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

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National Atmospheric Deposition Program

Critical Loads of Atmospheric Deposition Science Committee

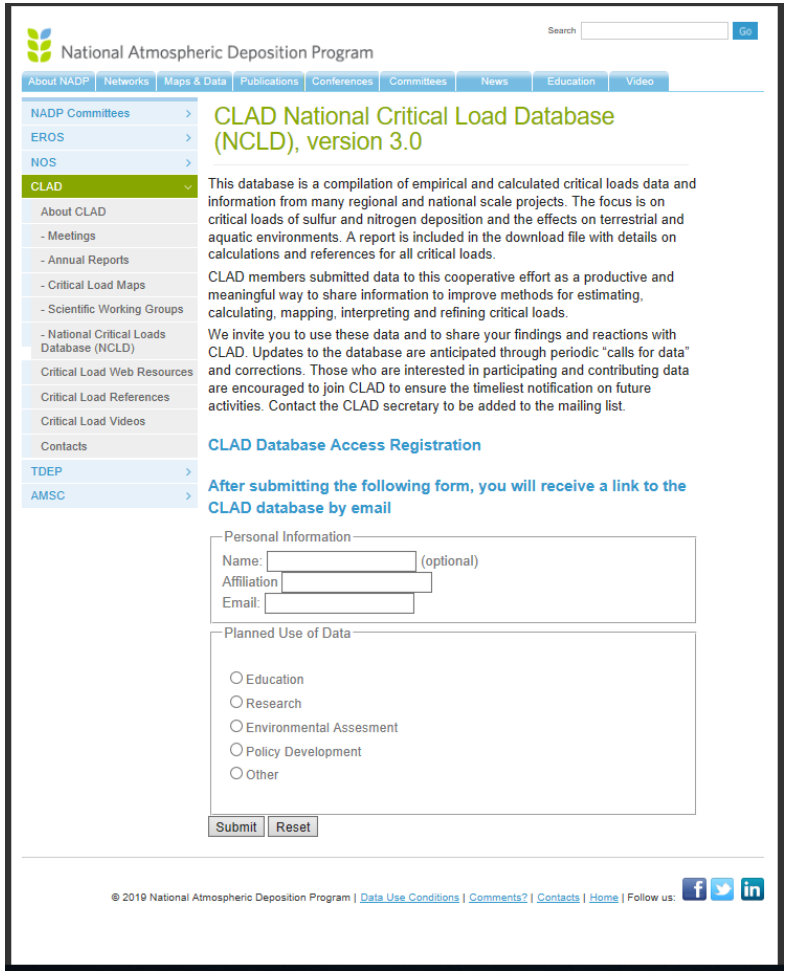
Critical Load (CL) “Transitions” in the U.S.

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

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



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

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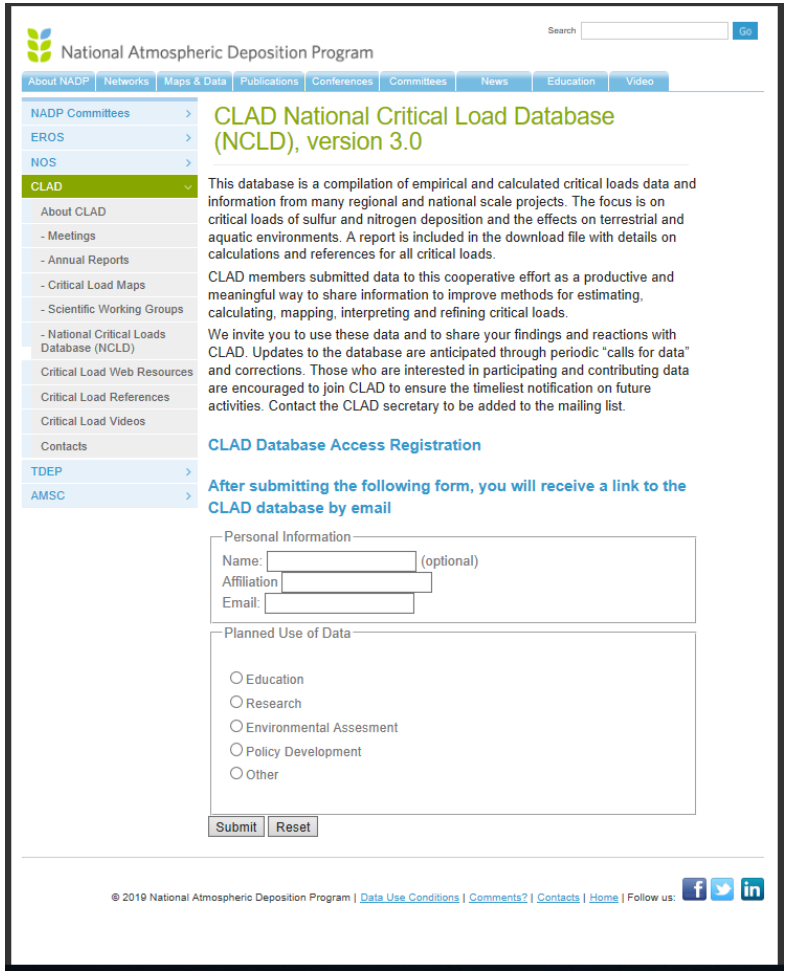

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New studies for the NADP-CLAD NCLD

