National Atmospheric Deposition Program

Critical **L**oads of **A**tmospheric **D**eposition Science Committee

NATIONAL ATMOSPHERIC DEPOSITION PROGRAM (NADP) CRITICAL LOADS OF ATMOSPHERIC DEPOSITION (CLAD) 2016-2017 ANNUAL REPORT

1.0 INTRODUCTION

Critical Loads of Atmospheric Deposition (CLAD) is a Science Committee of the National Atmospheric Deposition Program (NADP). The purpose of CLAD is to discuss current and emerging issues regarding the science and use of critical loads (CLs) for effects of atmospheric deposition on ecosystems in the United States (U.S.). This document serves as the 2016-2017 Annual Report of CLAD. The Annual Report contains sections that document the Fall 2016 and Spring 2017 CLAD meetings, the United Nations Economic Commission for Europe (UNECE) International Cooperative Programme (ICP) Modelling and Mapping (M&M) Working Group on Effects (WGE) Coordination Centre for Effects (CCE) annual meeting, progress of the CLAD Working Groups, CLAD products, CLAD accomplishments, and CL-related publications added to the CLAD website during the year.

2.0 CLAD MEETINGS

The Fall CLAD Meeting was conducted on November 1 during the NADP Fall Meeting from October 31 – November 3 in Santa Fe, New Mexico. The Spring Meeting was conducted April 25th during the NADP meeting from April 25th - 28th in Louisville, Kentucky. The minutes from the Fall and Spring Meetings are presented in Sections 2.1 and 2.2, respectively.

The 2016 Fall NADP CLAD Science Sub-Committee Meeting was held on Tuesday, November 1, 2016 in Santa Fe, New Mexico. The event took place at the La Fonda on the Plaza Hotel in the Lumpkins Ballroom North.

10:15 am Welcome (Claire O'Dea & Tonnie Cummings)

1. Introductions

The participants introduced themselves:

In person – Claire O'Dea (USFS), Tonnie Cummings (NPS), Jennifer Phelan (NADP), Doug Burns (USGS), Chuck Sams (USFS), Chris Clark (EPA), Linda Pardo (USFS), Mike Bell (NPS), Tamara Blett (NPS), Jason Lynch (EPA), Linda Geiser (USFS), Rodolfo Sosa Echeverriz (UNAM), Tara Greaver (EPA), Jeff Herrick (EPA), Amanda Cole (ECCC), Joe Pinto (EPA), Norm Anderson (CSTE), Selma Isil (AmecFW), Kevin Horn (VT), Eladio Knipping (EPRI), Tim Sullivan (E&S Environmental Chemistry) Phone/online – Randy Waite (EPA), Sean Watmough (Trent University)

2. CLAD Accomplishments

- Represented CLAD as the U.S. non-official National Focal Centre (NFC) at the 26th CCE Workshop and 32nd Task Force Meeting of the ICP M&M was held in Dessau, Germany
- Produced the CLAD NCLD Critical Load Map Summary (http://nadp.sws.uiuc.edu/committees/clad/db/NCLDMapSummary_2015.pdf)
- Produced CLAD Critical Load Definitions document (http://nadp.sws.uiuc.edu/lib/CLAD/NADP_CLADdefinitions.pdf)
- Initiated three scientific Working Groups (WGs) within CLAD to advance the estimation and representation of CLs in the U.S. and improve the CLAD NCLD
3. Accept Spring Meeting Minutes
- Minutes were approved

10:20 – 10:50 am CLAD Workgroup updates

1. WG1: Adding new data and CLs to the NCLD (Jason Lynch)
- Aiming to produce NCLD v3 database and documentation/metadata – deadline by 12/20/16. Updates to NCLD v3 will include:
    o NCLD v3 database will also be restructured to be more user friendly (along with more metadata)
    o NCLD v3 will also work towards a standardized projection (USA_Contiguous_Albers_Equal _Area_Conic_USGS_version (Datum NAD 83)
    o Data and CL updates that will be included in v3 include:
        ▪ Surface Water CL of acidity:
            • TMDLs for VT, NH, and NY
            • DuPont et al., 2005
            • McDonnell et al., (2014) – 140,000 points in the Southern Appalachian Mountains (as far south as Georgia)
            • Sullivan and McDonnell et al. in NY CLs and target loads
            • Metadata improvements:

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- New class of loads that are added to NCLD = target loads
- As there are a large number of different methods that can be used to develop CL, will add field and descriptions of different methods so that users can select different methods
  - Forest Ecosystem CL of acidity:
    - Correction and updating of metadata
  - Nutrient Enrichment for N
    - Add Herb biodiversity (Simkin et al.,, 2016)
      - By point locations and Ecoregion Level 1
      - Will also need to note the pH influence
      - May want to consider these CLs as Empirical Cl of N – this will be revisited/considered
- Coming in the Spring or Summer of 2017
  - Aquatic N enrichment – Williams et al. manuscript
  - Individual CL studies (building on Pardo et al. (2011))
  - Forest trees – Horn et al. manuscript
  - Lichens – Linda Geiser has been using lichen community data from FIA and other monitoring plots to develop relationship between lichen community composition and N and S deposition (CMAQ) and nine other environmental variables as drivers of (climate, forest composition, etc.). Linda will be talking about this in her presentation tomorrow. Her study found that CLs are related to background levels of N and S. She hopes to have the study submitted for publication by the summer or fall of 2017
  - Herb (species level) – for summer/fall
- Would like to start keeping a list of the projects that are using the NCLD (will be as list that is updated each year)
  - Projects that are currently using the NCLD:
    - US EPA CL Mapper
    - US EPA Clark et al. manuscript that compares CLs and deposition from 1800-2025
    - UT Sun et al. manuscript
    - US-Canada Progress Report
    - EPA CAMD Progress Report
    - INI Phelan et al. poster
  - LRTAP Report
  - Columbia University Study
- Have some questions regarding NCLD that still have to be resolved:
  - What grid size to use?
    - CMAQ 12-km
    - TDEP 4.13435-km (due to issue with the "extent" adopted by TDEP)
    - 4-km?
    - It would be nice to be able to adopt a consistent grid cell size
    - Having problems/issues with standardizing the size / original extent of datasets
      - Should TDEP be resampled to adopt a standardized 4-km grid?

Linda Pardo – how would a datalayer created at a very fine resolution be included in the NCLD?

Jason Lynch – including a finer resolution dataset is manageable (e.g., McNulty's 1-km cells for Terrestrial Acidification CLs). McDonnell's work in the Southern Appalachians is also at a fine resolution (i.e., 30-m). So, it is possible. We will just need to think about it.

Linda Pardo – we could aggregate up to 4-km scale.

Jason Lynch – will need to consider the aggregation, especially as it relates to deposition.

