



Atmospheric Deposition at Big Bend NP

Importance

Air pollution damages resources and values that national parks are mandated to protect. Both the Clean Air Act and the National Park Service (NPS) Organic Act protect air resources in national parks, and NPS managers have a special responsibility to protect park natural and cultural resources. The Chihuahuan Desert Network (CHDN) monitors air quality conditions to understand their interactions with physical and biological components of the ecosystem. At Big Bend National Park, the CHDN has identified atmospheric deposition, visibility, and ozone as high-priority vital signs for monitoring.

Long-term Monitoring

For Big Bend National Park (NP), the CHDN acquires, analyzes, and reports on air quality data from the National Atmospheric Deposition Program/National Trends Network (NADP, wet deposition), Clean Air Status and Trends Network (CASTNet, dry deposition), National Park Service-Air Resources Division (NPS-ARD) Gaseous Pollutant Monitoring Program (ozone), and the Interagency Monitoring of Protected Visual Environments (IMPROVE) Program (visibility).

CHDN air quality monitoring objectives are to:

- Determine the conditions and spatial and temporal trends in ozone, nitrogen deposition, sulfur deposition, and visibility-reducing pollutants.
- Determine how ozone, nitrogen deposition, sulfur deposition, and visibility-reducing pollutants vary with associated vital signs (such as vegetation community composition, exotic plant status, and climate).

Management Applications

Information gathered from this protocol will support evaluation of compliance with legislative requirements of the Clean Air Act, regional haze guidelines, National Environmental Policy Act, and the Government Performance and Results Act (GPRA).

Park Overview

Big Bend NP is designated as a Class 1 air quality unit under the Clean Air Act, which means it receives the highest protection under the Act. Visibility, vegetation, surface waters, soils, fish and wildlife, and night skies are all potentially sensitive to air pollution and are identified as air quality-related values (AQRVs) for the park. Coal-



NPS/DAN LEAVITT

Santa Elena Canyon in Big Bend National Park.

burning power plants and transportation are two major sources of smog and pollution throughout the region. Some of the concerns about atmospheric deposition include the sensitivity of soils and *tinajas* (water catchments or pools in bedrock) to eutrophication or acidification and the potential increase of fire risk in the park, due to an increase in vegetation cover.

Atmospheric Deposition

Overview

Atmospheric deposition can be wet (contributed through rain or snow) or dry (particles carried in the air). Wet deposition occurs when air-pollutant emissions, such as sulfur dioxide (SO₂), nitrogen oxides (NO_x), and ammonia (NH₃) from power plants, automobiles, agriculture, and other sources are transported and transformed in the atmosphere and deposited to

ecosystems as sulfate (SO_4), nitrate (NO_3) and ammonium (NH_4) compounds via rain or snow. Dry deposition of particles and gases occurs through complex processes, such as settling, impaction, and adsorption.

Nitrogen (N) and sulfur (S) compounds deposited from air pollution can harm surface waters, soils, and vegetation. N and S deposition cause acidification of streams and lakes in some parts of the country, while N deposition is known to disrupt soil nutrient cycling and alter aquatic and plant communities. Surface waters and soils at Big Bend NP are likely to be well-buffered from acidification because of an abundance of base cations like calcium in the soils and rocks; however, arid, upland areas in the park are sensitive to fertilization from excess N. The sparse native vegetation is not adapted to higher N levels and therefore may be displaced by invasive species like cheatgrass. Such non-native species can readily take up N and use it to their advantage.

Potential effects of N deposition at Big Bend NP include:

- A decrease in soil microbe diversity as N increases, evidenced by fertilization experiments in the high elevation oak and pine forest;
- Increased fire risk in the park, as the interaction of climate change and increased N enhances vegetation coverage and exotic plants;
- Higher concentrations of nitrates in grasslands soil and changing soil pH.