- **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

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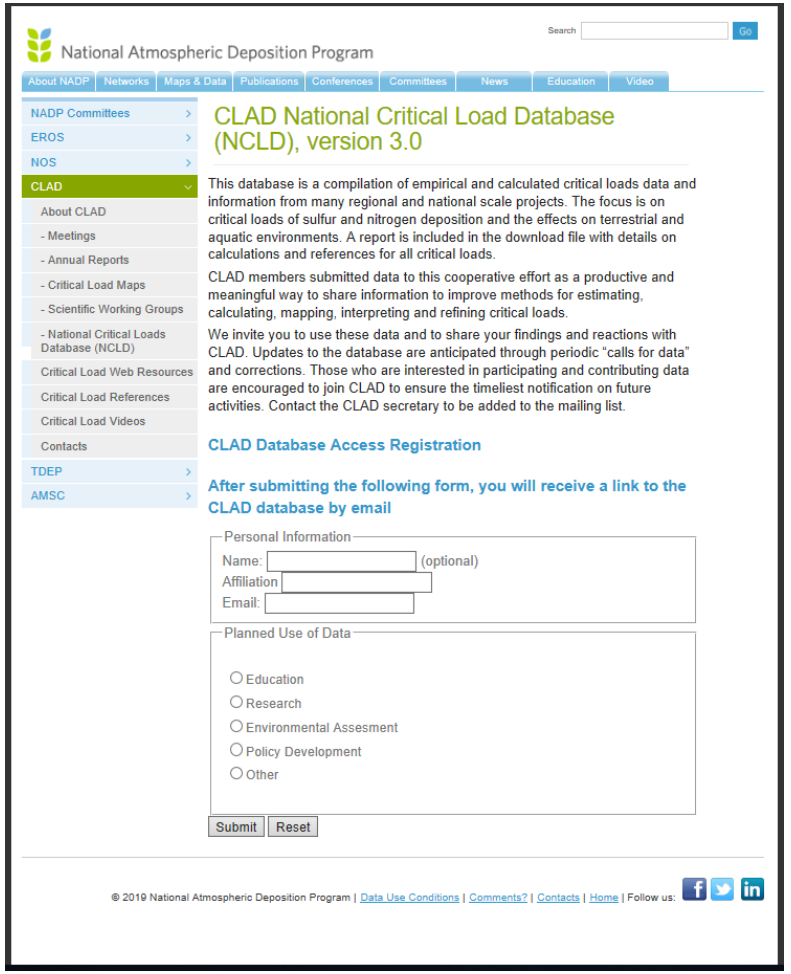

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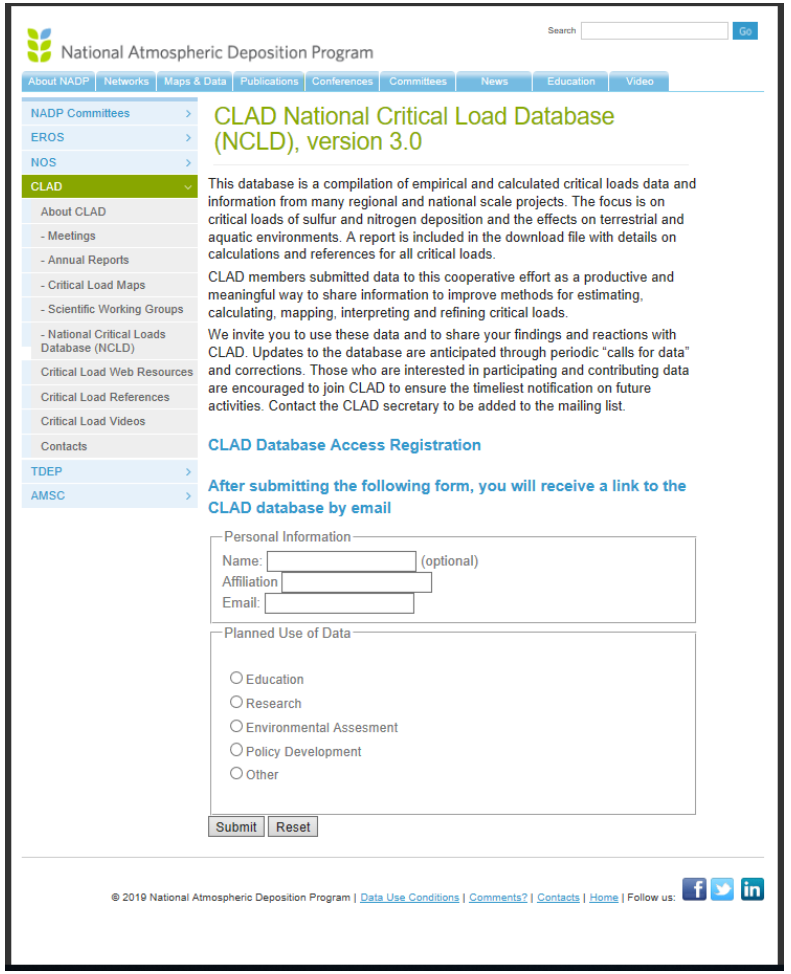

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U.S. Federal Agencies that use CLs

