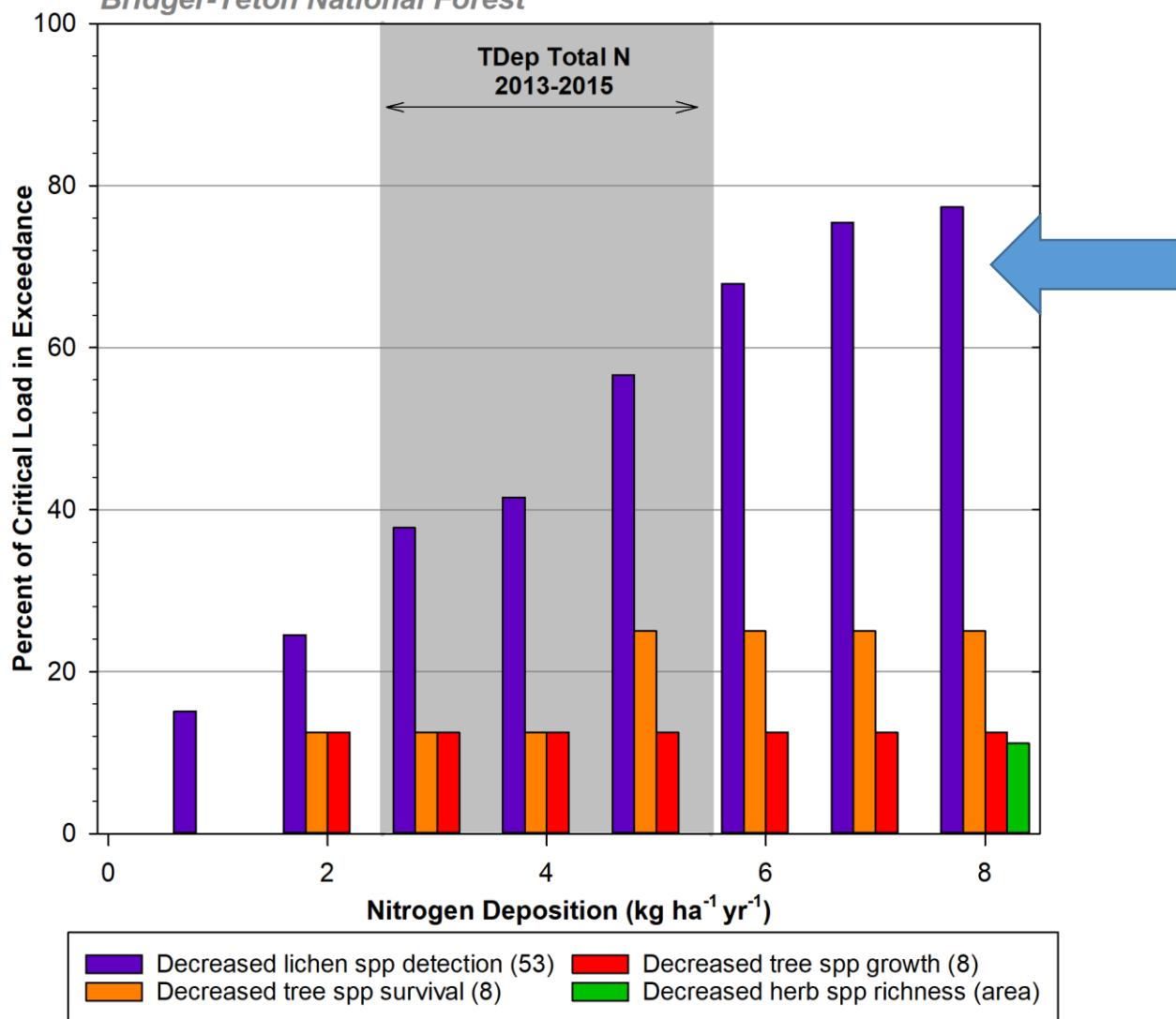


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## Critical Load of N

Bridger-Teton National Forest



# Bridger-Teton National Forest

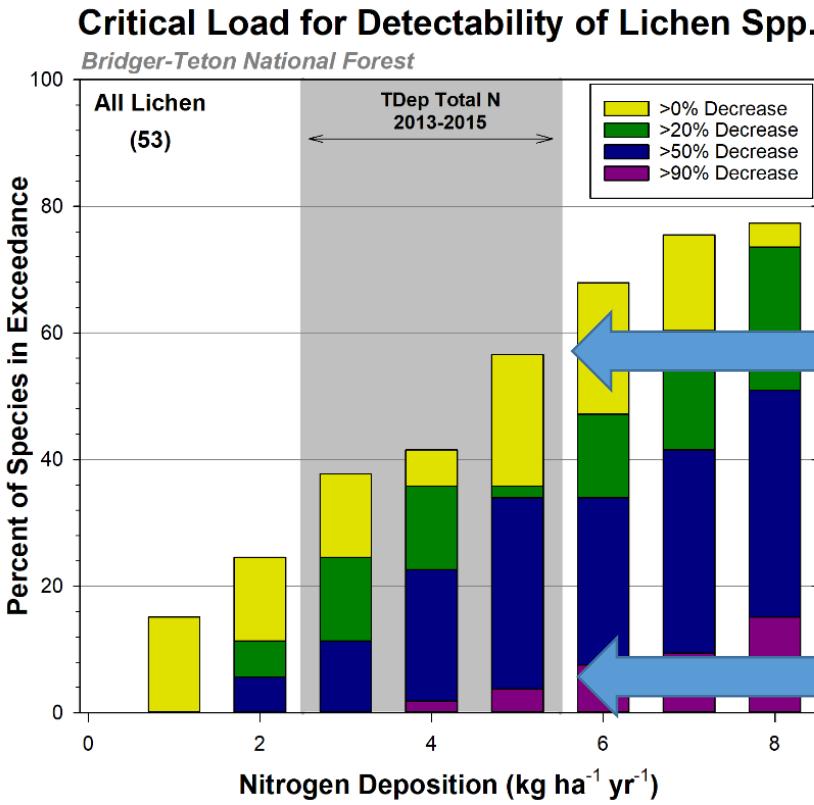
- Critical Loads (N) available:
  - Terrestrial - N
    - Lichen species detectability (53 spp)
    - Tree species survival (8 spp)
    - Tree species growth (8 spp)
    - Herbaceous species richness (open and closed canopy)
- Critical Loads range from:
  - 1 – 8 kg N/ha/yr
- Exceedances range from:
  - 0 – 80% of spp
  - 2 biological receptors / 3 CL types