2. WG2: Characterizing uncertainty in CL estimates (Linda Pardo & Chris Clark)
- Purpose of WG-2 is to develop internally-consistent scores of the confidence of CLs
- 2 approaches:
    o Bottom-up – using data in publications to develop
    o Top down – conceptual approach. In a perfect world, what kind of information would we like to have to characterize CL uncertainty?
- So far have been focusing on the bottom-up approach and have completed draft scoring systems for:
    o Herb diversity
    o Tree species
    o Lichens
- Next steps include:
    o Start working on Pardo et al. (2011) Empirical CL in NCLD
        ▪ 2 different ideas:
            • Short-term
            • Long-term more analytical approach
    o Work on Top-down approach for characterizing CL uncertainty
        ▪ Moving forward, we would like to provide guidance for future CL work and projects regarding what data should be produced for including the CL in the NCLD
    o Also need to work on Terrestrial and Surface Water Acidification CLs
    o Need to determine how to include dynamic model CLs and data (e.g., ForSAFE-Veg, VSD-Props, etc.)
    o Would also like to document the methods in a white paper and published article

Tim Sullivan – it would be great to get this process in a peer-reviewed article.

Chris Clark – agreed. It will be documented as a white paper and hopefully will also result in a peer-reviewed publication.

Linda Pardo – clarified that are referring to CLs that are currently in the NCLD and new studies that will be included/added to the NCLD.

Tara Greaver – agreed that it would be great to get this published. Do you have a date in mind?

Chris Clark – yes, we are going to have to decide on a deadline date. The cut-off will probably be sometime after we do the uncertainties for the Pardo et al. (2011) empirical CLs.

Jason Lynch – working with Todd McDonnell to try to characterize the uncertainty of SW CLs and hoping to come up with uncertainty scores for Surface Water CLs.

Chris Clark – yes, we would like to have uncertainties characterized for all the CLs currently in the NCLD.

Linda Pardo – thinks that the Surface Water CLs should be prioritized followed by Terrestrial Acidification CLs. Empirical CL of N are very different than the others. It would be great to have all of these completed before the white paper and publication are produced.

> o   Aiming to have the bottom-up CLs completed by the end of the year

Lindo Pardo – seems reasonable that could have draft of the report completed by Spring 2017 CLAD meeting.

Chris Clark – agreed.

3. WG3: Synthesizing multiple CLs (Chris Clark)
- Still in the early phases of the WG
- Have had discussions regarding case studies in US
   o   5-6 different case study locations for different regions of the US
- Goal is produce the process for how to put CLs together in a common area at different scales (e.g., by state, Class I area, ecoregion, etc.)
- Approach will recognize/incorporate different criteria for including CL and different approaches for protecting different sensitivities
- Will take a lot of work. Chris is aiming to using a combined effort of EPA Orise fellow and contract/project to conduct the case studies

Tim Sullivan – will need to develop an approach that recognizes the most sensitive species, but something else as well (because most sensitive species will be effected by deposition above background levels).

Linda Pardo – yes, that is the goal. Sensitivities and protections will be approached in different ways by different interest groups.

Chris Clark – yes, there are lots of different options and different approaches. We would like to include these different approaches. However, can't include everything. So, we will need to include a set based on a set of goals and criteria. This approach will be necessary to produce a product that will be useful to land managers and policy makers. It has to be user friendly.

Tara Greaver – this is very important. She is having similar discussions in EPA. For example, what % of loss of diversity is acceptable (i.e., CL of 10% loss of biodiversity).

Tim Sullivan - % protection approach is very important, but can also identify as "iconic" species that resonate with people.

Sean Watmough – similar problem in Canada. When referring to the % area exceeded, the challenge is trying to define what the denominator is (i.e., what is the area of interest to summarize?). This decision will greatly influence the % area of exceedance.

Chris Clark – agreed. That is why we want to include different scales.

10:50 – 11:00 am EPA CL Mapper Tool (Chris Clark)

- The CL Mapper Tool is coming along very well

- Is a "living" interface of the NCLD; represents the CL data in the NCLD
- Presentation during Joint Session will provide more information on the Tool
- Online version of the Tool is not yet publically available
- Currently, the Tool consists of maps of deposition, CLs, and CL exceedances
- Have a new contract with the USFS to add additional functionality. This will include the capability to provide regional, location specific CLs and CL exceedances

11:00 – 11:45 am Critical Loads Projects: Status and Results "Round Robin" (Claire O'Dea & Tonnie Cummings)

1. Announce CL papers and posters that will be presented at the NADP science symposium
- Claire announced the 3 different sessions
- CL posters will also be presented during the poster session
2. Round robin of current and new critical loads projects being conducted by CLAD participants – maximum of 5 minutes per person

Tim Sullivan:

- NYSERDA understory species and soil acidity in NY. More than half the variation in species richness can be explained by soil Ca, Mg and other base cation metrics. The study also identifies species that are linked to different levels of base saturation
- Recovery of Addirondack lakes from acidification and how climate change is influencing the recovery
- Project for NPS using ForSAFE-Veg at two sites with goals of looking at evaluating and improving the model
- Project with EPA using VSD-Props on the same two sites and Hubbard Brook. Part of this project will include model (ForSAFE-Veg and VSD-Props) comparison
- New book – Air Pollution in the National Parks is published. It should be released by February 2017
- EMDS update – 500 new streams with data. This project will regenerate coverages for CLs and other parameters
- USFS – developing forest management recommendations for two wilderness areas
- Target Loads and CLs for Addirondack streams using PnET-BGC model

Doug Burns – trying to take different flow rates into account as part of the project as well.

Eladio Knipping:

- Nothing to share

Mike Bell:

- Finishing up the AQES Workshop (2015) by completing a series of papers linking air quality and CL exceedances and ecosystem services
  o Submitted and currently being reviewed by Ecosphere
  o Want to move forward and apply the AQES framework in some management/recommendation contexts and case studies
- Hosting a session at the ACES conference in December
- Finding outside of network deposition data to provide data for checks against TDEP (can also be used in TDEP white paper)

Doug Burns:

- Atmospheric Environment has a special issue on Acid rain that has just been released and there are at least four CL papers that are included in this special issue. The issue include an interesting study in Ireland that looks at species diversity across a gradient and determined that the CL used in Europe may be too high

Norm Anderson:

- Importance of human health benefits of a healthy forest, as an ecosystem service. This is an example of the connections between ecological health and human health

Mike Bell – these types of services are included in AQES.

Amanda Cole:

- Project evaluating the variability of TDEP model across North America (including Alaska)
- Canadian air quality model (GEM-MAQC) – 10-km resolution

Chuck Sams:

- Utilizing work of E&S Environmental Chemistry to influence/inform timber program
- Conducting quantitative analysis of timber harvesting in the Appalachians and how the levels of harvesting may be impacting CLs of acidity

Linda Pardo:

- NCLAS Tool is a GIS web-based tool that will allow users to present empirical CL in NE U.S. The tool looks at the responses of individual species. It allows the user to summarize trends at different scales. Linda is hoping to also build in future climate and deposition scenarios

Kevin Horn:

- Submitted tree response to N deposition for publication
- Current work is further refining these relationships to try and account for other site variables (e.g., soils, etc.)

Jeff Herrick:

- Working on EPA NOxSOx Secondary Standards Review Integrated Science Assessment (SSA). He is focusing on the Terrestrial Acidification section

Tamara Blett:

- Summary of new CL literature (since Pardo et al., 2011) that is specific to US National Parks. Some studies specific to National Parks are just in report form (haven't been published yet). The goal is to use these data in NPS management

Chris Clark – don't really need to have point data specific to parks. Could use equations built on a larger amount of data and bigger geographically area to provide CL information specific to park areas.

Doug Burns – what is the goal of this product?

Tamara Blett – to be a management tool that is available on website. These data will be used to produce a synthesis of CLs recommended for each National Park.

