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FOCUS: A pilot study for national-scale critical loads development in the United States

Tamara F. Blett [a,*], *Jason A. Lynch* [b], *Linda H. Pardo* [c], *Cindy Huber* [d], *Richard Haeuber* [b], *Richard Pouyat* [e]

[a] *Air Resources Division, National Park Service, PO Box 25287, Lakewood, CO 80225, USA*
[b] *US EPA Clean Air Markets Division, 1200 Pennsylvania Avenue NW, Washington, DC 20640, USA*
[c] *USDA Forest Service, Northern Research Station, University of Vermont Aiken Center, 81 Carrigan Dr., Burlington, VT 05405, USA*
[d] *National Atmospheric Deposition Program, Illinois State Water Survey, 2204 Griffith Dr., Champaign, IL 61820, USA*
[e] *USDA Forest Service R & D, 1601 North Kent Street, RPC-4, Arlington, VA 22209, USA*

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ABSTRACT

The development and use of critical loads of air pollutant deposition in the U.S. is gaining momentum, and recent research efforts in the U.S. have produced valuable data for calculating critical loads. Critical loads are used to quantify the levels of air pollutants that are expected to impact forest health, soil fertility, aquatic biota condition, and other ecosystem responses. In addition, model refinements for improving critical loads estimates, and maps for illustrating critical loads for acidification and nitrogen saturation and eutrophication resulting from excess nutrient nitrogen, have been developed at various scales. However, prior to the effort described here, no cohesive process existed to provide a national-scale critical loads database and maps as a unified product representing all U.S. ecosystems. The FOCUS (Focal Center Utility Study) Project was initiated to coordinate the development and implementation of a clear, consistent, repeatable process for calculating and mapping critical loads within the U.S. In the FOCUS Phase I Pilot Study, empirical and calculated critical loads data for the U.S. were synthesized from dozens of regional and national-scale monitoring networks, research projects and publically available databases following an approach similar to that used in Europe. The United Nations Economic Commission for Europe (UNECE), through its International Cooperative Programme on Modelling and Mapping of Critical Levels & Loads and Air Pollution Effects, Risks and Trends (ICP-M&M) collects, analyzes and maps critical loads data. Countries participating in the Convention on Long-range Transboundary Air Pollution (CLRTAP) use a Critical Loads "Focal Center" in each country to serve as the point of contact for submitting regional and national-scale critical loads data to the ICP-M&M. One of the purposes of this study was to develop a foundation for interacting with other Focal Centers by assembling critical loads data, creating a database, establishing modeling protocols, and developing infrastructure within the U.S to report and update critical loads on a national scale. Because the U.S. does not currently have an officially designated Focal Center, critical loads data were provided as an informal, unofficial submission to the Coordination Center for Effects (CCE) of the ICP-M&M in March 2011, in the interest of international cooperation and exchange of information on the effects of atmospheric deposition of pollutants on ecosystems. We envision that

* *Corresponding author*. Tel.: +1 303 969 2011; fax: +1 303 969 2822.
E-mail addresses: tamara_blett@nps.gov (T.F. Blett), lynch.jason@epa.gov (J.A. Lynch), lpardo@fs.fed.us (L.H. Pardo), chuber@illinois.edu (C. Huber), haeuber.richard@epa.gov (R. Haeuber), rpouyat@fs.fed.us (R. Pouyat).
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these data will enable U.S. scientists, land managers, and environmental policymakers to enter into a productive and meaningful dialogue within the US, and also with the international scientific community on methods for estimating, calculating, mapping, interpreting, and refining critical loads for the effects of acidification and excess nutrient nitrogen on terrestrial and aquatic ecosystems. This paper describes the process used to develop national-scale critical loads in the U.S., summarizes the FOCUS Phase I approach and database development effort, and presents some initial national-scale critical loads mapping products.