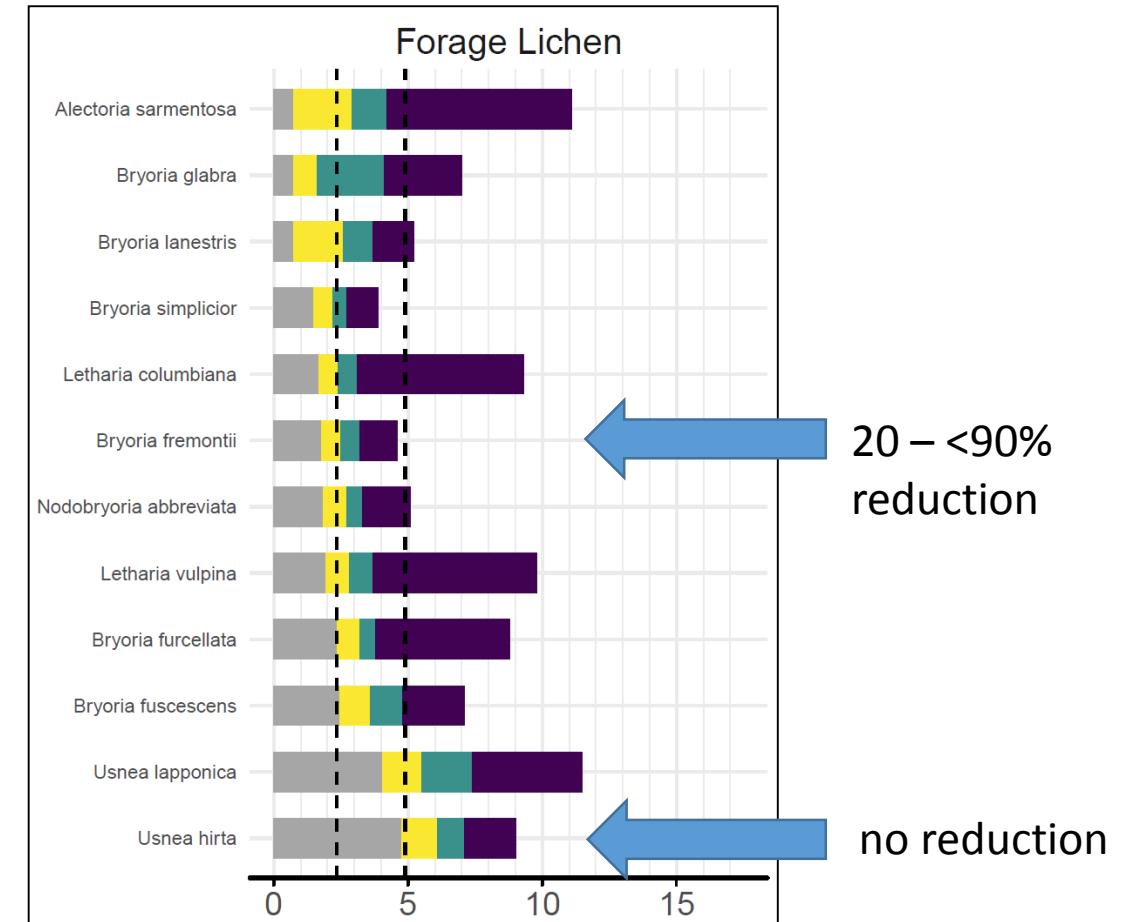
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# Different levels of acceptable change