Tara Greaver:

- Creating EPA NOxSOx Secondary Standards ISA. They have identified ~ 1200 new papers related to deposition, ecosystem responses, and CLs to include in the ISA. The first draft of ISA targeted release is January 13, 2017. The goals of the ISA are to inform the next stages of risk and policy assessment.

Rodolfo Sosa Echeverriz:

- Working in department of air quality and monitoring in Mexico

Chris Clark:

- Manuscript evaluating CL exceedances of 6 CL from 1800-2025 is near completion
- Working on USFS Species Handbook (1 or 3 volumes - tree volume) that documents species responses to deposition
- CL Mapper Tool
- Working with RTI on white paper evaluating remediation efforts in areas impacted by deposition
- Working with RTI to update soil BCw estimates for terrestrial acidification CLs. The project has completed an uncertainty analysis and the next stage will produce estimates for the continental U.S.

Linda Geiser:

- Manuscript that outlines national scale CL of N and S for lichens (based on looking at the most sensitive elements to provide broader protection for system). The CLs are based on changes in lichen community
- 3-volume set of handbooks that document species (trees, understory plants, lichens) responses to N deposition, their ecological roles and ecosystem services

Tonnie Cummings:

- International Nitrogen Initiative (INI) Nitrogen Management Demonstration projects – attended meeting for the project proposed for North America (located in northern Washington and southern British Columbia) – are 13 other projects located around the world. Drivers of the N budget in this system are N in surface water and ground water from agriculture. Tonnie is not sure if CLs will be a component of this work

Claire O'Dea:

- Doing a series of videos on CLs. Currently finalizing the scripts for three of these videos. The goal is to link CL exceedance map with ecosystem services. They are also considering how to include management recommendations in these videos

Jason Lynch:

- Working on the NOxSOx Secondary Standards Risk Exposure and Assessment

Jennifer Phelan:

- Working with EPA to develop of manuscript that documents exceedance of six CL by deposition from 180-2025
- Supporting the development of the EPA CL Mapper Tool
- Near completion of project evaluating the impacts of N on future forest stand composition and changes in ecosystem services
- Working with EPA to update soil base cation weathering (BCw) estimates to support Terrestrial Acidification CLs for continental U.S.

Randy Waite:

- Several posters in CLAD:
    o Conceptual approach for connection between S deposition and methyl mercury in waterways. The approach is based on the relationship between S concentrations and methyl mercury concentrations
    o Amount of air deposition necessary to reach water quality standards

Sean Watmough:

- In British Columbia have been using CLs to help risk assessment for permits for new facilities and emissions from natural gas facilities
- In Alberta have been working in oil sands and looking at base cation deposition. The study is finding that deposition is a large and is making the soils more alkaline
- In Saskatchewan are examining aquatic and terrestrial CLs and evaluating uncertainty and forecasting impact of climate change on the CLs
- In Ontario have been looking at Ca levels and interactions with timber harvesting

11:45 – 12:30 pm General Discussion and CLAD Business (Claire O'Dea & Tonnie Cummings)

1. Elect CLAD Co-Chair and Secretary (Claire O'Dea & Tonnie Cummings)
- CLAD Co-Chair will be Jason Lynch; unanimously supported by CLAD
- CLAD Secretary will be Mike Bell; unanimously supported by CLAD
2. CLAD Program Manager update (Jennifer Phelan)
- CLAD Working Groups:
    o Reminded everyone of the meetings for WG-2 and WG-3 during NADP
    o May initiate WG-4 which is focused on deposition and CL
    o Should be co-lead by CLAD and TDEP (possibly John Walker)
- CLAD Working Group Summary document which describes past and present CLAD WG is finished and will be posted to CLAD website
- CLAD 2015/2016 is finished and will be posted to CLAD website
- CLAD Structure, Roles and Responsibilities document which provides a description of the structure and positions within CLAD is near completion. It is currently being reviewed and revised by the CLAD Advisory Board. The final version will be presented to CLAD during the Spring 2017 meeting and will be posted to the CLAD website thereafter.
3. Critical Load Definitions (Claire O'Dea)
- The CL definitions document has been finalized, published and posted to CLAD website

4. Critical Load Maps (Jason Lynch)
-   Idea for next update of maps (in 2017). The goal is to have draft maps ready for Spring 2017 meeting, with the maps published for Fall 2017 meeting
5. Open Discussion – new topics/issues for CLAD/Spring 2017 meeting (Claire O'Dea & Tonnie Cummings)

Doug Burns – follow-up on TDEP discussion regarding CL exceedance.

Jason Lynch – if we've decided that we want to produce CL exceedance maps with TDEP, need to determine how we would go about making these maps. We should have discussions on how to proceed with producing these maps and how to include uncertainty in the calculations.

Jason Lynch – Gary Lear's comment about NH_3 deposition and how it impacts ecological end points. We need to look at nitrification of N in soil and examine the charge balance of the acidification versus N effect.

Linda Pardo – should look at Bengt Nihlgaard – N effect paper that addresses this topic and N within soil.

Kevin Horn – uncertainty in CLs. We do need to understand the impact of eutrophication versus acidification with N deposition.

Tim Sullivan – N as a nutrient has an impact everywhere, whereas N as an acidifying agent acts in more limited locations.

Chris Clark – eutrophication and acidification is happening everywhere, but to varying degrees in different places. We also need to get an understanding of sites of N limitation (could use the Horn et al. equations of tree response to identify this).

Chris Clark – CL is a point. Perhaps we should be focusing more on dose-response curves/functions to understand responses to different levels of deposition.

Linda Geiser – relating CL and climate change.

Doug Burns – Charlie Driscoll has run PnET-BGC to model impacts of climate change on CLs.

CLAD group – we should try and put together all the information that we have on climate effects (empirical and modelled relationships).

Adjourn ~ 12:30 PM

2.2 SPRING 2017 MEETING

The 2017 Spring NADP CLAD Science Sub-Committee Meeting was held on Tuesday, April 25, 2017 in Louisville, Kentucky. The event took place at the Brown Hotel in Citation A Room.

Attendance

<u>In Room:</u> Jason Lynch (EPA, CLAD Co-Chair), Tonnie Cummings (NPS, CLAD Co-Chair), Jen Phelan (NADP), Jonathan Jernigan (NPS), Doug Burns (USGS), Anita Rose (USFS), Rich Pouyat (USFS), Tim Sullivan (E&S), Linda Pardo (USFS), Mike Bell (NPS, CLAD Secretary), Tamara Blett (NPS), Anne Rae (EPA), Jill Webster (FWS), Linda Geiser (USFS), Bret Schictel (NPS)

<u>On Phone:</u> Chris Clark (EPA), Amanda Cole (ECCC), Shaun Watmough (Trent University), Eladio Knipping (EPRI), Anne Mebane (USFS),

1:30-1:45 PM – Welcome
Web meeting logistics (Tonnie Cummings)
- Passed around sign in sheet
- Announced Happy Hour for 6:30pm this evening
- Tomorrow WG-3 will meets here from 8am – 12pm

Introductions (All)
Approve Fall Meeting Minutes (Mike Bell)
- Motion to approve Fall meeting minutes moved by Tamara Blett, seconded by Jason Lynch. No dissention.