- 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

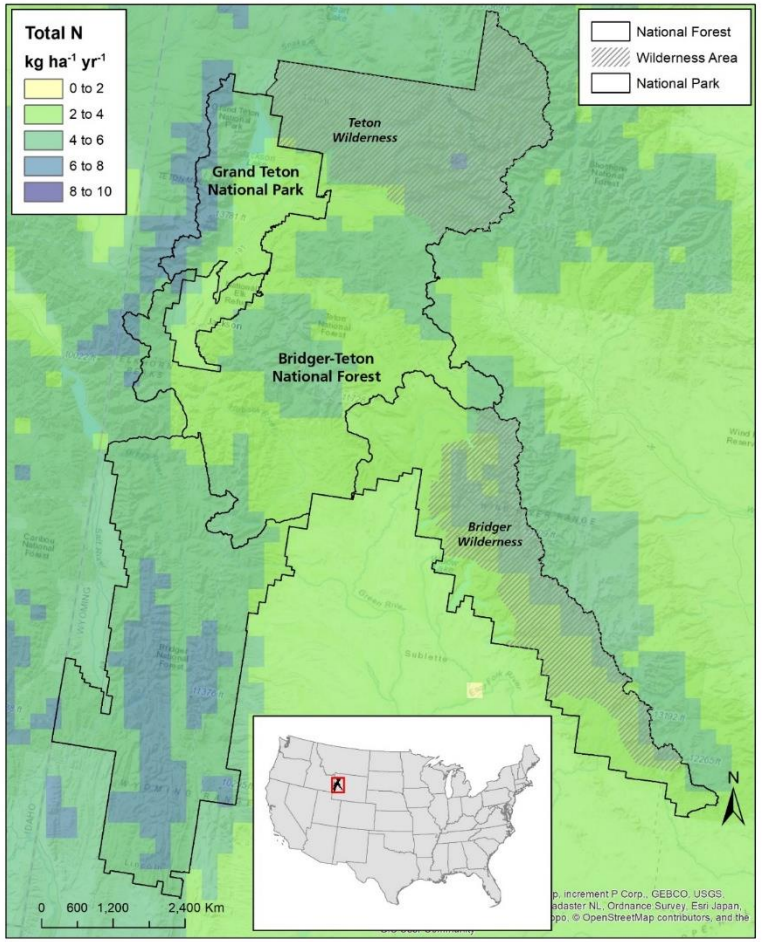
CLAD Scientific Working Groups

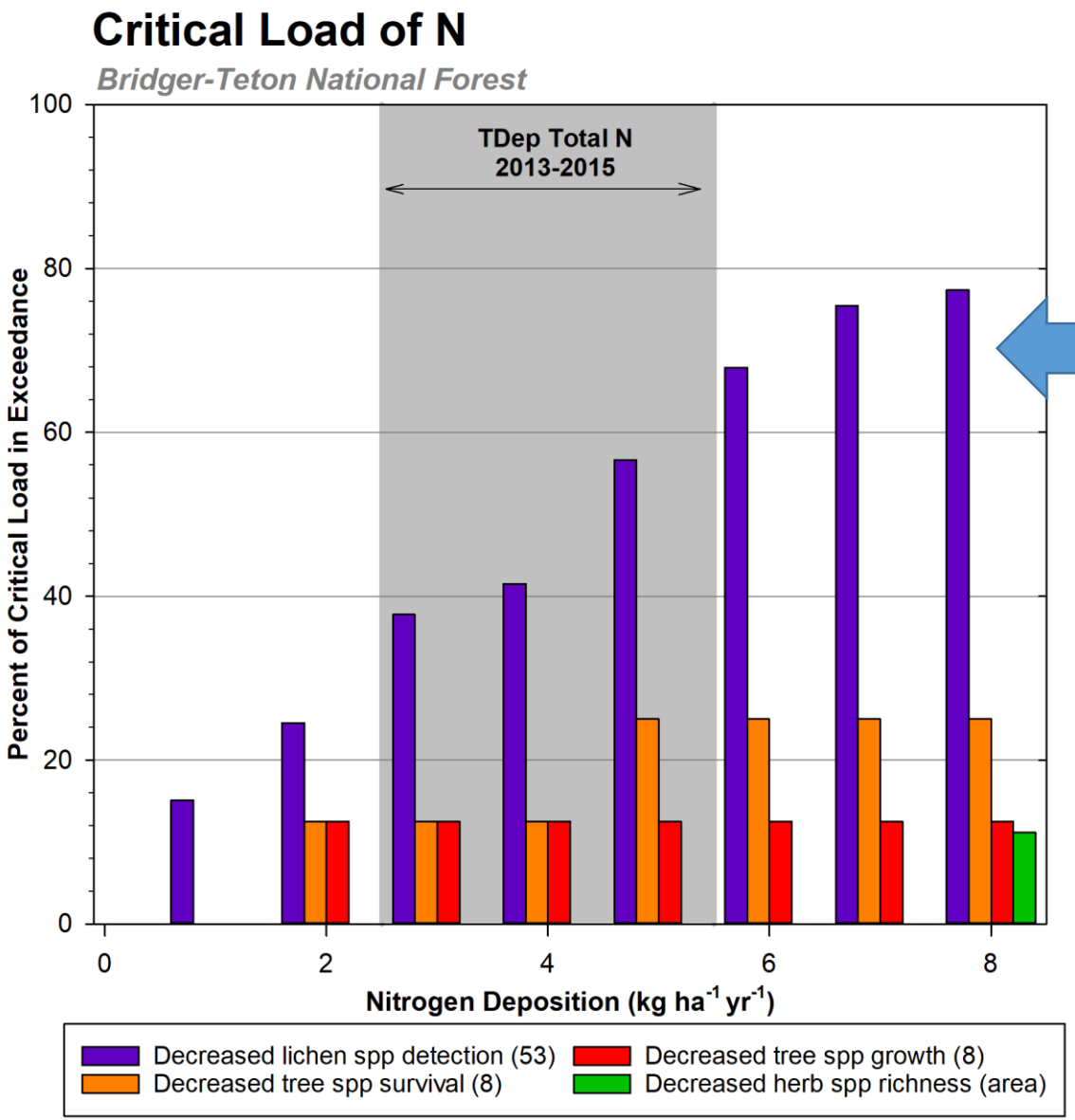
- **WG-1:** National Critical Load Database (NCLD)
- **WG-2:** Critical Load Uncertainty
- **WG-3:** Critical Load Synthesis
- **WG-4:** Uncertainty in Deposition Estimates
- **WG-5**: Critical Loads Communication and Outreach