# Different sensitivities by species

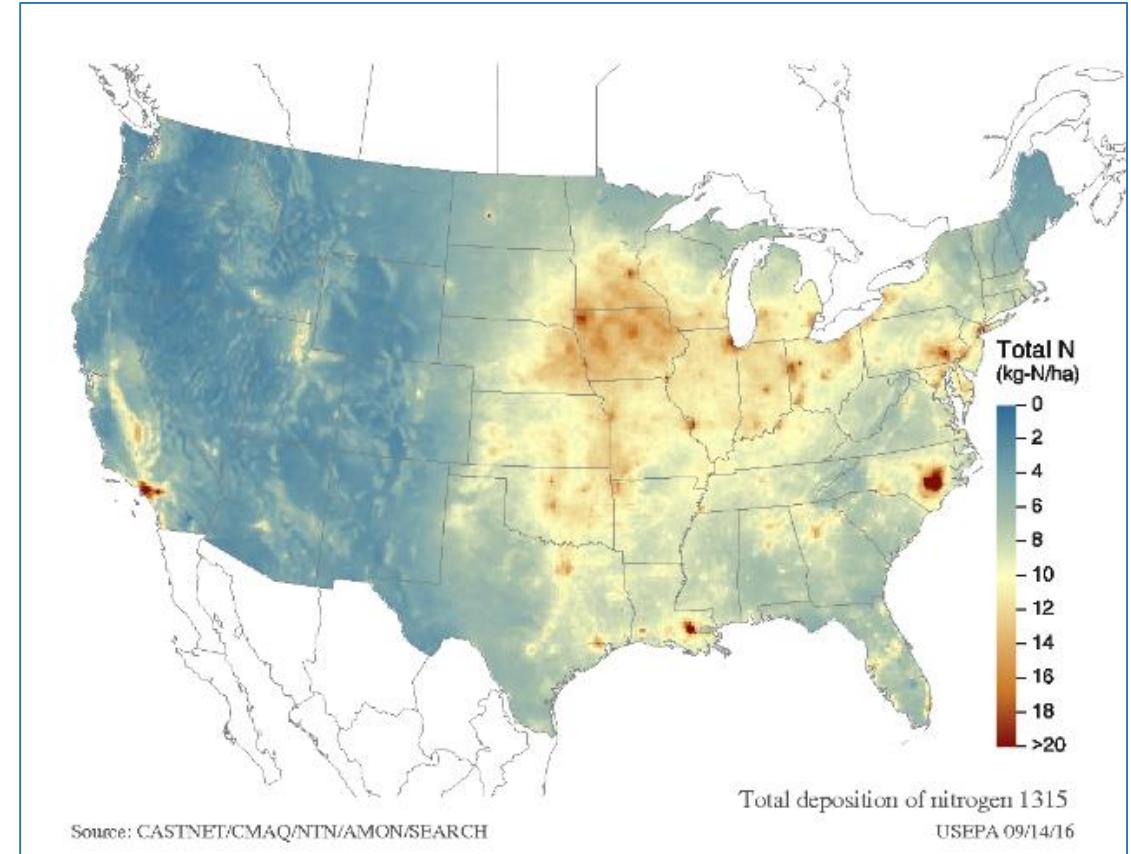


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# CLAD Scientific Working Groups

- **WG-4: Uncertainty in Deposition Estimates**
  - Objective: Characterize the uncertainty of deposition estimates through measurement–model and model–model comparisons.
  - Goal: Understand the degree to which variation and uncertainty in deposition estimates influence CL exceedances.
  - Lead by: Mike Bell (NPS) and John Walker (EPA)