Agenda overview (Tonnie Cummings)
1:45-2:00 PM – CLAD Program Manager Update (*Jennifer Phelan*)
CLAD Updates
<u>Structures roles and responsibilities document</u>
- This document describes structure of CLAD, the roles and responsibilities of each of the positions.
- The document was recently finalized and approved by the CLAD Advisory Board and will be posted to website shortly.

<u>Website</u>
- Will be revised soon with this document and recent publications associated with CLs.

<u>Working Groups</u>
- Four groups various levels of progress. Leaders will update below.
    o WG-1 – NCLD
    o WG-2 – Uncertainty
    o WG-3 – CL Synthesis
    o WG-4 – Deposition
- WG-3 meeting tomorrow

UNECE ICP meeting
- This meeting took place in Wallingford, UK at Oxford University. Jen Phelan, Chris Clark, and Todd McDonnell attended from CLAD
- The group had a call for data for CL and biodiversity
    o Only 6 countries responded with CL data
    o Not quite up to policy level of quality

- o Will extend call for data until Sept 2018
- Jen presented NADP/CLAD updates on CL mapper tool
  - o A lot of excitement around CL Mapper tool.
    - ▪ Some want to convert it to Europe
    - ▪ Add own platform? Or just add directly to tool?
- Chris Clark presented updates on CL research (herbs, trees, etc.)
- Chris Clark also talked with Todd about increasing utility of VSD+PROPS in US
- Updates to the Mapping Manual included adding 0 eq/ha/yr as an option to represent long-term steady state N immobilization within the steady-state models (based on recommendations from N immobilization workshop in Switzerland in February 2017)

Status of ICP M&M WGE-CCE
- Will discontinue funding at the end of 2017
- Need a new country to host the Programme Centre of the WGE-CCE
- May not be an ICP M&M WGE-CCE 2018 meeting

How do we respond to call for data?
- They want biodiversity CL based on vegetation
- HSI through VSD-PROPS
- Need data sampling scheme to approximate low deposition data, since most of our plots exist in areas with higher deposition; false minimum.
- Will move forward in searching for answers with Tim/Todd
- We previously said we would not respond/submit. Do we want to change this?
- Joint WGE-EMEP meeting will be conducted in Sept 2017.

UNECE ICP M&M Task Force 2018
- There currently is no meeting planned for 2018, because of the lack of funding.
- There is the potential for CLAD to host meeting during NADP in 2018. Do we want to pursue this?
  - o Costs may outweigh benefits.
    - ▪ How do we pay for it? Is this the right venue as it may pull us away from joint etc.?
    - ▪ Lots of logistics to work out before we can consider it
  - o Could be a good opportunity to interact as we are leading efforts in some areas
  - o Conclusion: We want to continue discussion and see if there are any European options first. No recommendation at this point

Three questions to CLAD AB
1. Call for data?
   - o Our work doesn't currently align with the HSI concept. But our community data could be adapted. Do we want to work towards HSI?
     - ▪ HSI used to summarize results that comes out of VSD+PROPS

- Uses properties of ecosystem to determine if it is suitable for endpoint. These are currently only good for VSD+PROPS, but we could adapt them for anything.
    - o European countries wanted to protect most sensitive thing. Decided it was herbaceous biodiversity and took empirical approach towards that.
2. Potential to host ICPM&M meeting in spring 2018 CLAD meetings?
3. European countries in CL Mapper?

TS: Our data suggests C:N ratio is important based on models

2:00 – 3:45 (with break) PM Critical Loads Projects: Status and Results "Round Robin" (2:11)
(5 mins summary of project(s) you want to let everyone know about; CLAD Workgroup leaders will have additional 5 mins for updates)

Chris Clark (is only highlighting a few of his many projects)
<u>WG-2 – Uncertainty</u>
- Has developed uncertainty scores for herb biodiversity, trees, and lichens (both 2010 and one underway).
- Revealed consistencies and inconsistencies of critical loads data, but need
- Need to revisit lichen and trees due to recent analysis
- What makes more sense for next steps?
    - o Aquatic acidification?
    - o Switch gears to top down approach?

<u>Trees/Herbs Critical Loads</u>
Herbs – Sam Simkin now has CLs for 184 herb species coming from the same analysis of the herbaceous biodiversity dataset. Hoping to submit the manuscript in 2-3 months

Trees – Kevin Horn has incorporated S into analysis. Know where S and N impact tree growth. He is working with Quinn Thomas on text and plans to submit in a month.

Herb/tree has shown multi-colinearity of pollutants by species. Some species N is dominant, sometimes correlated with other factors (S, temp, precip). There is more uncertainty in CL if N/S are less independent.

Amanda Cole
- Working on a Measurement Model Fusion project for deposition. Finalizing and testing deposition maps for 2010. US and Canada N and S deposition.
- Spoke at TDep on workshop in Geneva. Global Total deposition on measurement/model fusion. Potentially may have other deposition maps available besides TDep soon.

Shaun Watmough
Working with Julian on critical load project in British Columbia designed to assess the potential impact of increased SO2 emissions from an Al smelter.

<u>Alberta</u>
Identifying CLs of N in boreal forests through experimental studies that apply N at dosages from $5 - 25$ kg N ha^{-1} y^{-1} via helicopter above the jack pine canopy.

Also examining how dust from mines is leading to soils becoming more basic and how this can be managed via critical loads. What are the impacts when soils are naturally acidic and becoming more basic? We're trying to establish guidelines for management.

<u>Saskatchewan</u>
Working with Colin Whitfield on steady-state and dynamic critical loads in Saskatchewan for acidification and eutrophication and incorporating aspects of climate change.

<u>Ontario</u>
Looking at recovery from timber harvesting and impacts on CLs and calcium depletion in both terrestrial and aquatic systems.

Jen Phelan
<u>NO$_x$/SOx Secondary Standard ISA – Terrestrial Acidification and Terrestrial Eutrophication chapters</u>

<u>CL Mapper</u>
- Tech support and management of contract

<u>Improved base cation weathering (BCw) estimates for terrestrial critical load determinations for the continental U.S.</u>
- <u>Complete uncertainty analysis of Profile model – draft manuscript detailing results near completion</u>
- Next phase of project – estimate BCw and CL for forested sites across continental US

Forest composition - Ecosystem Service looking at changes out to 2100 (in response to 12 N deposition-climate scenarios)

- Completing manuscript of phase I of project (based on Thomas et al. (2010) tree species and region (northeastern U.S.)
- Phase 2 of project just beginning – will revise future estimates based on Horn et al. (in press) relationships (revision will include expanding from 24 to 94 species and adding S deposition as a predictive variable)

Continued work on project evaluating the impacts of climate and deposition scenarios on understory diversity and biogeochemical cycling in northeastern hardwood forests (using ForSAFE-Veg):

- Published results for Bear Brook and Hubbard Brook; new manuscript is evaluating the trends at 24 USFS FIA sites.

Doug Burns
<u>Acidification CL for streams</u>
- Working with Tim Sullivan, Charlie Driscoll, and Greg Lauwrence. They have data for lakes, but not a lot of streams. Pnet-BGC model. 15-20 (+?) streams. Want to extrapolate results to total stream network (400 streams) using chemistry.

