Chapter 9: Ecosystem Response

Critical Loads Analysis

Acidic deposition resulting from SO_2 and NO_x emissions may negatively affect the biological health of lakes, streams, and other ecosystems in the United States. Trends in measured chemical indicators allow scientists to determine whether water bodies are improving and heading towards recovery or if they are still acidifying. Assessment tools such as critical load analysis provide a quantitative estimate of whether acidic deposition levels of sulfur and nitrogen, resulting from reduction in SO_2 and NO_x emissions, may protect aquatic resources.

Analysis and Background Information

A critical load is an assessment tool used to provide a quantitative estimate of whether acid deposition levels resulting from reduction in SO_2 and NO_x emissions are sufficient to protect aquatic biological resources. If acidic deposition is less than the calculated critical load, harmful ecological effects (e.g., reduced reproductive success, stunted growth, loss of biological diversity) are not anticipated, and ecosystems damaged by past exposure are expected to eventually recover.[12]

Lake and stream waters having an ANC value greater than 50 µeq/L are classified as having a moderately healthy aquatic biological community; therefore, this ANC concentration is often used as a goal for ecological protection of surface waters affected by acidic deposition. In this analysis, the critical load represents the annual deposition load of sulfur and nitrogen to which a lake or stream and its watershed could be subjected and still support a moderately healthy ecosystem (i.e., having an ANC greater than 50 µeq/L). Surface water samples from 6,000 lakes and streams along acid sensitive regions of the Appalachian Mountains and some adjoining northern coastal plain regions were collected through a number of water quality monitoring programs. Critical load exceedances were calculated using the Steady-State Water Chemistry model.[13, 14]

Key Points

Critical Loads and Exceedances

- For the period from 2011–2013, 20 percent of all studied lakes and streams were shown to still receive levels of combined total sulfur and nitrogen deposition in excess of their calculated critical load. This is a 42 percent improvement over the period from 2000–2003 when 34 percent of all studied lakes and streams were in excess of their calculated critical load.
- Emission reductions achieved since 2000 are anticipated to contribute to broad surface water improvements and increased aquatic ecosystem protection across the five regions along the Appalachian Mountains.
- Current sulfur and nitrogen deposition loadings still fall short for recovery of many modeled lakes and streams, which indicates that additional emission reductions would be necessary for some acid-sensitive aquatic ecosystems along the Appalachian Mountains to recover and be protected from acid deposition.

More Information

Surface Water Monitoring at EPA http://www.epa.gov/airmarkets/monitoring-surface-water-chemistry
National Acid Precipitation Assessment Program (NAPAP) Report to Congress
http://ny.water.usgs.gov/projects/NAPAP/