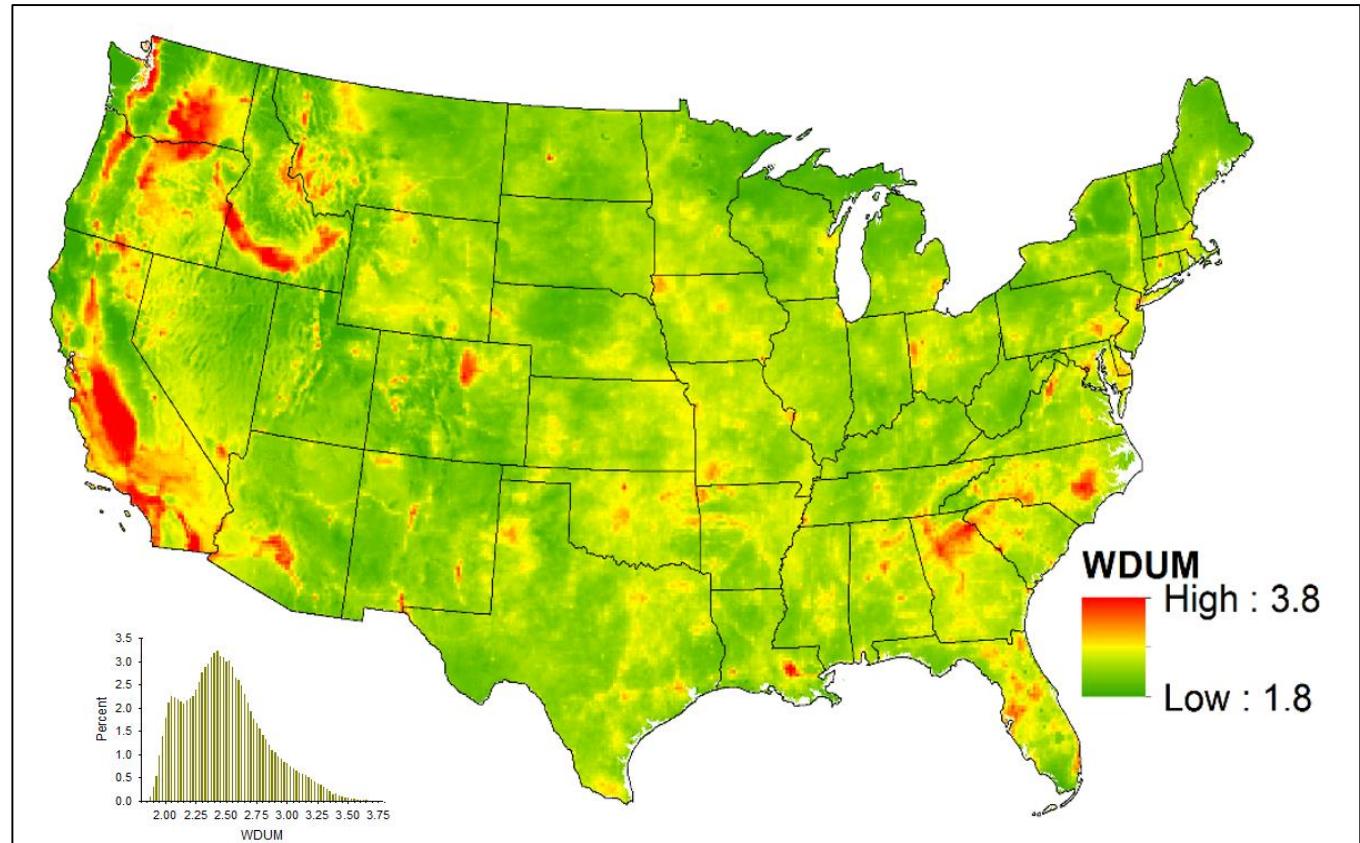


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# Uncertainty in total N deposition

- WDUM = Weighted Deposition Uncertainty Metric
- 8 categories of uncertainty
  - Wet/Dry ammonia
  - Wet/Dry nitrate
  - **Wet/Dry non-measured nitrogen**
  - Dry nitric acid and ammonium