- Using 50 ue/l threshold as chemical criterion.
- Looking at episodic acidification with shifts in flow.
  - At 50 in summer, may get down to zero at low flow. Archer creek, buck creek, some sites with data in 80s. Most have been done in last 12 years by Greg (target specific flow conditions; snow melt, summer).
- Seeing relationships between flow and ANC. Sampled 4-7 times. Like Todd's method, but slightly different.

Jason Lynch recommended that he contact UVA as they are looking at their data too. May be worth linking up. They have at least four sites where they are measuring flow, ANC, etc.

Linda Geiser
Introduce Anita Rose
- Anita is taking on lead USFS role in WG-3. Working with NPS to use CL to manage effects of AQ

Finishing up lichen CL.
- FIA dataset. 350 species used to create community based site score. Relate to community response to N dep. Acidity and nutrient N. How these CLs are related to changes in lichen composition, biodiversity, ecological important functional groups, relative composition of community. CL will be low, but want them to be defensible on how the environment is affected. Not just where we see a shift. Relevant.

Handbook of individual species responses.
- Subset of 250 species N/S responses. Photo, dist map, traditional human uses. 260 get response. Will feature 90 that we understand ecological role or traditional use by tribes etc. Will publish as GTR. May not be useful as CL since it only relates deposition to likelihood to identify lichen. Doesn't take into account climate, precip, etc. One future course of action will be to look into species responses along the different gradients.

Will present at Tribal Air Quality Forum next week (highlighted by Rich Pouyat)
- Opportunity to get word out and get Tribal representatives to come to CLAD. EPA has been integrated in the past. JL will also attend. TS- Some tribes very interested in CLs. Helps them argue with state about Hg and acid dep.

Standardized CL Presentation
- Should we pull together a general talk about Critical Loads and why they are valuable?
- This would be a canned presentation that we can all share to ensure that we are all using the same language around critical loads.
- Have familiar face give presentation. When WG2/3 come to close. It would good to disseminate the information and get people on the same page before FLAG begins.

CAA requires FLM participate in permit process. NPS/FWS/USFS document guides permittees on what information we need to evaluate the permits. We can use this to guide use of CLs. BLM wants to be part of revision. Also want to be part of WG2/3.

Linda Pardo

WG-3 – Synthesis WG.
- Focused on developing rulebook for how to set CLs for regulatory process. Try to streamline process
- Started for aquatic biota and herbaceous
- *Rulebook, is guidelines given by NPS/USFS to inform what CL values should be used.
- Additionally, need to develop guidelines for how FS specialists choose CL they want to use for management.
- Use pathways to identify which CL options need to publically available
- Also, what choices we would like to have but don't.
- Give feedback to CL Mapper so that it can output our interests.
- Workshop in DC at end of March with EPA, NPS, USFS
    o FS made commitment to move forward, LP co-chair effort with Anita
    o Lots of complexity
    o National Air Program meeting in middle of May
- Next meetings focusing on: CL classes (classifications), Herbaceous plant examples (Mike), then tree CL rulebook. In Fall, Lichen.
- Other topics: Handbooks and how we deal with them. Deposition maps not synced with lands on the border, what does this mean? Comparing CLs based on CMAQ with CLs based on TDep; does this affect exceedance?
- Some discussion will happen at Dep. FARM team. Will work through topics on Linda's secret list.
    o May: How important is it to have plots within that Class I area; for herbs
    o June: Same for aquatic; and maybe CL Classes (categories)
    o Fall: Monthly topic meetings.

NCLAS
- Continued development.
- Working with stakeholders to identify their needs and link outputs to such. Will have summer intern.
- Goal to calculate figures and tables on the fly; not static.
- Future – Go to national scale by inserting Kevin Horn data into core of tool.

Tim Sullivan

Completion of Book "Air Pollution and Its Impacts on U.S. National Parks"
- Last book.
- Need reviews of park book on Amazon (https://www.amazon.com/Pollution-Impacts-U-S-National-Parks/dp/1498765173/).

Sugar maple study
- Manuscript in review at Ecosphere. 50 sites in Adirondacks. At low base saturation sites they found that you lose canopy Sugar maple and American beech to beech bark disease. Gaps allow Red maple and black cherry to grow changing soil structure. This was in collaboration with USGS and SUNY Syracuse and should be available in 3-6 months.

Understory biodiversity in Adirondacks
This used the same sites as the previous study and evaluated understory plants and their relationships to soil characteristics. Used Nonmetric Multidimensional Scaling analysis. The 1st axis contained acidification metrics (Ca++, Deposition, BS) and the second Axis had forest characteristics (Canopy, etc.). Results show that there are indicator species of low and high soil base saturation and by using this information you can understand soils by understory species composition.

Plant Biodiversity modeling studies
Working with EPA and NPS on modeling forest response to deposition and climate change using two different models (ForSAFE-Veg and VSD+PROPS) at three sites (GRSM, SHEN, Hubbard Brook). Both models have their limitations. ForSafe-Veg uses empirical data and expert opinion on species requirements while VSD+PROPS just uses empirical data. We have not compared the results of the two models yet, because it is complicated, and we don't want to give it full focus if we're going to attempt this. One of the main limits of PROPS is the availability of plant data at low dep data. No sites less than 4 kg in the east. Model thinks that zero plant occurrence at 0-4 kg means plants can't grow. Trying to bring in Canada data to broaden the relevance of results.

Acidification CL for streams
Project Doug Burns commented on.

NAAQS Reviews
- Wrote chapters for the NOx/SOx Secondary Standard ISA

Ecosystem Services
Author on O'Dea Ecosphere manuscript "Impacts to ecosystem services from aquatic acidification: using the FEGS framework to understand the impacts of air pollution," which is in press.

EMDS – Ecosystem Management Decision Support.
100s of new sites measured for base cation weathering. Doubling/tripling number of sites.

Mike Bell
WG-4 – Deposition Quality
Development of WG-4 is in a waiting period until I finish working on TDEP White Paper about Research needs for deposition.

I want to focus the group more around the current types of deposition measurements and the pluses and minuses of each. After discussions with the TDep group, defining a set TDep uncertainty number seems unlikely.

Linda Geiser mentions that she knows there are known issues with interpolation in west.

She thinks that lichen data should be added to the analysis as it can be used as a surrogate for deposition and is just as effective.

<u>Air Quality and Ecosystem Services</u>
Four of the five papers have been accepted and are in press (Overview, Terrestrial Acidification, Aquatic Acidification, and Aquatic Eutrophication). The terrestrial eutrophication paper will be resubmitted next week.

<u>Jason Williams Manuscripts</u>
Deposition model performance paper published

Williams, J. J., S. H. Chung, A. M. Johansen, B. K. Lamb, J. K. Vaughan, and M. Beutel. 2017. Evaluation of atmospheric nitrogen deposition model performance in the context of U.S. critical load assessments. Atmospheric Environment 150:244-255.

Jason Williams alpine aquatic health CL in prep.

Anita Rose
Developed a Media toolkit for Air Quality Awareness Week (May 1-5). The forest service will publish pictures, publications, and tweets to push out information on air quality on different media platforms. The hope is that it will highlight the benefits of air quality to educate the public.

Anne Mebane/Eladio Knipping/Jill Webster/Anne Rae/Rich Pouyat
Did not share updates

3:45-4:15 PM – Brainstorm Topics and Speakers for Fall Science Meeting
This year, we are hoping to reach out to more people rather than just hope people submit/show-up to give talks. We need to identify the topics and the people and then reach out and invite them.

