

Effects of Acid Rain on the Appalachian Trail

Results of the Appalachian Trail MegaTransect Deposition Effects Study



Deposition collectors, VA



Clingmans Dome vista, TN



Soil core with enlarged close-up, PA

Overview

The Appalachian National Scenic Trail (AT), a unit of the National Park Service (NPS), spans over 2,000 miles from Georgia to Maine, encompassing a diverse range of ecosystems. Acidic deposition (acid rain) threatens the AT's natural resources. Acid rain is a result of sulfur (S) and nitrogen (N) compounds produced from fossil fuel combustion, motor vehicles, and agricultural practices. The AT is particularly vulnerable to S and N because it passes along ridgetops that receive higher levels of acid rain than lower valley terrain, and these ridges are often underlain by bedrock with minimal ability to buffer acidic inputs. Further, there are numerous S and N emission sources across the region. In the environment, acidic deposition can lower the pH of streams and soils which can ultimately affect fish, invertebrates, and vegetation that inhabit these areas. To address this concern, the MegaTransect Deposition Effects Study evaluated the condition and sensitivity of the AT corridor with respect to acidic deposition, and defined air pollution thresholds (critical and target loads) and recovery rates. Findings indicate that additional S emission reductions are needed to restore the AT.

Research Questions

1. How might acidic deposition levels change along the AT and how are these changes likely to affect soils and water along the trail?
2. What can soil and stream chemistry tell us about current and future sensitivity to acidification?
3. Has acid rain accumulation in soils over time altered nutrients to the extent that vegetation health or species distribution have been affected?
4. Using both computer models and on-site and regional data, what are the thresholds of acidic deposition at which sensitive soils, plants, and streams begin to change now and in the future?
5. Can soil, water, and plant acid sensitivity maps reveal whether certain sections or types of sites along the AT are more sensitive than others?

Definitions

- The *critical load* (CL) is the level of acidic deposition below which damage to ecological resources is not expected to occur.
- The *target load* (TL) represents a future projection of deposition for a particular point in time, or a management goal for desired future deposition protective of resources.
- *Exceedance* represents the extent to which the CL is exceeded by existing levels of acidic deposition.

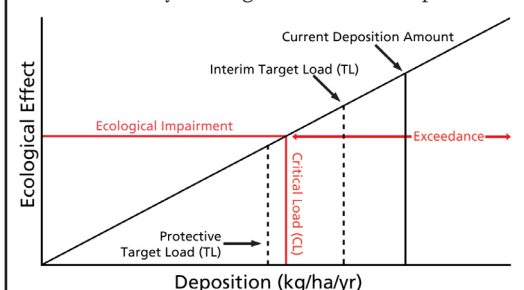


Figure 1. CLs, TLs, and exceedances.

Sampling Design

Tier	# Sites	Measurement		
		Stream	Soil	Vegetation
Level 1	12	x	x	x
Level 2	48	x	x	*
Level 3	205	x		

Table 1. AT sampling approach. *Vegetation was sampled at 18 Level 2 sites

A three-tiered sampling approach was used to collect environmental data at over 200 sites along the AT (Table 1). Data collected at these sites were integrated using models and geographic information systems (GIS) to enable extrapolation of acidification status over the entire AT corridor.

Results

The AT has long been recognized as potentially sensitive to acidic deposition and high levels of acidic deposition have been measured at locations along the AT in the past. Prior to this study, however, the acidification status of soils and streams was unknown over most of the length of the trail.

Findings indicate that acid rain has caused soils to lose calcium (Ca) at approximately two-thirds of the sites sampled. Ca buffers acids and is necessary for plant and soil health. Ca depletion can lead to mobilization of aluminum (Al) from soils to water at levels toxic to plants, fish, and other organisms. Almost 75% of study sites along the AT exceeded the threshold protective of Al mobilization. Soils with the highest concentrations of Ca were generally in areas with low levels of acidic deposition.

Sugar maple is one of many acid-sensitive tree species. Low availability of soil Ca affects sugar maple regeneration and therefore may limit its occurrence in the future. Sixty-one percent of sites along the AT did not meet the threshold for sugar maple regeneration and 73% of sites did not meet the overall threshold for healthy growth of plants.

Spatial modeling of atmospheric S and N deposition revealed high variability over the length of the AT. The highest levels occurred in

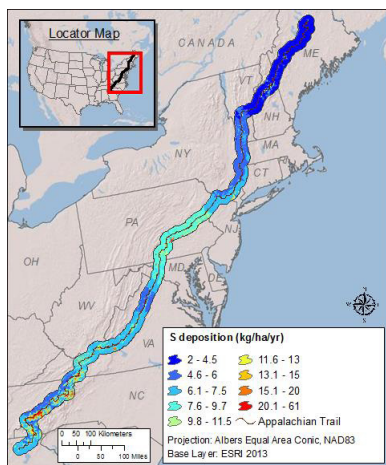


Figure 2. Estimated atmospheric S deposition.

the South and lowest levels in the North (Figure 2).

Acid-neutralizing capacity (ANC), or the ability of water to buffer acidic inputs like acid rain, was lowest in the northern streams and highest in the southern streams, meaning that streams are generally more sensitive in the North. While acid rain levels are highest in the South, many of the southern streams can withstand higher deposition - although a few high elevation streams are greatly affected. Results also showed that over the entire AT, at least 40% of the study streams exhibited pH and/or Al impairment. Thus, acidification has altered stream chemistry to levels understood to damage wildlife like fish and invertebrates.

Model predictions indicate that target loads of S deposition may still be exceeded in the year 2100 in some watersheds throughout the AT corridor (Figure 3). This is because projected decreases in acidic deposition are not sufficient to allow ANC to recover to levels needed to support healthy aquatic ecosystems. Model simulations also suggest that reduced acidic deposition would result in increased buffering (higher ANC) in many northern streams by 2100.

However, southern streams would be slower to recover because their soils retain more of the deposited sulfur.

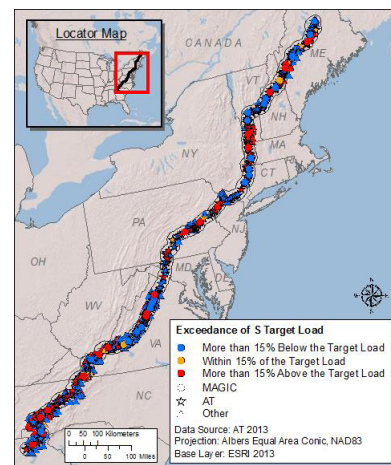


Figure 3. Exceedance of S target loads to achieve stream ANC = 50 µeq/L by 2100.

Conclusions

The entire AT is highly sensitive to acidic deposition and natural resources show the signature of acidification effects. Reversal of effects will likely require decades to achieve. While soils and streams in the North are more vulnerable to acid rain than those in the South, they recover more quickly when acid rain is reduced. Model projections suggest that conditions of forests and streams at the most sensitive and impacted sites won't improve without additional reductions in atmospheric S deposition.

This study demonstrates the value of the AT for monitoring environmental change across a large geographic region. Results enable the NPS to set meaningful air quality management goals (target loads) to ensure protection of AT resources. Additional outreach efforts will promote awareness and understanding of the negative effects of acidic deposition to state and federal air quality management agencies, scientific forums, and the stakeholder community.

For More Information

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