

# CLAD CRITICAL LOAD DEFINITIONS: Version 1.1

Critical Loads of Atmospheric Deposition Science Committee

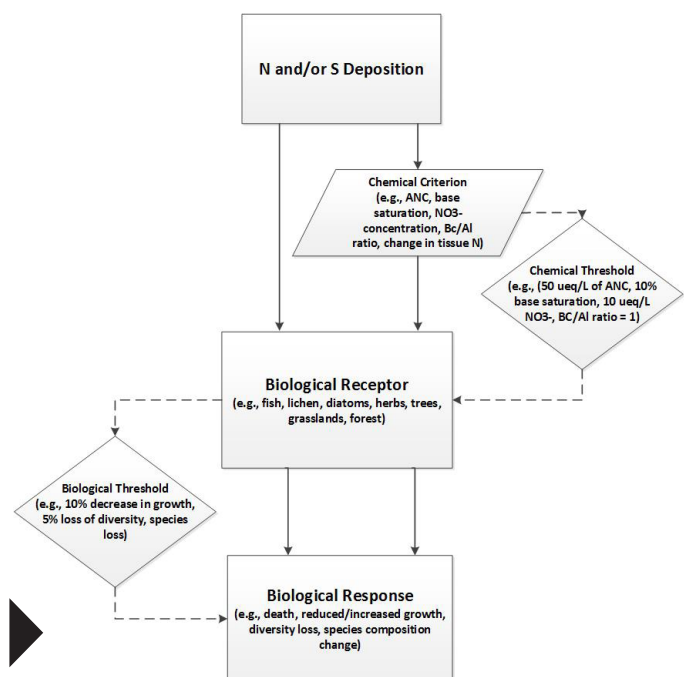


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## BACKGROUND

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 of atmospheric deposition for effects on ecosystems in the United States. Members of CLAD identified the need for documentation of critical load terms and definitions. This document presents a summary of the critical load terms and definitions that were developed through a series of conference calls and webinars and have been adopted by CLAD. As critical load science continues to develop, these terms and definitions may be revised and updated.

**This diagram illustrates how atmospheric deposition can lead to biological responses in an ecosystem by documenting the relationships between the terms defined in the “Supporting Definitions” section.**



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## CRITICAL LOAD DEFINITIONS

- Critical Load:** A quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge (Nilsson and Grennfelt 1988, UNECE 2004).  
*Informal Definition: The threshold of deposition below which specified harmful ecological effects do not occur (Porter et al. 2005).*
- Empirical Critical Load:** A critical load that is developed using empirical approaches.  
*Empirical approaches involve observed spatial or temporal gradient studies or experimental manipulations of pollutants. Empirical critical loads are applied to sites or landscapes that are ecologically comparable to location(s) from which critical loads were determined (cf. Pardo 2010).*
- Steady-State Mass Balance Critical Load:** A critical load that is derived from mathematical mass-balance models under assumed or modeled equilibrium conditions.  
*The models used to derive steady-state critical loads vary in complexity with regard to process representation. A steady-state condition may be achieved far into the future.*
- Target Load:** The deposition load that is selected or determined to provide a level of protection for or recovery of sensitive ecosystem components based on time frame for resource protection, feasibility of emissions reductions, and/or other considerations.  
*Target loads can be determined through management or policy considerations, or by using dynamic process-based models that calculate the deposition load that leads to a desired chemical or biological state of an ecosystem in a given future year (Posch et al. 2003). The target load may be set higher or lower than or equal to the critical load. Target load has sometimes been referred to as “dynamic critical load.”*

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## SUPPORTING DEFINITIONS

- Biological Receptor:** A biological element that is impacted by the conditions created by atmospheric deposition.  
*Biological receptor is also referred to as biological indicator and biological end point.*
- Biological Response:** The biological measure affected by atmospheric deposition that represents the increased probability of damage to the biological receptor of interest.  
*Some examples of biological responses are decreased growth rates, increased mortality, reductions in species richness, changes in species composition, and increases in invasive species.*
- Biological Threshold:** The threshold or value of the biological response beyond which the biological receptor of interest is negatively impacted.  
*An example of a biological threshold is a change in species composition greater than 10% (McDonnell et al. 2014).*
- Chemical Criterion:** The chemical measure affected by atmospheric deposition that is used to predict the increased probability of damage to the biological receptor of interest (Aherne et al. 2001).  
*Chemical criterion is also referred to as chemical indicator.*
- Chemical Threshold:** The threshold or value of the chemical criterion beyond which the biological receptor of interest is negatively impacted.  
*The critical load of a system is the point where deposition levels result in the value of the chemical criterion being equal to the chemical threshold. Chemical threshold is also referred to as critical limit. Some examples of chemical thresholds are 20% base saturation to protect forest growth and health, and ANC of 50  $\mu\text{eq/L}$  to protect the majority of acid-sensitive aquatic biota.*

**Deposition Load:** The amount of material deposited from the atmosphere to the earth's surface expressed as mass or charge per unit area per unit time.  
*Deposition load is also referred to as deposition flux. Examples of commonly used units of atmospheric deposition are kg/ha/yr and eq/ha/yr.*

**Critical Load Exceedance:** The critical load is exceeded if the deposition load of a pollutant is greater than or equal to the critical load of the pollutant for the same location. The source of the deposition load estimate is defined by the user.

*In mathematical terms, the exceedance (Ex) of the critical load CL(X) is given as:*

$$Ex(X_{dep}) = X_{dep} - CL(X)$$

*(UNECE 2004)*

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