Student Presentations
We can't offer money for travel but Tamara is going to propose to Exec to waive registration fees for students (and postdocs?) who present posters or talks.

We want to emphasize student/postdoc participation by asking them to co-chair sessions and potentially have a breakfast event, or focused networking event. We also want to get a message out ahead of the June submission to give them time to prepare.

Sessions
We are defaulted one session, but if we have enough submissions, we may be able to get two.

If we do one normal CL session, potentially we could have a second on:

1. Critical loads and climate change?
2. Synthesizing CL on federal lands *
3. Other options welcome

While it doesn't have to be people outside of this room, a mix of current and future CLAD members would be good. This would be a great opportunity to pull new people into the mix and add new voices to our efforts.

Think local to CA.

Names thrown out during the meeting:

Pete Homyak, Justin Valliere (UCLA), Scott Parker (UC Irvine), Julian, Shaun Watmough, Mark Fenn (USFS), Edie Allen (UCR), Leela Rao (CARB), Air Specialist in CA area? More focused on smoke, human health, and monitoring smoke (Ricardo, Don), Jim Sickman (UCR), Sarah Jovan (USFS), Jill Baron and students, Charlie Driscoll (Syracuse), Jim Galloway (UVA), Peter Vitousek (Stanford), George Vourlitis (CSU San Marcos), Beth Boyer (Penn State), Josh Schimel (UCSB), Gary Lovett, Alex Pivavaroff (UCLA), Nicole Piatrasiak (NM State).

**Tonnie/Jason will have a draft of email to send out by CLAD Exec Team meeting May 9. This will be distributed to everyone to send out to their contacts.

4:15-5:30 PM – CLAD Products
National CL Database (30 mins Jason Lynch)
Broad Updates
- NLCD 3.0 coming soon
- Jason wants to get to more of a rolling release schedule
- The datatables have been expanded as defined below.
- Each CL can have many citations. Primary, secondary, etc.
- Metadata document has information on how to calculate exceedance
- Reworking empirical CL for N.

Table Structure
- Different table for each type of CL.
- CL-ID is unique to each CL, therefore could be combined if needed. Simpler to have individual tables because need is generally based on CL type (class). Also, leads to having many empty columns.
- Acidity has 2.5 million data points.
- Will also have GIS files

Table 1.
- Site Information
- Same for all CLs. Long/lat, Ecoregion, etc.
- *Added Ecoregion Level 4

Table 2: CL table
- Used to be CL-ID and CL info; had to merge tables to get anything useful
- Now: provides key data about CL
    o Project ID
    o CL estimates (maxS, minS, MaxN, MinN)

- o ChemCriterion
- o ChemThreshold
- o PrimRef – Who you can credit CL to
- Bill Jackson used new tables (for WG-3 example) and verified it was easy to use.

Table 3 and 4
- No changes

Tables 5 and 6
- 5 = Lookup table -> goes from one record to many records. Sometimes more than one publication that references critical load and allows to query for all of them.
- Ex/ Surface water: need immobilization and N for soil data reference linked to CL it was used for.
- 6= Al references to all critical loads

Generally speaking, these tables should be more functional, more user friendly, and include more information.

New CL Data
Surface Water

- MCDonnell et al. 2014- 140,000+ Defines CL for every reach in their domain.
  - o Gives us region in US with estimated CL
    - For S only, but could easily be modified to include N
    - *N concentrations are very low in these streams and not contributing a lot.
  - o *being revised with 500 new streams from USFS that will update/improve estimates.
- Database has a placeholder for target load (need to know TL year). Important because CLs calculated as target loads.
- Enhanced metadata

Next steps
- New McDonnell and Sullivan projects
  - o NY, AT, others
- EPA national Lake assessment
  - o Lots of resampling. Sites in south and west are reservoirs
- Natural vs. Reservoir classification
  - o Could be issue where lake was dammed, so it's now larger than original, but not "natural"
- Watershed Areas and Elevation
  - o Could you link this to a geodatabase? Spatial representation of each CL.
  - o Both measurement and how it is represented on the landscape.

Forest Ecosystem
- Target Loads (Sullivan/McDonnell)
- Updated table structure

Empirical CL for N (in progress)

- New Data
  - o Updated CL table 2
  - o Herb biodiversity – Simkin et al. 2016
  - o Individual studies from Pardo et al. 2011
- New table info
  - o Wanted a range of CL calculated of how it is calculated.
  - o Quantile distribution of modeled values
  - o Empirical table is a work in progress. Table headers based on C. Clark interest.
  - o Have a receptor column RecepI – Fungi, lichen, herb, etc.; RecepII – more specific information on RecepI – Conifer, deciduous, etc.
  - o BioResponse – species growth, survivorship, cover, etc.
  - o Responsne – Increase, decrease, change
  - o Threshold – Percent change, ratio, pH value
  - o Study – Metadata, Multiplot, single site
  - o PrimRef – Primary reference

Next steps

- Add Williams 2017 data
- Complete individual studies
- Add Simkin data by ecoregion I, II, III, IV, and others

GIS Files

- Some have been created, some need to be done.
- Some need to be modified to limit data for clarity.

Projects using NCLD

- USEPA CL Mapper
- CAMD Progress Report 2017
- UNECE Model and Mapping Meeting
- ISA First Draft
- AQES Papers
- Sullivan NPS book

Critical load exceedance maps summary (30 mins *Jason Lynch*)

We are scheduled to update in the maps in 2017

Last time we mapped CLs in individual form. We now have new data sets and can improve them.

Two potential sets of maps; CL maps and Exceedance maps.

CL maps

Yes, we want to update these

<u>Exceedance Maps</u>

There is some hesitation and some questions from the group.

To do this we would have to:

- Agree that we want to move forward, then get Exec approval. *There may be a limitation from program office about moving forward.*
- If approved, we would decide how to make them.
- Tim Sullivan mentions that if we do make them, we need to identify the time period applicable to when the CL was calculated and time period after CL calculation.
- Decisions that need to be made: what depositions? what years? what CLs?…lots of details
- What maps?
    o Simkin work
        ▪ Ecoregions and individual points
    o We would need to fine tune data to fit into exceedance decisions.
- We should aim for Fall Meeting to discuss this with NADP Exec. We will plan to:
    o Bring examples.
    o Need to expect to debate uncertainty in CLs and Deposition maps.
    o We can't just dump NLCD into a map.
        ▪ Need to be strategic about it.

- **Jason Lynch begins motion** to develop framework for exceedance maps; will mention on Thursday. *Discussion ensues about the questions above.* Tim Sullivan adds the caveat that this should be done at incremental process. Start with AA exceedance. Going too big too soon, may lead to derailing process. The group accepts this thought. The official motion presented to NADP Exec is:
    o **CLAD wants to develop exceedance maps to be included in future map summaries. As part of process, we are asking chairs to allow for a formal presentation at the Fall meeting to seek approval of including exceedance maps as an official NADP product. The first maps would be of exceedance of aquatic acidification critical loads and we would hope to have the first map ready in 2018, additional critical loads would follow when data is ready. Uncertainty will be taken into consideration.**
    o Phelan – Second; All in favor – yes; Motion accepted

Wikipedia CL page revisions (15 mins *Tonnie Cummings*)
Updates
- Last Fall Doug Burns googled Critical Loads and realized the Wikipedia article was very European focused.
- We updated text, sent it to CLAD AB for review then Tonnie updated the Wikipedia Site.
- The format is now: Introduction (based on CL definitions), European CLs (we left this at the top, and unchanged, since it was the initial entry), US CLs (included information from CLAD, USFS, NPS, FWS, EPA), Asia CLs (Mark Fenn reached out to Asian colleague, who wrote Asia section).
- There is more information than before, but still pretty simple.
- The article is easy to edit as Doug Burns made edit while in meeting.

