



Ozone 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.



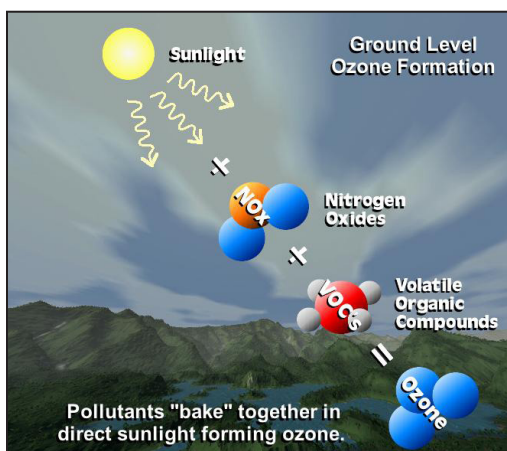
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Introduction to Ozone

Naturally-occurring ozone in the upper atmosphere absorbs the sun's harmful ultraviolet rays and helps to protect all life on earth. However, in the lower atmosphere, ozone is an air pollutant. It forms in the presence of sunlight when nitrogen oxides (NOx) from vehicles, power plants, and other sources combine with volatile organic compounds (VOCs) from gasoline, solvents, and vegetation. Ground-level ozone is one of the most widespread pollutants in the United States.

Ground-level ozone can harm both humans and plants. Human health risk from ozone is measured using the 4th-highest daily maximum 8-hour ozone concentration in parts per billion (ppb). Impacts on vegetation are evaluated using the W126 Index metric that relates plant response to ozone exposure during the growing season.

Ozone is monitored in Big Bend NP as part of the Gaseous Pollutant Monitoring Program that is jointly operated with the Environmental Protection Agency (EPA) and other partners through Clean Air Status and Trends Network (CASTNET). Standard monitoring stations include a UV-absorption ozone analyzer, a transfer standard, and a weather station.



NASA Ground-level ozone forms through a series of reactions involving pollutants such as nitrogen oxides (NOx) and volatile organic compounds (VOCs).

Big Bend National Park Air Quality Condition and Trend 2015: Ozone



Human
Health

Annual 4th-highest 8hr concentration

Condition: Moderate concern

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

Confidence: High



Vegetation
Health

3-month maximum 12hr W126

Condition: Moderate concern

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

Confidence: High

Ozone Impacts at Big Bend NP include:

- In 2011, national ambient air quality standard (NAAQS) for ozone (75 ppb 8-hr average at the time) was exceeded on 7 days in Big Bend NP. There were no other measured 8-hr average exceedances in the park between 2006-2015.
- Big Bend NP has several ozone-sensitive plants including skunkbush and ponderosa pine. Ozone concentrations and cumulative doses are at levels in the park known to cause injury to such sensitive plants.
- Generally dry conditions in the park cause reduces ozone uptake by plants and subsequent injury.

Ozone Monitoring Data

Using data from ongoing, long-term air quality monitoring in Big Bend NP, the NPS reports on the condition and trend of ozone via two measures: one for human health and the other for vegetation health.

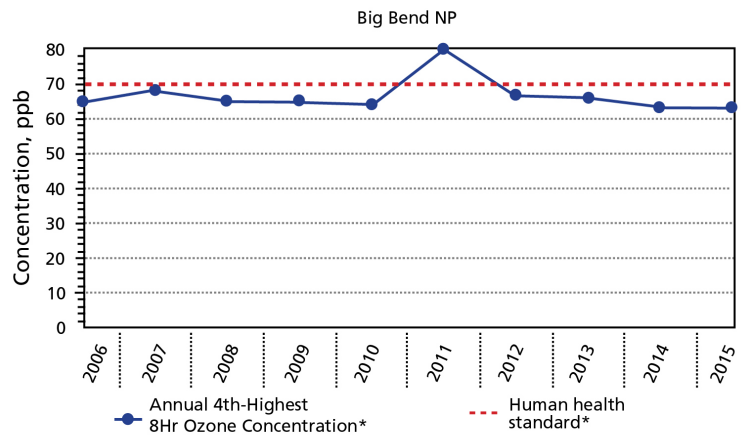
In 2015, the EPA set ozone national ambient air-quality standards (NAAQS) of 70 ppb, averaged over an 8-hour period, to protect human health (primary standard) and vegetation (secondary standard). Compliance occurs when the three-year average of the annual fourth-highest daily maximum 8-hour average ozone concentrations measured at a monitor does not exceed 70 ppb. Areas not meeting the standards are designated as non-attainment areas. Big Bend NP attained compliance with this standard between 2006-2015, although 8-hour averages exceeded 75 ppb on seven days in 2011. State-wide, Texas experienced high ozone levels, in addition to high temperatures and drought conditions in 2011. Ozone concentrations in the park are usually in the Good (0-54 ppb) to Moderate (55-70 ppb) advisory levels in the Air Quality Index. Unusually sensitive people should consider reducing prolonged or heavy exertion when air quality is in the moderate range.