Monitoring Results

Both wet and dry deposition are monitored in the park. Wet deposition data from NADP is used to evaluate trends and conditions in N and S compounds, as the NADP data record is longer than the CASTNet dry deposition record, and is also more spatially robust. NPS-ARD recently reported both long- and short-term trends and conditions for N and S in its *Air Quality in National Parks: 2009 Annual Performance and Progress Report*.

Long-term trend analysis (1989–2008) showed significant decreases ($p \leq 0.05$) in nitrate at Big Bend NP, possibly reflecting air quality improvements achieved by the Clean Air Act. Trends for sulfate and ammonium were not significant over that period. An analysis of the latter half of that period (1999–2008) found no significant trends ($p \leq 0.05$) in concentrations of nitrate, sulfate, or ammonium in wet deposition. As a result, Big Bend NP is considered to have met its 2009 GPRA goal of no degrading trend in either N or S over the 10-year period.

Data from the dry deposition network, CASTNet, is combined with NADP wet deposition data in Figures 1 and 2. Deposition rates for both N and S are quite low at Big Bend NP, but both are elevated above estimated natural background rates, and N deposition is approaching the range known to affect very sensitive ecosystems. For both N and S, dry deposition is approximately equal in magnitude to wet deposition, although N dry deposition is likely underestimated, as dry gaseous ammonia is not measured.

The NPS Air Resources Division uses an index to characterize air quality, including N and S deposition, as good, moderate, or of significant concern. Using a 5-year average of wet deposition data (2004–2008), N deposition was rated as a significant concern and sulfur deposition was rated as good at Big Bend NP. This reflects the fact that N deposition is approaching levels known to harm sensitive ecosystems similar to those found in Big Bend NP, while S deposition is quite low.

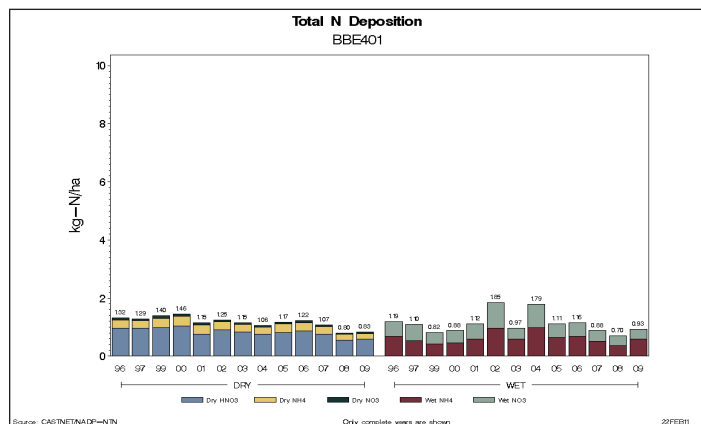


Figure 1. Wet and dry deposition of nitrogen at Big Bend NP, 1996–2008.

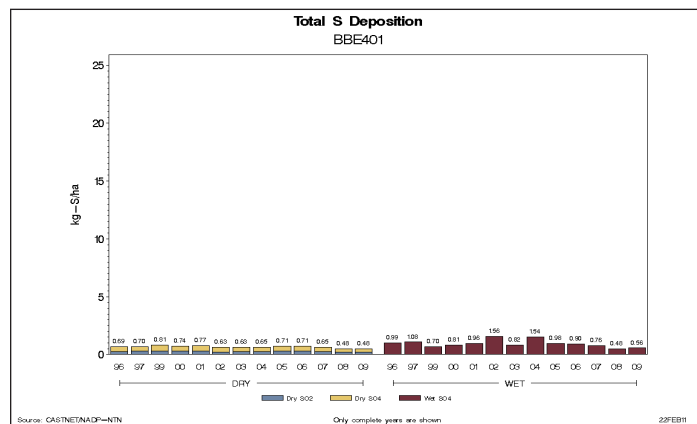


Figure 2. Wet and dry deposition of sulfur at Big Bend NP, 1996–2008.



For more information

Chihuahuan Desert Inventory & Monitoring Network | National Park Service | Las Cruces, New Mexico
<http://science.nature.nps.gov/im/units/chdn/>