Next Step

We plan to reach out to European colleagues and have them update their section accordingly. Hopefully they will go in and edit their own.

*This was not mentioned at ECC meeting, but we are reaching out now.

5:30-6:00 PM – Wrap-Up
Discussions about photochemical models

Linda Geiser talked to Bret Anderson (USFS) who thought it would be a good idea to bring in Kurt Anderson (EPA) or Tim Allen (FWS) (or someone similar) to discuss CAMx vs CMAQ models and understand the difference between models and what this means.

The consensus from modelers seems to be that generally speaking, CAMx is easier to run and only a few groups can do CMAQ.

- CAMx has better source apportionment tools. CMAQ more widely used, but CAMx has advanced N tools.

If we want to do this in person, it might be better at the next Spring meeting unless we want to have a special session on Monday/Friday in the Fall due to cramped schedule.

Alternatively, we can try to do this as a CLAD webinar which will allow a broader dissemination of the information quickly.

The objectives of this presentation would be to get a better understanding of:

- If we want to use CL in PSD/review what does it mean if CAMx being used but our CL is calculated using CMAQ?
- What are considerations from policy/regulatory point of view of how to present CL to regulatory community that will be acceptable? How can we get people to understand and use?
- Determine whether the new generation of tools will enable us to think differently about CLs? Is there new data that will allow us to assess impacts differently?
- How do use CL in New Source review? How do modeled vs empirical CLs differ?

Step 1: Webinar by modelers to CLAD
- This will allow us to get an understanding of what we don't understand before expanding.
- Will be of interest to subset of CLAD group, and some broader NADP.
- Will help with potential FLAG revisions
- The plan will be to make it a CLAD/TDep webinar
   o Tamara/Linda will develop agenda, invite list, people to present, etc.
   o June-July(ish)
   o Jason Lynch can handle logistics if someone handles contact.

Step 2: Webinar about CL to modelers
   o It might help to update the modelers on CLs and general information on effects after this so that they understand our world too.

Basic CL PowerPoint

- We want to develop a generic CL PowerPoint in an easy to understand format. This would allow any of us to give a presentation on CLs using the same language so that our messaging and facts are consistent.
    o Jason has this down as an Exec task.
    o He will collect slides (with notes)
        ▪ Draft presentation by the Fall meeting
        ▪ Fall only has a couple of hours of CLAD, but can add a couple of hours Monday/Friday
    o *We have a generic poster

6:00 PM Adjourn

3.0 UNECE ICP M&M WGE-CCE MEETING

The 33rd Task Force Meeting of the ICP M&M was held in Wallingford, England April 4th – 6th. The objective of this meeting was for representatives from each of the National Focal Centres (NFCs) of countries that are members and signatories of the Convention on Long-Range Transboundary Air Pollution (CLRTAP) to provide their respective country's response to the 2015-2017 Call-for-Data for biodiversity CLs. Other objectives, as outlined on the UNECE ICP M&M website - http://www.wge-cce.org/Activities/Workshops/Past_workshops/Walllingford_2017, included:

- Updates on experimental and modelling results of abiotic and biotic changes due to air pollution and climate change
- Review of the Mapping Manual
- Progress under the LRTAP Convention in relation to the workplan and the 3rd joint meeting of the EMEP Steering Body and Working Group on Effects

A total of 57 participants from 23 countries were present at the meeting. Jennifer Phelan represented CLAD as the non-official NFC from the U.S., and gave a presentation on CLAD activities and the CL Mapper Tool being developed by the EPA and supported by the USFS and NPS. Chris Clark and Todd McDonnell from the U.S., were also present at the meeting. Chris Clark presented on herbaceous diversity and tree CLs. All presentations from the meeting are available on the WGE-CCE website. During the meeting, updates to the Mapping Manual were discussed and accepted. These included the addition of new information and recommendations on how to estimate long-term N immobilization (based on outcomes of the February 2017 workshop in Switzerland). Only 6 countries submitted biodiversity CLs to the CCE in response to the Call-For-Data, and it was concluded that the data submissions were not ready for policy. The Call-For-Data was therefore extended until September 2018, with interim updates scheduled for April 2018. However, the Netherlands will not fund the CCE Programme Centre after December 2017 and the WGE is seeking a new host country for the ICP M&M WGE-CCE Programme Centre. The dates and locations of future WGE-CCE Task Force meetings (including April 2018) are unknown.

4.0 CLAD WORKING GROUPS

Scientific Working Groups (WGs) have been a component of CLAD since 2011. The objectives of WGs are to increase our understanding and ability to estimate and represent CLs of deposition in the U.S. This year, the three WGs that were initiated in 2015 and one WG that was formed in 2017 continued work on improving the CLAD National Critical Load Database (NCLD) and advancing the estimation and representation of CLs in the U.S.

WG-1 ADDING NEW DATA AND CLS TO THE CLAD NCLD

Objective: The objective of this WG is to produce, adopt, and practice a standardized method for review and incorporation of new published data and CLs into the CLAD NCLD.

During the year, WG-1 completed a total overhaul of the national Critical Load Database (NCLD). Version 3 of the database and supporting documentation was released on October 1, 2017.   The updated database and supporting documents included: (1) new CLs to the Forest Soil from Phelan et al. (2014) and Sullivan et al. (2011a, 2011b) and Surface Water Acidification datasets from McDonnell et al. (2014), DuPont et al. (2005) and others, as well as the addition of point and Ecoregion (I-IV) herbaceous biodiversity from Simkin et al. (2016). In addition, new supporting variables were added to the database to better describe CLs and make them easier to use. For example, three variables have been added for the empirical CLs that better describe the receptor, response, and threshold.   The NCLD documentation has been re-written to better connect the CLs with their supporting information. Lastly, ArcGIS files are available for download for each CL types.

WG-2 CHARACTERIZING UNCERTAINTY IN CL ESTIMATES

Objective: The objective of this WG is to provide estimates of uncertainty for CLs in a standardized way to support the comparison of the strength of critical loads between critical load types and datasets.

During the year, WG-2 held multiple conference calls and webinars and completed a 5-classed scoring system to characterize the uncertainty of tree, lichen and herbaceous biodiversity CLs. The WG also initiated work applying the system to characterize the uncertainties associated with surface water acidification CLs. The goals of WG-2 for next year will be to complete the uncertainty scoring systems for surface water and forest ecosystem acidification CLs and to publish at least one report and manuscript from the work.

WG-3 CL SYNTHESIS

Objective: The objective of this WG is to develop a methodology/process for combining and representing multiple CLs in a rigorous, reproducible, and defensible manner. Different methodologies may be necessary to meet the needs of the different federal agencies: EPA, NPS, and USFS.