The W126 exposure index quantifies ozone exposure to plants. It is considered to be biologically relevant because it takes into account both peak ozone concentrations and cumulative exposure to ozone. The W126 index is a weighted index designed to reflect the cumulative exposures that can damage plants and trees during the consecutive three months in the growing season when daytime ozone concentrations are the highest and plant growth is most likely to be affected. Big Bend NP has five ozone-sensitive species of plants: green ash (*Fraxinus pennsylvanica*), ponderosa pine (*Pinus ponderosa*), skunkbush (*Rhus trilobata*), swamp milkweed (*Asclepias incarnata*), and white sage (*Artemisia ludoviciana*). Ozone levels measured at the park are known to cause injury to such sensitive plants. However, Big Bend's generally dry conditions cause increased plant pore (stomatal) closures, thereby reducing ozone uptake by plants and the injury that results.

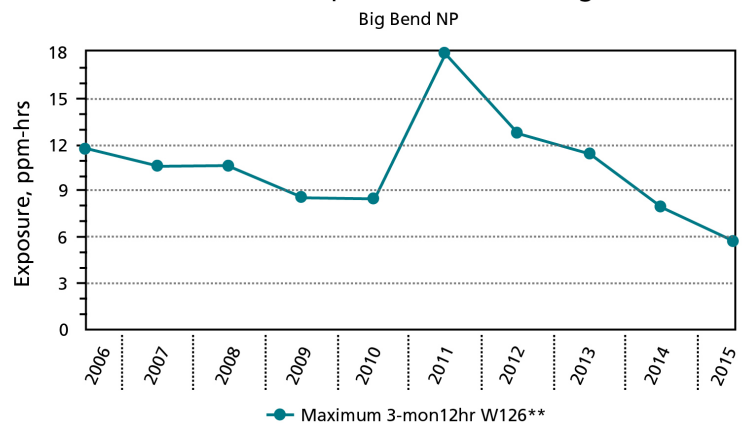
Ozone monitoring is one component of a comprehensive air resources monitoring program at Big Bend NP conducted by the NPS Air Resources Division. Information gathered via long-term monitoring supports evaluation of compliance with legislative requirements of the Clean Air Act, regional haze guidelines, 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, 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

Ozone Concentration



W126 Ozone Exposure Index for Vegetation



* The 2015 primary National Ambient Air Quality Standard is 70 ppb, daily maximum 8-hr average ozone concentration. The 2015 ozone standard is violated when the 3-yr average of the annual fourth-highest daily maximum 8-hr average ozone concentration is greater than or equal to 70 ppb.

** The W126 preferentially weights the higher ozone concentrations most likely to affect plants and sums all of the weighted concentrations during daylight hours. The highest 3-month period that occurs during the growing season is reported.

AQS Monitor ID: 480430101, 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 11, 2017)

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/>.

Information is from the 2015 Air Quality Summary produced by the NPS Air Quality Division. Human health condition status is based on NPS Air Resources Division benchmarks and the 2011–2015 estimated ozone of 67.9 parts per billion (ppb) for Big Bend NP. Vegetation health condition status is based on estimated W126 metric of 11.2 parts per million-hours (ppm-hrs). The W126 metric relates plant response to ozone exposure. A risk assessment concluded that plants at Big Bend NP were at low risk for ozone damage. Unchanged trends are based on the lack of statistically significant trends. The degree of confidence is high because there is an on-site ozone monitor. Visit <https://www.nature.nps.gov/air/data/products/parks/index.cfm> for additional information.