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

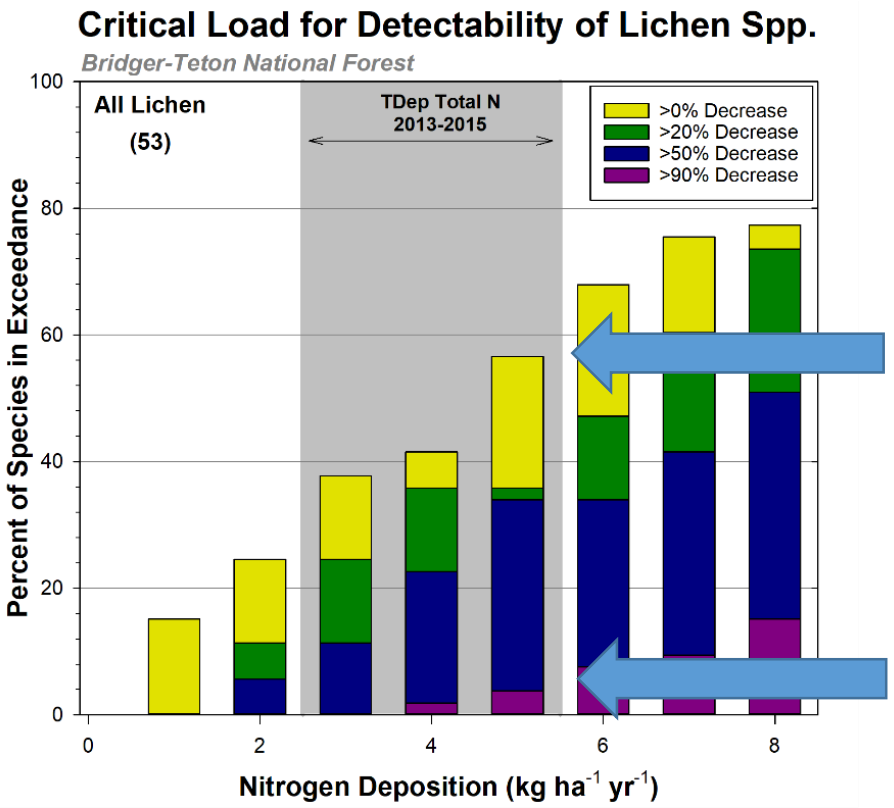




Bridger-Teton National Forest

- 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

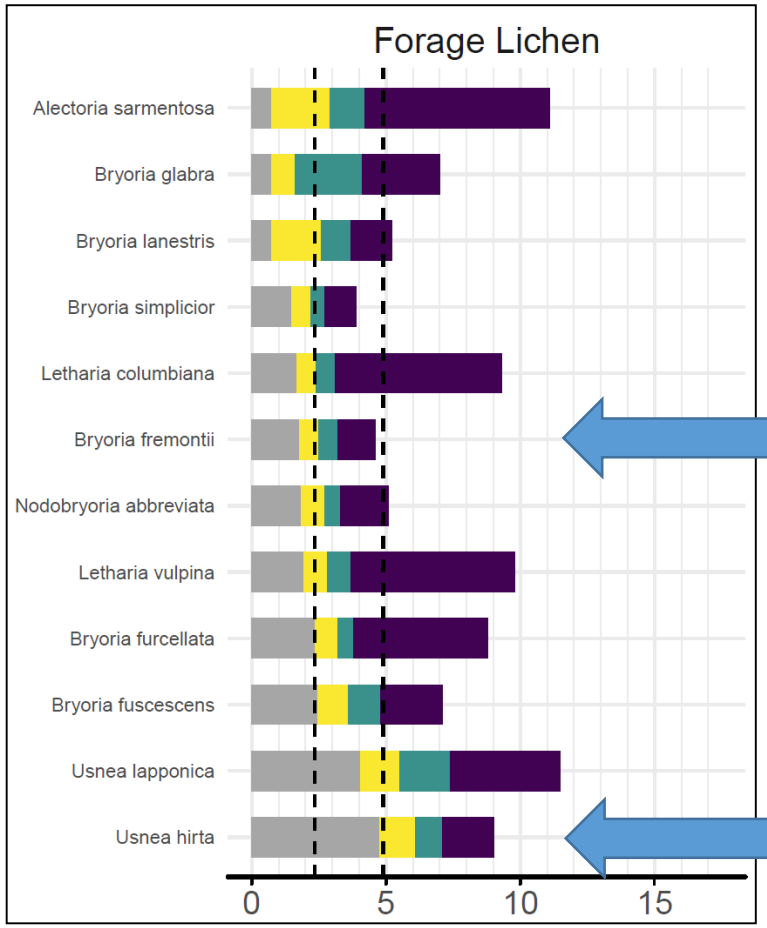
Different levels of acceptable change



58% with >0% reduction