During the year, WG-3 held multiple conference calls and webinars to explore options and methods for combining and representing multiple CLs in common geographical areas. Subgroups were initially formed to examine how CLs would be lumped for federal land managers, the EPA, and NYSERDA. We then realized that we needed to break off individual CL responses based on (and lead by): herbaceous diversity (Mike Bell/Bill Jackson), aquatic acidification (Jason Lynch/Bill Jackson), tree species (Chris Clark), and lichen (Linda Geiser). The NPS and USFS worked with the EPA to hold a 2-day meeting in March 2017 to kick start the groups and introduce a CL framework and draft CL Classification system that labels and classifies all CLs based on a common set of criteria. Since then, webinars have been held bi-monthly to go through case studies and decision making on each of the CL types. As the year ended, initial criteria for determining CLs for an area based on herbaceous biodiversity, aquatic acidification, and tree species were set.

The goals of WG-3 for next year will be to finalize decisions for each of the CL types, develop a manual for describing the processes for determining the CL for a specific area (with highlighted differences for each agency if they exist), and determine how to combine multiple CLs into a single value for an area.

WG-4 UNCERTAINTY IN DEPOSITION MODELS AND ESTIMATES

Objective: The objectives of this WG are to understand the uncertainty that exists in measurements and models used to estimate the deposition of nitrogen (N) and sulfur (S) to the ecosystem. Deposition measurements being assessed by this WG at this time include bulk precipitation collectors, IER resin columns, snow pack, and lichen tissue. Models being evaluated are CMAQ, TDEP, and CAMx. Measurements and models will be compared to attempt to assess the spatial variability of the uncertainty across the contiguous US. This will benefit CL analysis by developing a framework of how CLs developed from different sources can be compared and used in unison.

During the year, WG-4 was advertised to the CLAD and TDEP communities and officially launched in August 2017. Early meetings fine-tuned the scope of the WG and focused discussion on existing efforts to compare measurements and models to ensure that the work of the group was not duplicative. The goals of WG-4 for next year will be to produce a map of deposition measurements outside of the US with associated metadata, develop a best practices manual for collecting data so that it can be used in concert with previous data, explore the opportunity to downscale PGM models using landcover data to improve accuracy of dry deposition measurements, and to create a spatial analysis of uncertainty across the US to be more aware of where more research needs to take place.

5.0 CLAD PRODUCTS

CLAD produces documents, maps, datasets and other materials to support advancing the estimation and representation of CLs in the U.S. Two products were developed during the year.

2.1 CLAD STRUCTURE, POSITIONS, AND RESPONSIBILITIES – VERSION 1.0 AND 1.1

The objective of the CLAD Structure, Positions, and Responsibilities document is to outline the structure of CLAD as a Science Committee of NADP and the responsibilities associated with each of the six defined CLAD positions. It serves as a resource and reference for all CLAD members, and should be updated as new positions and responsibilities within CLAD develop. Version 1.1 can be accessed at http://nadp.sws.uiuc.edu/committees/clad/clad_structure.pdf.

2.2 CRITICAL LOAD PRESENTATION

CLAD members identified the need for a presentation that describes CLs as both a scientific concept and management tool. Therefore, CLAD developed a generic PowerPoint presentation consisting of over 35 slides that define and provide information about CLs and atmospheric deposition for audiences that vary in their background knowledge on the subjects.

6.0 CLAD SUMMARY OF ACCOMPLISHMENTS

The CLAD Summary of Accomplishments document was updated with CLAD accomplishments that occurred during this year. These accomplishments included:

1. Sponsored a critical load session at the Fall 2016 Scientific Symposia
2. Attendance at CLAD meetings during the Spring and Fall NADP meetings was between 20 and 32 participants
3. Represented CLAD as the U.S. non-official National Focal Centre (NFC) at the 33rd Task Force Meeting of the ICP M&M that was held in Wallingford, UK
4. Continued the efforts of three scientific Working Groups (WGs) and initiated a fourth WG within CLAD to improve the CLAD NCLD and advance the estimation and representation of CLs in the U.S.
5. Supported the publication of five articles in a special issue of Ecosphere. These articles presented the application of an ecosystem services framework to characterize the impacts of CL exceedance by atmospheric N and S deposition in terrestrial and aquatic ecosystems
6. Max Posch, RIVM in the Netherlands, gave a webinar on New Addition of a Critical Load Sub-model/Component to the VSD-PROPS Model
7. Became a partner of the International Nitrogen Initiative – North American Nitrogen Committee (INI-NANC) in 2015 and presented CLAD poster at the 2016 INI meeting in Australia
8. Completed the CLAD Structure, Positions, and Responsibilities document
9. Updated Wikipedia website on CLs to include U.S. and CLAD information
10. Supported development of EPA CL Mapper and USFS N-CLAS Tools for mapping CLs and exceedances
11. Developed a generic CL PowerPoint presentation that can be used by all CLAD members

8.0 PUBLICATIONS

CL-related publications that were added to the CLAD website this year included the following.

2017

Bell, M.D., Phelan, J., Blett, T.F., Landers, D., Nahlik, A.M., Van Houtven, G., Davis, C., Clark, C.M., and J. Hewitt. 2017. A framework to quantify the strength of ecological links between an environmental stressor and final ecosystem services. Ecosphere 8(5):e01806. http://dx.doi.org/10.1002/ecs2.1806

Clark, C.M., Bell, M.D., Boyd, J.W., Compton, J.E., Davidson, E.A., Davis, C., Fenn, M.E., Geiser, L., Jones, L., and T.F. Blett. 2017. Nitrogen-induced terrestrial eutrophication: cascading effects and impacts on ecosystem services. Ecosphere 8(7):e01877. http://dx.doi.org/10.1002/ecs2.1877

Crowley, K.F., and G.M. Lovett. 2017. Effects of nitrogen deposition on nitrate leaching from forests of the northeastern United States will change with tree species composition. Canadian Journal of Forest Research 47(8): 997-1009. https://doi.org/10.1139/cjfr-2016-0529

Fakhraei, H., Driscoll, C.T., Kulp, M.A., Renfro, J.R., Blett, T.F., Brewer, P.F., and J.S. Schwartz. 2017. Sensitivity and uncertainty analysis of PnET-BGC to inform the development of Total Maximum Daily Loads (TMDLs) of acidity in the Great Smoky Mountains National Park. Environmental Modelling & Software 95: 156-167. http://dx.doi.org/10.1016/j.envsoft.2017.06.013

Irvine, I.C., Greaver, T., Phelan, J., Sabo, R.D., and G. Van Houtven, 2017. Terrestrial acidification and ecosystem services: effects of acid rain on bunnies, baseball, and Christmas trees. Ecosphere 8(6):e01857. http://dx.doi.org/10.1002/ecs2.1857

Nanus, L., McMurray, J.A., Clow, D.W., Saros, J.E., Blett, T., and J.J. Gurdak. 2017. Spatial variation of atmospheric nitrogen deposition and critical loads for aquatic ecosystems in the Greater Yellowstone Area. Environmental Pollution 223: 644-656. http://dx.doi.org/10.1016/j.envpol.2017.01.077

O'Dea, C.B., Anderson, S., Sullivan, T., Landers, D., and C.F. Casey. 2017. Impacts to ecosystem services from aquatic acidification: using FEGS-CS to understand the impacts of air pollution. Ecosphere 8(5):e01807. http://dx.doi.org/10.1002/ecs2.1807

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