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1. Introduction

1.1. Development of a U.S. critical loads approach

Air pollution impacts on sensitive ecosystems in the United States (U.S.) have been widely documented at local and regional scales; impacts include acidification due to nitrogen (N) and sulfur (S) inputs, eutrophication, declines in plant health, alterations in species composition, and increases in invasive species (Baron et al., 2000; Driscoll et al., 2003; Fenn et al., 2003; Pardo et al., 2011a). However, systematic use of the data to inform air quality and land management policies has not yet been achieved on a national basis. Although a critical loads framework for the U.S. was proposed in the early 1990s (Hunsaker et al., 1993; Strickland et al., 1993), implementation has only recently become possible now that comprehensive and integrated datasets are accessible (U.S. EPA, 1995). Several recent assessments are now available which provide sufficient data to inform policy and land management applications of critical loads (Baron et al., 2011; Burns et al., 2011; Pardo et al., 2011a,b).

Following a series of critical loads workshops held in the U.S. from 2003 to 2005, the Critical Loads of Atmospheric Deposition Science Committee (CLAD) under the National Atmospheric Deposition Program (NADP) was formed in 2006 to facilitate enhanced collaboration on critical loads topics (Burns et al., 2008). While CLAD has been successful in providing a communications venue for scientists, land managers, air quality regulators, and others working on developing critical loads, CLAD discussions early on revealed that most of the U.S. efforts to develop critical loads were disjointed: data were scattered amongst universities, agencies and others, various methodologies were utilized, and impacts were assessed at different scales. CLAD members concluded that the next frontier in U.S. critical loads progress should be to develop a comprehensive, national-scale critical load database and maps. They recommended that synthesis be conducted of multiple critical loads research efforts across the country, and protocols developed to provide a consistent approach to critical loads that would be useful in policy and land management decision-making.

1.2. International collaboration

CLAD established early on that efforts to assemble critical loads information for the U.S. into a comprehensive database would be most effective and efficient if the expertise and experience of others who had conducted similar previous assessments could be engaged. CLAD's collaborative work with the United Nations Economic Commission for Europe International Cooperative Programme on Modelling and Mapping of Critical Loads and Levels and Air Pollution Effects, Risks and Trends (ICP-M&M) highlighted the advantages in adapting protocols and processes for critical loads (UBA, 2004) and coordinating approaches with the European effort (CCE, 2011). The process the ICP-M&M employs to collect, analyze, and map critical loads data from participating countries utilizes a ''Focal Center'' in each country to serve as a point of contact for regional and national-scale critical loads data. CLAD initiated the FOCUS project as a small scale prototype of a U.S. Focal Center to coordinate and manage the development and implementation of a clear, consistent repeatable process for standardized, mappable critical loads within the U.S. Iterative collaboration between scientists and researchers from public and private institutions was employed to assemble existing critical loads and acquire data that could be used to calculate additional critical loads to produce a national critical loads database. As a result, these critical loads and supporting information were provided to the ICP-M&M Coordination Center for Effects (CCE) in March 2011 (CCE, 2011).

1.3. Assessment goals

Critical loads are currently being utilized as an approach in the U.S. to simplify complex scientific information and effectively communicate air pollution thresholds for ecosystems to the policy community and the public (Burns et al., 2008, 2011). Federal land managers and air quality regulators are increasingly relying on critical loads frameworks to quantify the levels of air pollutants that are expected to impact forest health, soil fertility, aquatic biota condition, and other ecosystem responses (Burns et al., 2011; Porter et al., 2005). In addition, activities utilizing current and exploring future uses of critical loads in decision making processes are increasing, such as setting of air quality health and welfare standards, exploring options for multi-pollutant strategies, developing land management plans, and developing site specific goals for natural resource protection from air pollutant emissions. Efforts are also underway by NADP to develop estimates of total deposition (wet and dry), for the U.S., based on monitored and modeled data, which will enable more accurate calculation of critical loads exceedances. The