References

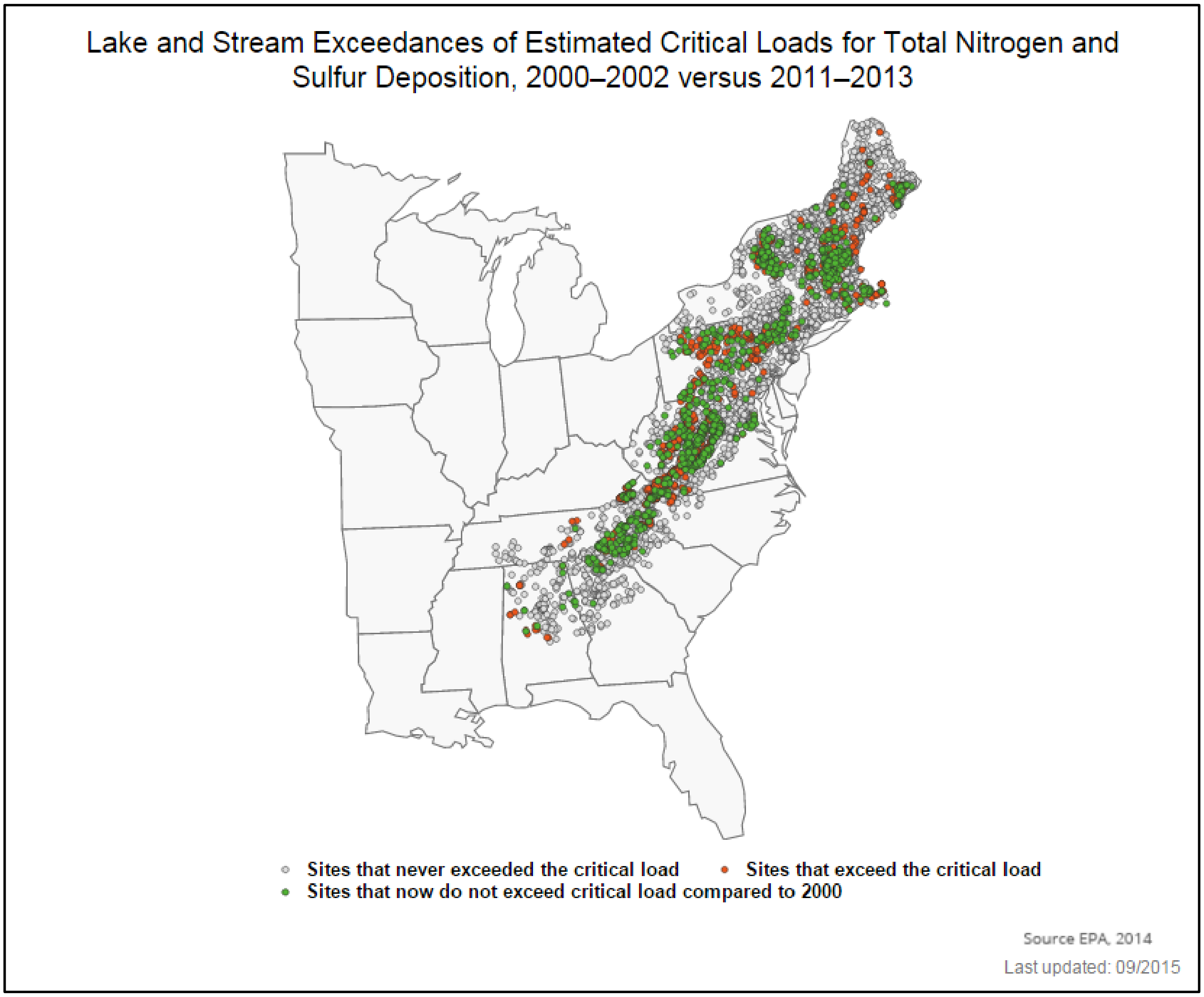
12. Dupont, J., T.A. Clair, C. Gagnon, D.S. Jeffries, J.S. Kahl, S.J. Nelson, and J.M. Peckenham. 2005. Estimation of critical loads of acidity for lakes in the northeastern United States and eastern Canada. Environmental Monitoring and Assessment 109:275-291.

13. Sullivan T.J., B.J. Cosby, J.R. Webb, R.L. Dennis, A.J. Bulger, and F.A. Deviney, Jr. 2007. Streamwater acid-base chemistry and critical loads of atmospheric sulfur deposition in Shenandoah National Park, Virginia. Environmental Monitoring and Assessment 137:85–99.

14. Nilsson, J. & Grennfelt, P. (Eds) (1988) Critical loads for sulphur and nitrogen. UNECE/Nordic Council workshop report, Skokloster, Sweden. March 1988. Nordic Council of Ministers: Copenhagen.

Figures

Subtopic: Critical Loads Analysis



Notes:

- Surface water samples from the represented lakes and streams compiled from surface monitoring programs, such as National Surface Water Survey (NSWS), Environmental Monitoring and Assessment Program (EMAP), Wadeable Stream Assessment (WSA), National Lake Assessment (NLA), Temporally Integrated Monitoring of Ecosystems (TIME), Long Term Monitoring (LTM), and other water quality monitoring programs.
- Steady state exceedances calculated in units of $meq/m^2/yr$.

Figure 1. Lake and Stream Exceedances of Estimated Critical Loads for Total Nitrogen and Sulfur Deposition, 2000–2002 versus 2011–2013

Critical Load Exceedances by Region

Region	Number of Water Bodies Modeled	Water Bodies in Exceedance of Critical Load				Percent Reduction
		2000-2003		2011-2013		
		Number of Sites	Percent of Sites	Number of Sites	Percent of Sites	
New England (ME, NH, VT, RI, CT)	2,027	461	23%	242	12%	48%
Adirondack Mountains (NY)	315	144	46%	69	22%	52%
Northern Mid-Atlantic (PA, NY, NJ)	1,166	279	24%	148	13%	47%
Southern Mid-Atlantic (VA, WV, MD)	1,597	856	54%	562	35%	34%
Southern Appalachian Mountains (NC, TN, SC, GA, AL)	896	286	32%	150	17%	48%
Total Units	**6,001**	**2,026**	**34%**	**1,171**	**20%**	**42%**

Source EPA, 2014

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Notes:

- Surface water samples from the represented lakes and streams complied from surface monitoring programs, such as National Surface Water Survey (NSWS), Environmental Monitoring and Assessment Program (EMAP), Wadeable Stream Assessment (WSA), National Lake Assessment (NLA), Temporally Integrated Monitoring of Ecosystems (TIME), Long Term Monitoring (LTM), and other water quality monitoring programs.
- Steady state exceedances calculated in units of $meq/m^2/yr$.

Figure 2. Critical Load Exceedances by Region