4% with >90% reduction

Different sensitivities by species

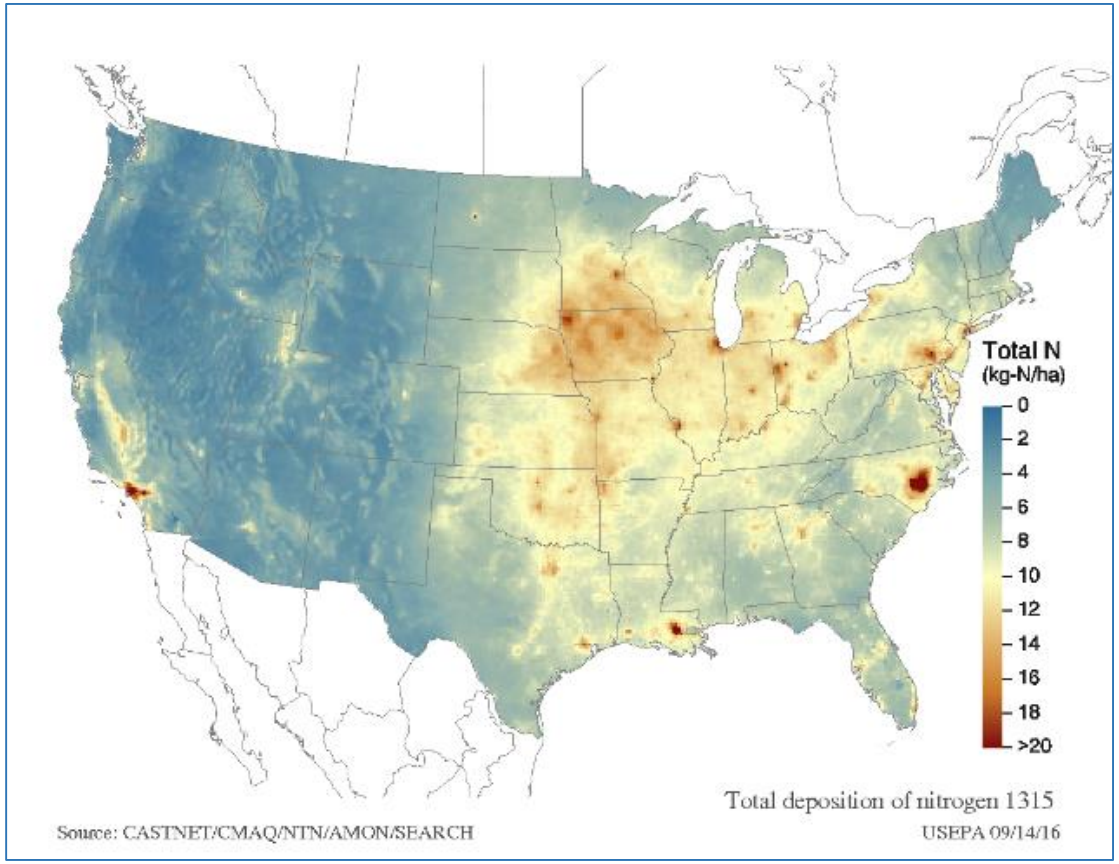


20 – <90% reduction

no reduction

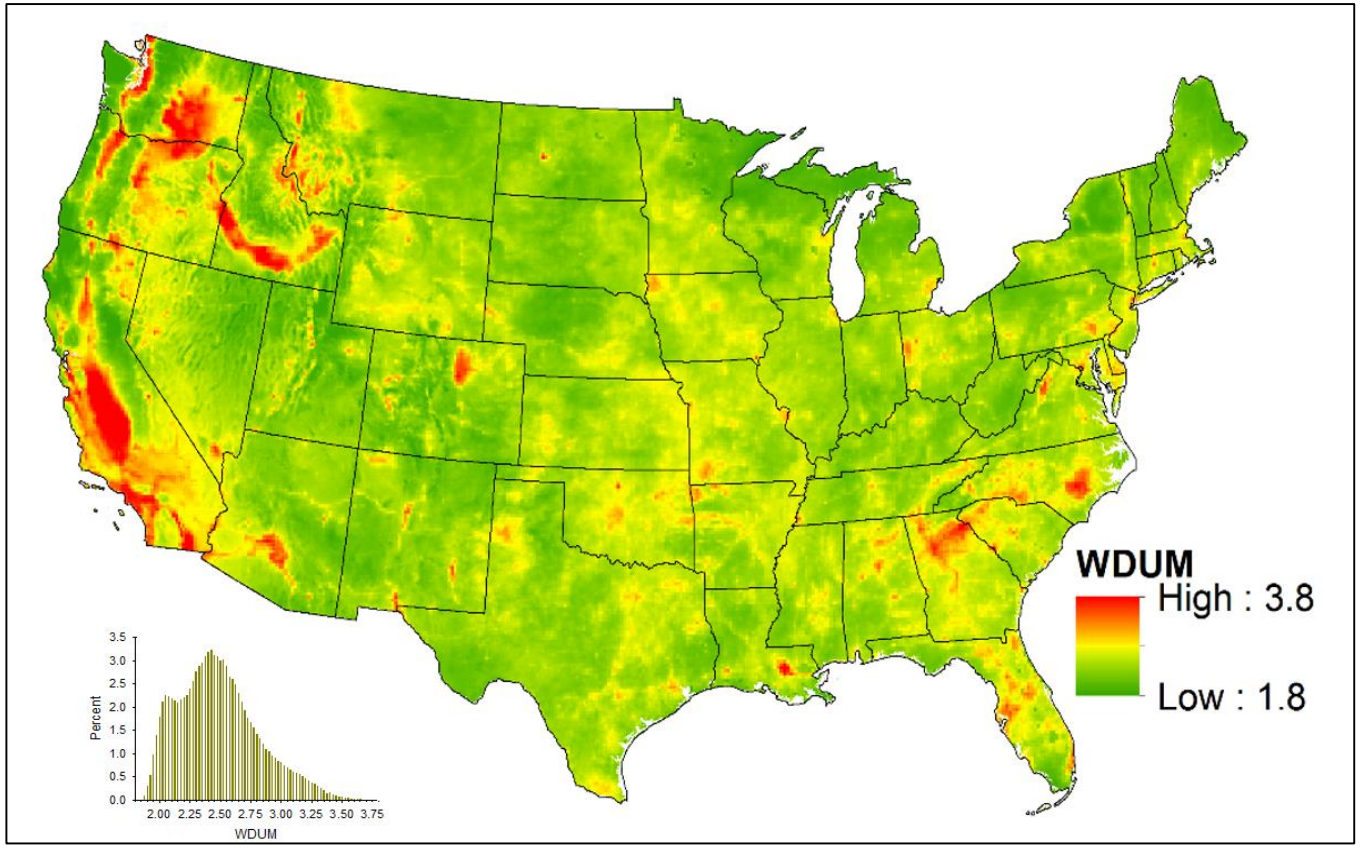
CLAD Scientific Working Groups

- **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)



