



Atmospheric Deposition at Big Bend National Park

Importance of Clean Air

Clean air that is free of impacts from air pollution is essential to the integrity of national parks. Both the Clean Air Act and the National Park Service (NPS) Organic Act of 1916 protect air quality in national parks, and NPS managers have a special responsibility to protect park natural and cultural resources. As a Class I area, Big Bend National Park (NP) has the highest level of air quality protection under the law.

Most people who visit national parks expect clean air and clear views. At Big Bend, panoramic vistas of the ribbon-like Rio Grande River, distant mountain ranges such as the Chisos, or the seemingly-endless miles of Chihuahuan Desert, are essential aspects of the park. However, Big Bend NP lies downwind of major pollution sources in eastern Texas, other U.S. states, and Mexico. Air pollutants carried into the park can diminish air quality, impair visibility, harm natural and scenic resources (such as forests, soils, streams and fish), and impact human health.



NPS PHOTO

Introduction to Atmospheric Deposition

Atmospheric deposition occurs when airborne pollutants are deposited to the earth. These pollutants include, but are not limited to, sulfur dioxide, nitrogen oxides, ammonia, and mercury. Wet deposition occurs when air-pollutant emissions from power plants, automobiles, agriculture, and other sources are transported and transformed in the atmosphere and deposited in precipitation (as rain or snow) as sulfate (SO_4), nitrate (NO_3), and ammonium (NH_4) compounds. Dry deposition of particles and gases occurs through settling, impaction, and adsorption.

Both nitrogen and sulfur deposition can harm ecosystems by acidifying soils and surface waters. Nitrogen can also artificially enrich them. The NPS assesses condition for atmospheric deposition using

only wet deposition in kilograms per hectare per year (kg/ha/yr) because data on dry deposition isn't available in many areas. Nitrogen and sulfur deposition trends are evaluated using pollutant concentrations in precipitation (micro equivalents/liter) to control for yearly variations in precipitation.

Wet deposition is monitored in Big Bend NP as part of the National Atmospheric Deposition Program (NADP), and dry deposition is monitored via the Clean Air Status and Trends Network (CASTNET).

Big Bend NP Air Quality Condition and Trend 2015: Atmospheric Deposition



Nitrogen

Wet Deposition

Condition: Significant concern

Trend: For 2006–2015, the trend in nitrogen deposition remained relatively unchanged

Confidence: High



Sulfur

Wet Deposition

Condition: Moderate concern

Trend: For 2006–2015, the trend in sulfur deposition remained relatively unchanged

Confidence: High

Potential Impacts of Atmospheric Deposition at Big Bend NP include:

- A decrease in soil microbe diversity as N increases, evidenced by fertilization experiments in the high elevation forest.
- Increased fire risk, since the interaction of climate change and increased N enhances vegetation coverage and exotic plants.
- Higher concentrations of nitrates in grasslands soil, especially in fragmented and disturbed sites.
- Eutrophication, or acidification, of water in tinajas.
- Surface waters and soils are likely to be well-buffered from acidification because of an abundance of cations like calcium.

Information is from the 2015 Air Quality Summary produced by the NPS Air Quality Division. Wet nitrogen condition status is based on NPS Air Resources Division benchmarks and the 2011–2015 estimated wet nitrogen deposition of 2.2 kilograms per hectare per year (kg/ha/yr), a level that normally warrants moderate concern. However, the status has been elevated to significant concern because ecosystems at Big Bend NP may be very highly sensitive to nitrogen-enrichment effects relative to all Inventory & Monitoring parks. Wet sulfur condition status is based on NPS Air Resources Division benchmarks and the 2011–2015 estimated wet sulfur deposition of 1.4 kilograms per hectare per year (kg/ha/yr). Ecosystems in the park were rated as having high sensitivity to acidification effects relative to all Inventory & Monitoring parks. Unchanged trends are based on the lack of statistically significant trends. The degree of confidence is high because there is an on-site deposition monitor. Visit <https://www.nature.nps.gov/air/data/products/parks/index.cfm> for additional information.

Monitoring Data

Using data from ongoing, long-term air quality monitoring in Big Bend NP, the NPS reports on the condition and trend for wet deposition of sulfate and nitrogen.

When air pollutants such as sulfur and nitrogen are deposited into ecosystems, they may cause acidification, and/or enrichment of soils and surface waters. In general, arid and semi-arid ecosystems are sensitive to increased levels of nitrogen and sulfur. Acidification and nutrient enrichment cause shifts in native species composition and encroachment of exotic species and grasses. Although nitrogen is an essential plant nutrient, excess nitrogen from atmospheric deposition can stress ecosystems. Excess nitrogen acts as fertilizer, favoring some plants and disadvantaging others. This creates an imbalance in natural ecosystems, which over time may lead to shifts in the types of plant and animal species present, increase in insect and disease outbreaks, disrupt ecosystem processes (such as nutrient cycling), and change fire frequency.