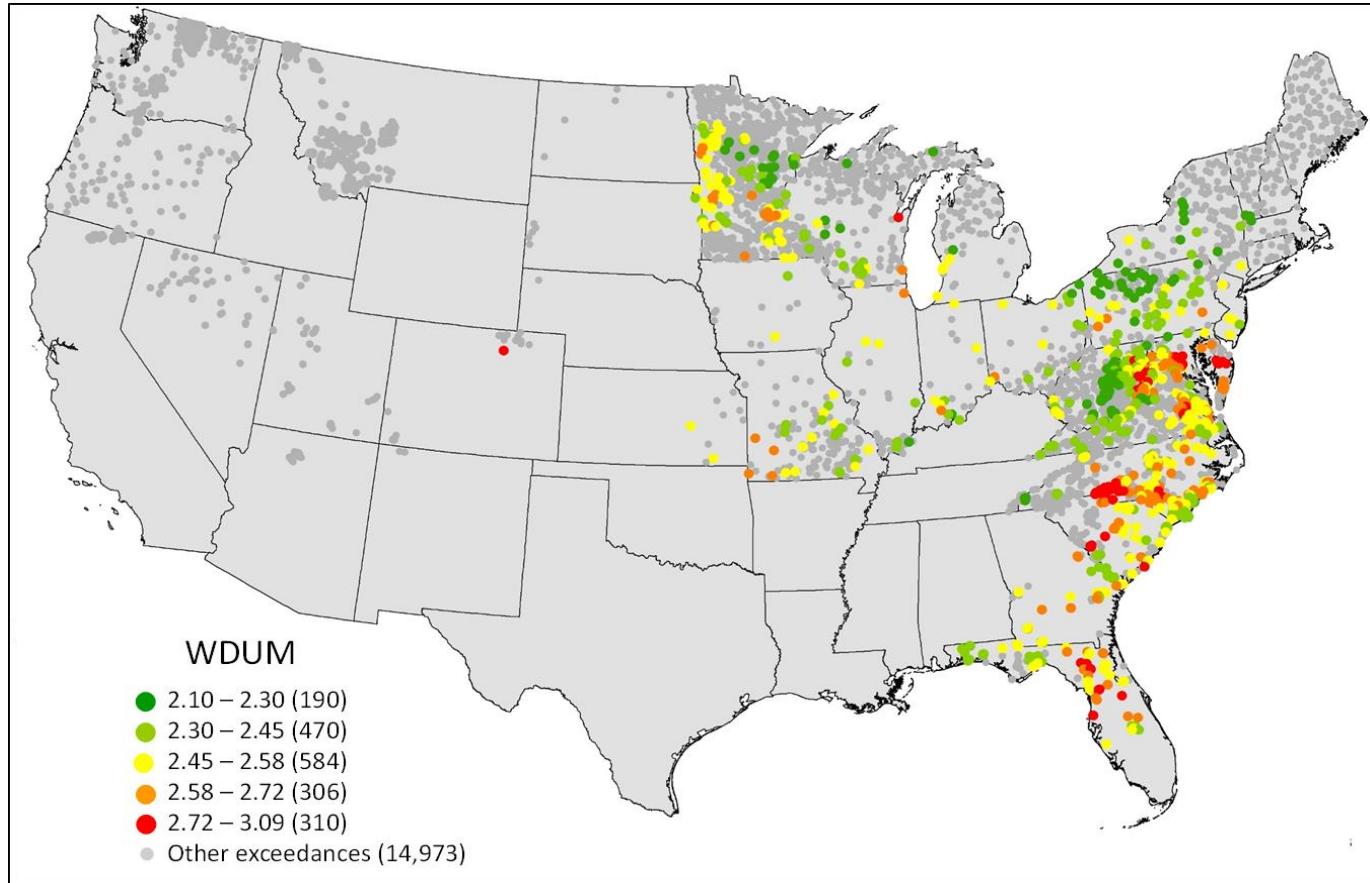


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# Uncertainty in CL Exceedance by total N deposition

- Herbaceous species richness CLs
- Points with color = near exceedance in 2013-2015 (+/- 2 kg/ha/yr)