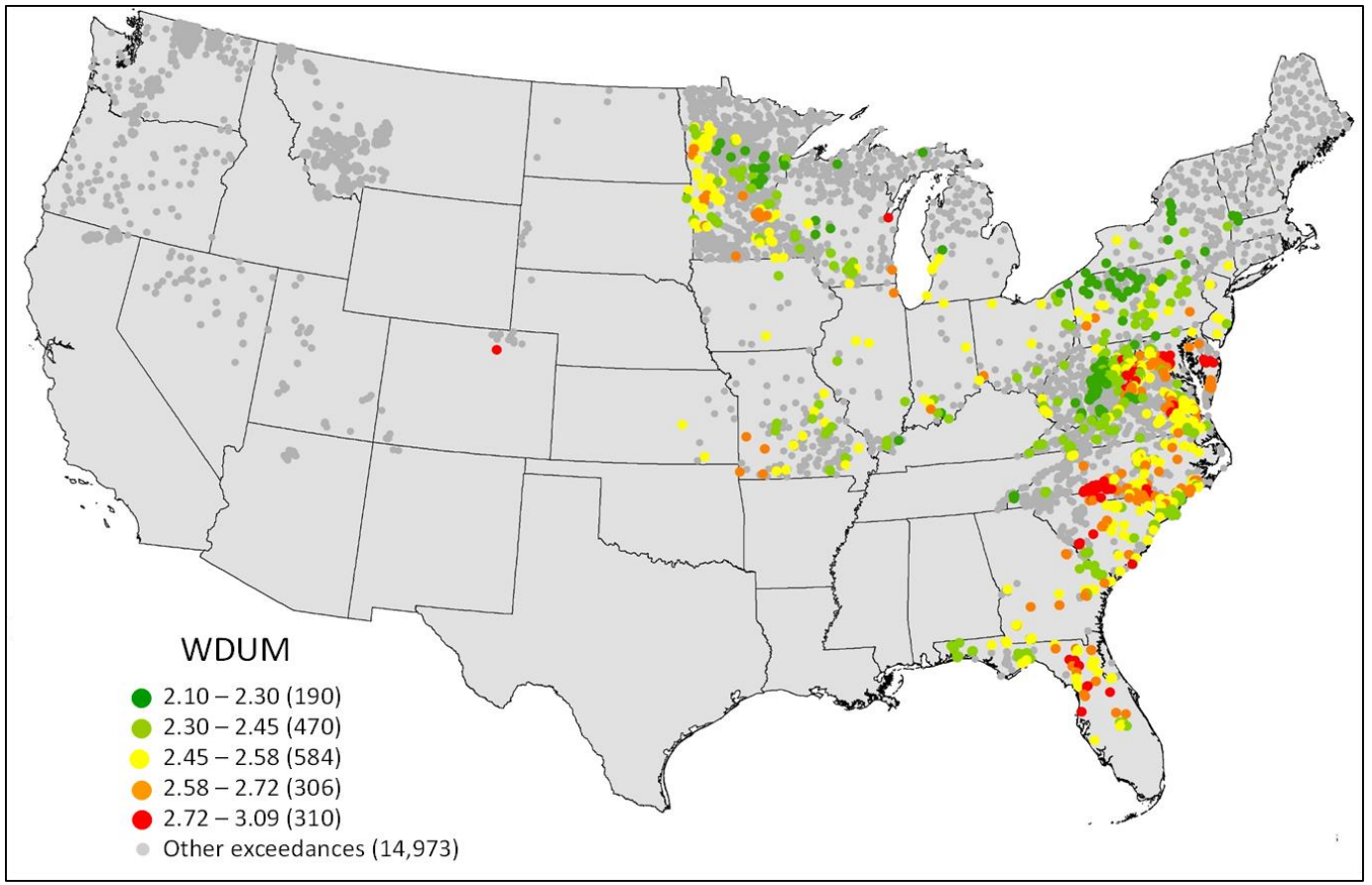
Uncertainty in total N deposition

- 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