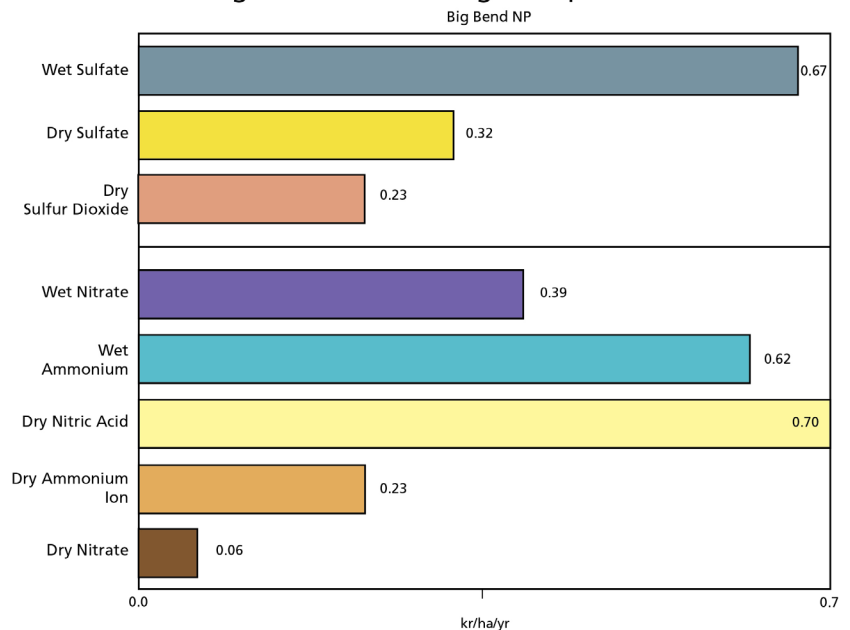
Big Bend NP contains extensive arid and semi-arid vegetation communities, which are at risk from increased deposition, particularly nitrogen, and is considered to have very high ecosystem sensitivity and very high risk for nitrogen enrichment. The NPS Air Resources Division (ARD) has funded research in Big Bend NP to better understand how excess nitrogen deposition impacts soil and plant health and to determine what the critical load, or the threshold of air pollution deposition that causes harm to sensitive resources, for park ecosystems. The park also has high sensitivity for acidic deposition with a moderate risk.

Wet sulfur and nitrogen deposition condition at Big Bend NP warrants moderate and significant concern, respectively, given the park's high sensitivity to atmospheric deposition. Trend analysis in micro equivalents/liter shows no statistically significant trend. Dry deposition also contributes significantly to total deposition at Big Bend NP, with dry and wet forms contributing about equally to total deposition.

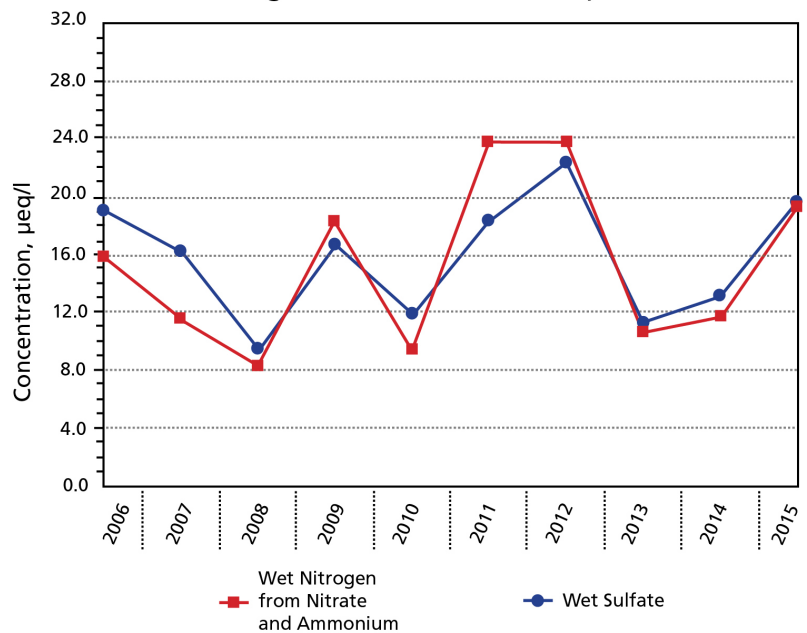
Atmospheric deposition monitoring is one component of a comprehensive air resources monitoring program at Big Bend NP conducted by the ARD. Information gathered via long-term monitoring supports evaluation of compliance with legislative requirements of the Clean Air Act, regional haze guidelines, National Environmental Policy Act, other applicable laws and NPS policies.

The Chihuahuan Desert Inventory & Monitoring Network identified atmospheric deposition, visibility, and ozone as high-priority vital signs for monitoring at Big Bend NP. The network's protocol harvests data provided by the Air Resources Division and produces these briefs. The objectives of air quality monitoring at Big Bend NP are to determine the conditions and spatial and temporal trends in ozone, nitrogen deposition, sulfur deposition, and visibility-reducing pollutants,

Average Sulfur and Nitrogen Deposition 2011-2015



Nitrogen and Sulfate in Precipitation



CASTNET Monitor ID: BIBE401, TX; NADP Monitor ID: TX04, TX

Data are from Air Quality and Trends, Big Bend National Park (<https://www.nature.nps.gov/air/data/products/parks/index.cfm>; accessed April 14, 2017)

and determine how these measures vary with associated vital signs (such as vegetation community composition, exotic plant status, and climate). The Chihuahuan Desert Network is one of 32 inventory and monitoring networks for the national park system. Networks facilitate basic inventories, conduct long-term monitoring, and deliver key scientific data to park managers and partners.

Additional information about air resources in national park sites is available at <https://www.nature.nps.gov/air/>.