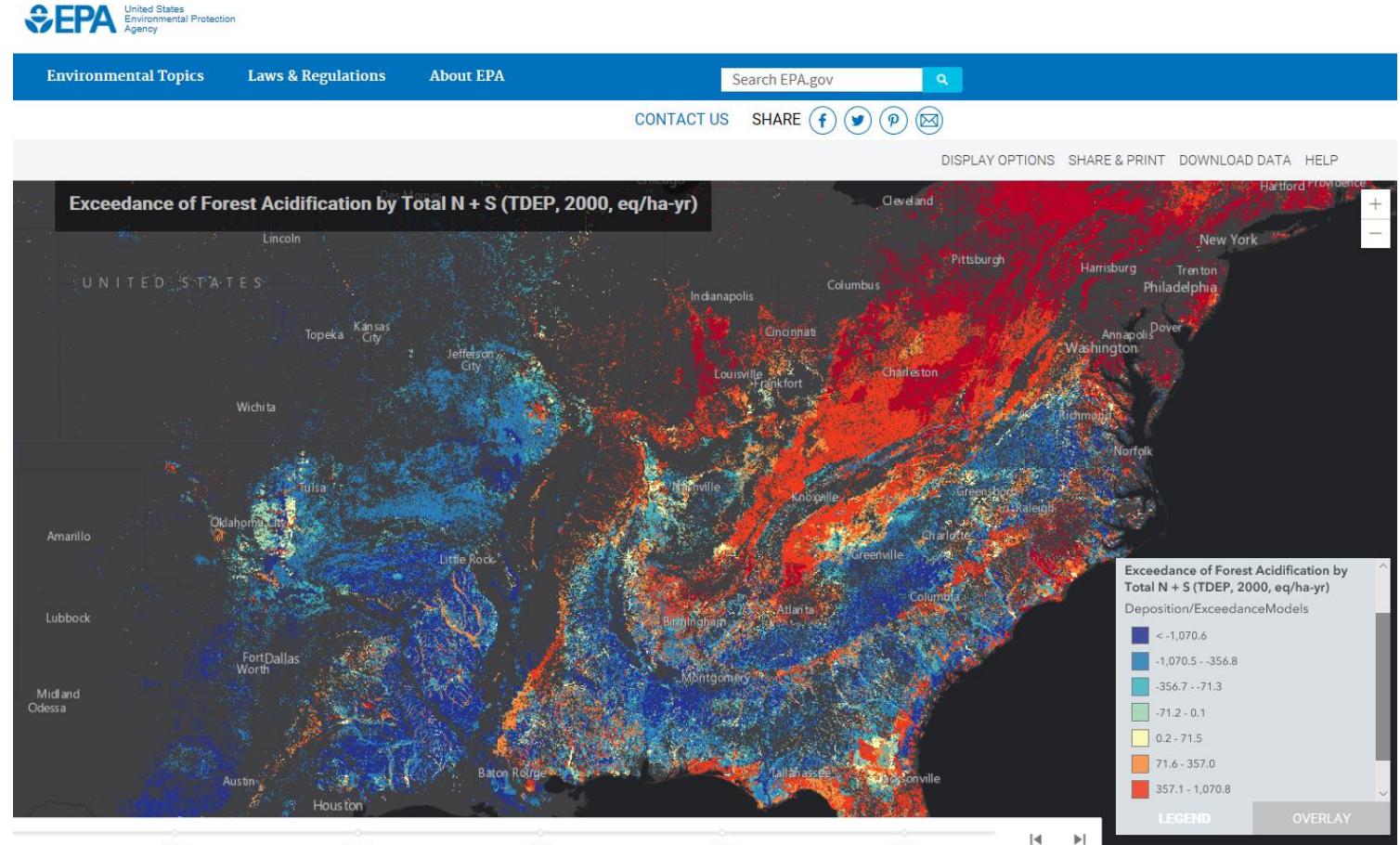


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# CL Mapper Tool

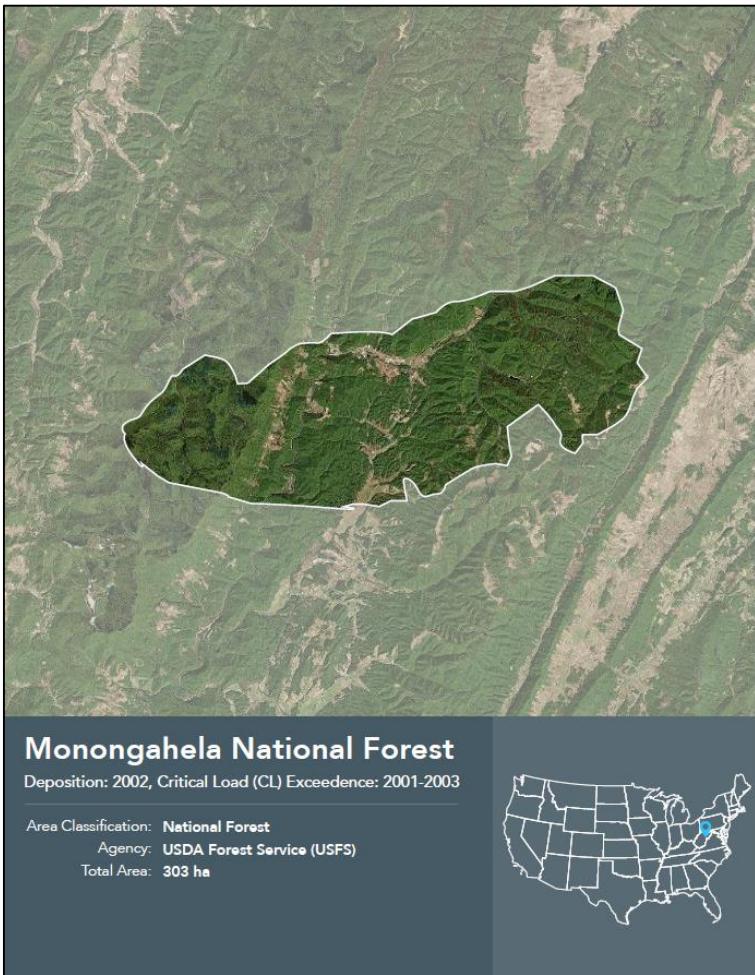
- V2.0 available online (<https://clmap.er.epa.gov/>)



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# CL Mapper Tool – Report



## Contents

### D Deposition

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D1 - Nitrogen (N), Deposition (3-Year Average)  
D2 - Sulfur (S), Deposition (3-Year Average)  
D3 - Nitrogen and Sulfur (N+S), Deposition (3-Year Average)

### CL Critical Load

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CL - Critical Loads (CLs)