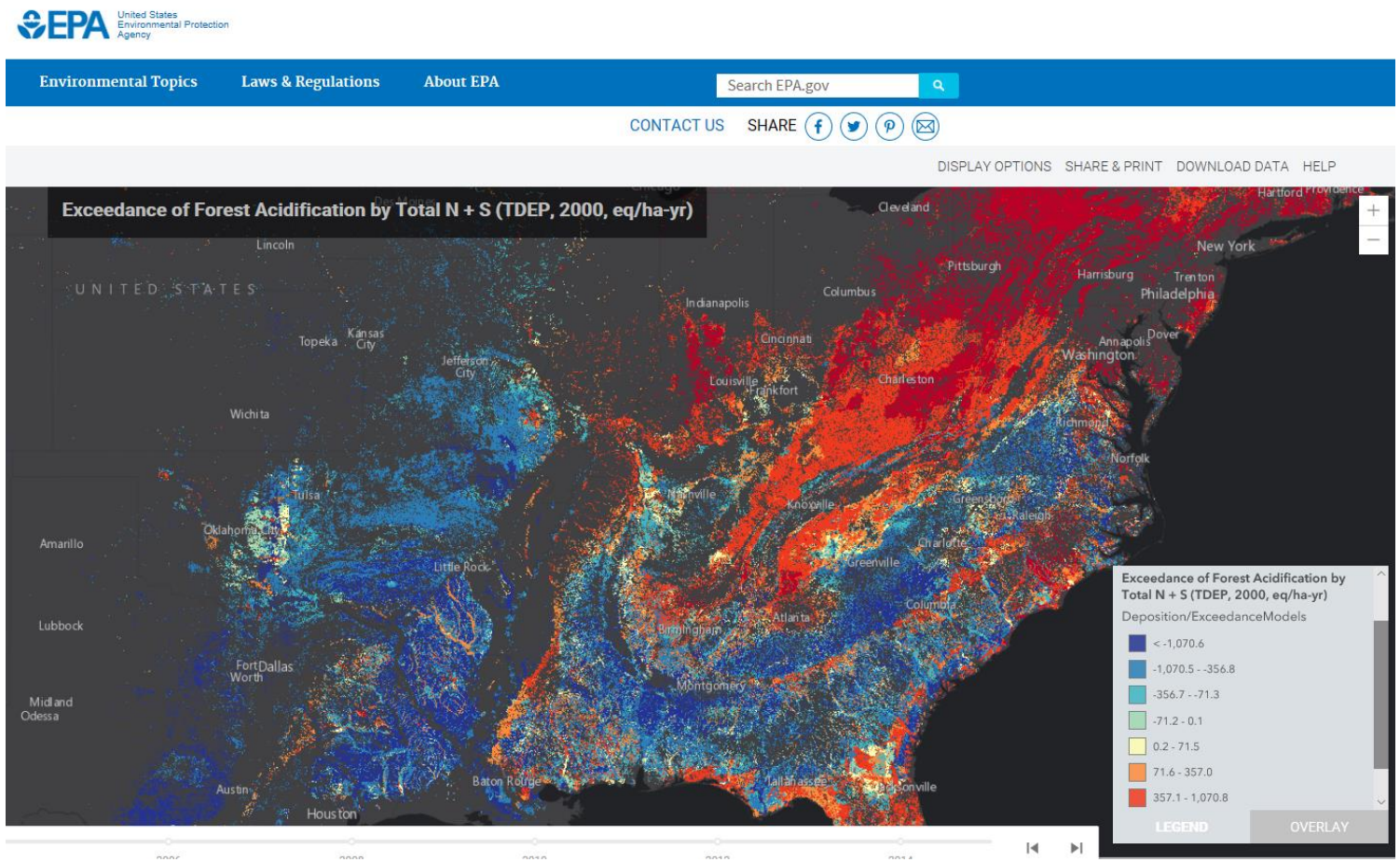
Uncertainty in CL Exceedance by total N deposition