### E CL Exceedance

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E1 - CL Exceedance (1-Year) Trends  
E2 - Terrestrial Acidification (N+S, 3-Year Average)  
E3 - Aquatic Acidification (N+S, 3-Year Average)  
E4 - Empirical Forest Min (N, 3-Year Average)  
E5 - Empirical Forest Mid (N, 3-Year Average)  
E6 - Empirical Herb/Shrub Min (N, 3-Year Average)  
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E8 - Empirical Mycorrhizae Min (N, 3-Year Average)  
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### EE CL Exceedance Extent

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EE1 - CL Exceedance Extent  
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EE3 - Aquatic Acidification (N+S, 3-Year Average)  
EE4 - Empirical Forest Min (N, 3-Year Average)  
EE5 - Empirical Forest Mid (N, 3-Year Average)  
EE6 - Empirical Herb/Shrub Min (N, 3-Year Average)  
EE7 - Empirical Herb/Shrub Mid (N, 3-Year Average)  
EE8 - Empirical Mycorrhizae Min (N, 3-Year Average)  
EE9 - Empirical Mycorrhizae Mid (N, 3-Year Average)

### ES CL Exceedance Severity

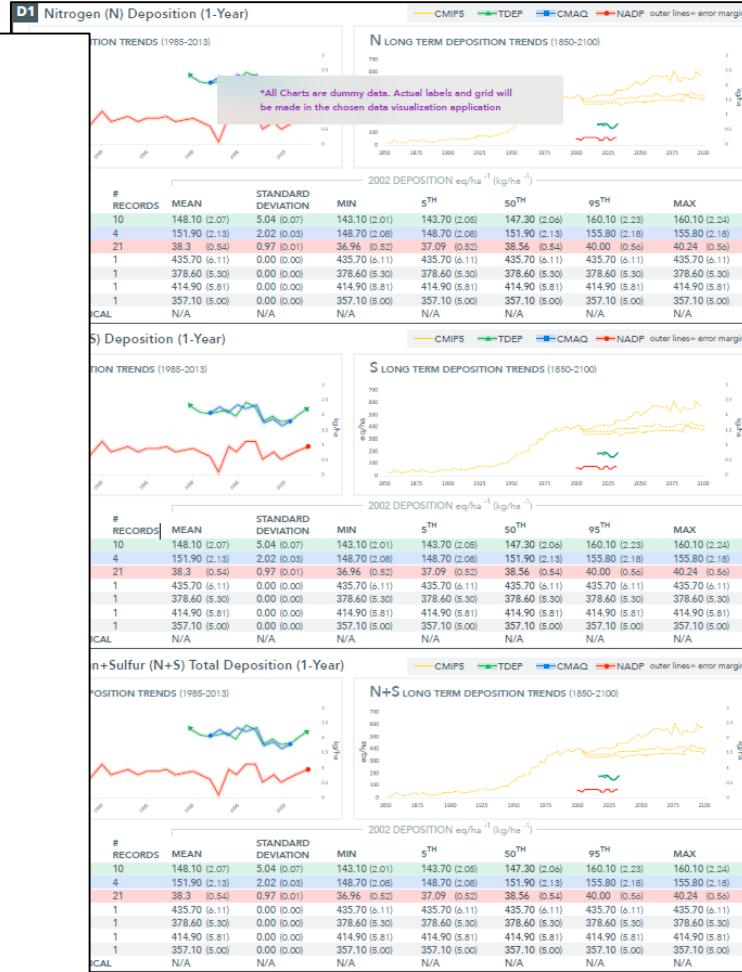
Page 10

ES1 - CL Exceedance Severity

### Final Report

Page 11

The final report lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.



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# Transitions with NADP-CLAD

- NADP-CLAD objectives:
  - discuss, support, and advance current and emerging issues regarding the science and use of critical loads for effects of atmospheric deposition on ecosystems in the U.S.
  - Developed and “houses” NCLD
  - Serve as “non-official” U.S. National Focal Centre (NFC) to WGE-CCE
- NADP-CLAD Program Manager:
  - New manager in Fall 2019
  - Committed to continued participation with ICP M&M WGE-CCE



# Transitions with NADP-CLAD

- Interim contact until position filled:

Michael Bell (CLAD Co-Chair)  
National Park Service  
[michael\\_d\\_bell@nps.gov](mailto:michael_d_bell@nps.gov)



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# Thanks and Questions?



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