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

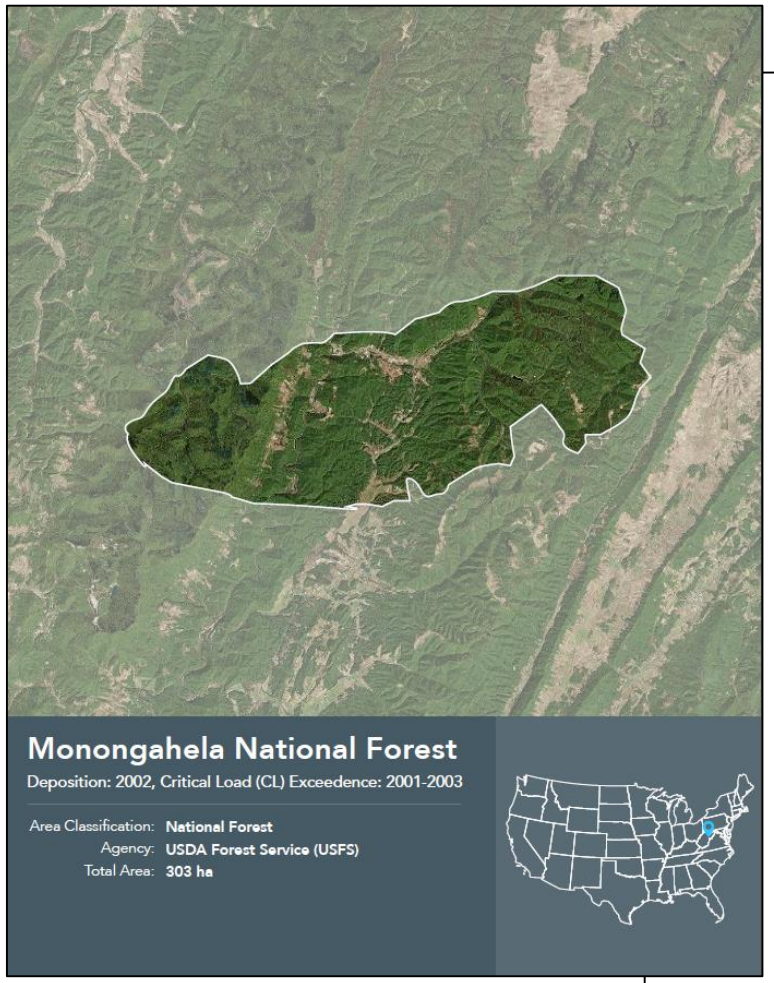


CL Mapper Tool

- V2.0 available online (https://clmapper.epa.gov/)



CL Mapper Tool – Report



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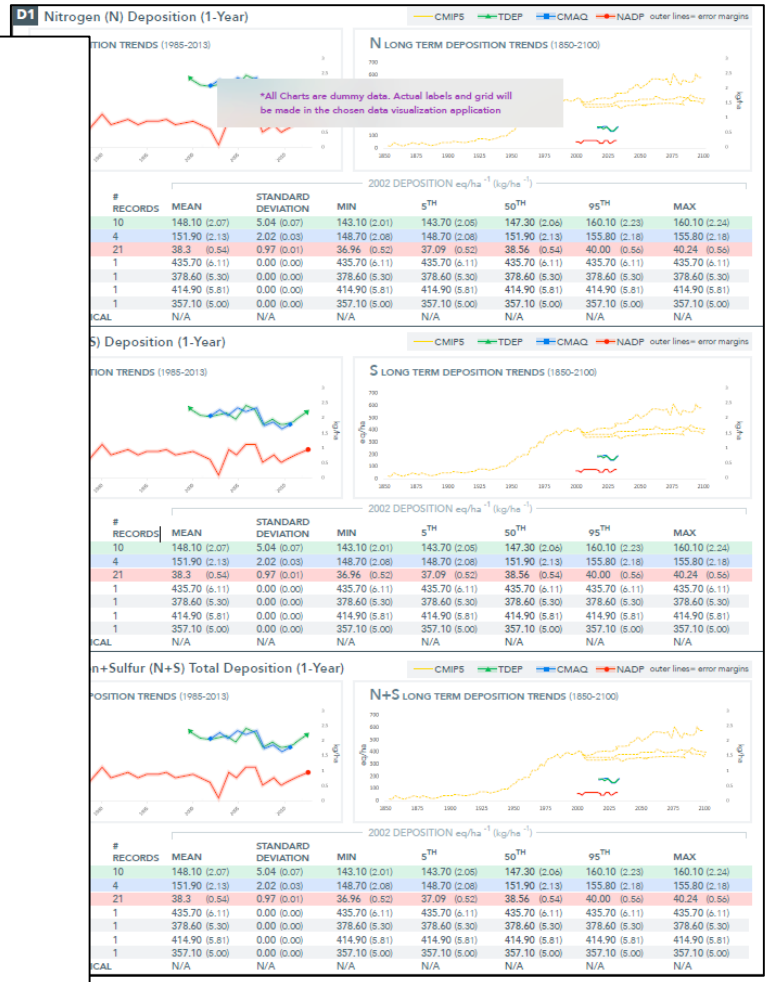

# RECORDS	MEAN	STANDARD DEVIATION	MIN	5TH	50TH	95TH	MAX
10	148.10 (2.07)	5.04 (0.07)	143.10 (2.01)	143.70 (2.06)	147.30 (2.06)	160.10 (2.23)	160.10 (2.24)
4	151.90 (2.13)	2.02 (0.03)	148.70 (2.08)	148.70 (2.08)	151.90 (2.13)	155.80 (2.18)	155.80 (2.18)
21	38.3 (0.54)	0.97 (0.01)	36.96 (0.52)	37.09 (0.52)	38.56 (0.54)	40.00 (0.56)	40.24 (0.56)
1	435.70 (6.11)	0.00 (0.00)	435.70 (6.11)	435.70 (6.11)	435.70 (6.11)	435.70 (6.11)	435.70 (6.11)
1	378.60 (5.30)	0.00 (0.00)	378.60 (5.30)	378.60 (5.30)	378.60 (5.30)	378.60 (5.30)	378.60 (5.30)
1	414.90 (5.81)	0.00 (0.00)	414.90 (5.81)	414.90 (5.81)	414.90 (5.81)	414.90 (5.81)	414.90 (5.81)
1	357.10 (5.00)	0.00 (0.00)	357.10 (5.00)	357.10 (5.00)	357.10 (5.00)	357.10 (5.00)	357.10 (5.00)
ICAL	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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

Thanks and Questions?