

Assessment of Current Air Quality Conditions

The National Park Service (NPS) Air Resources Division (ARD) has developed an approach for assessing the current condition of air quality within NPS units. This approach has been used in ARD's annual report, "Air Quality in National Parks." The most recent report is available at http://www.nature.nps.gov/air/Pubs/pdf/gpra/GPRA_AQ_ConditionsTrendReport2006.pdf.

To assess condition, ARD uses all available monitoring data over a five-year period to generate interpolations for the continental United States. Monitors used include NPS, EPA, state, tribal, and local monitors. These interpolations allow us to derive estimates of the air quality parameters at all NPS units located within the continental United States, including those without on-site monitoring. (Since there are not sufficient monitors to generate interpolations outside the continental US, on-site monitor data are used to derive the condition category estimates for Denali, Virgin Islands, Hawaii Volcanoes, and Haleakala.) We then use these interpolated values to determine an index for each type of air quality data collected (ozone concentrations, wet deposition, and visibility) that assigns air quality to one of three condition categories:

Air Quality is a Significant Concern

Air Quality is in Moderate Condition

Air Quality is in Good Condition

The procedures for assigning these categories are described below.

Ozone Condition

The ozone standard is used as a benchmark for rating current ozone condition. This standard was revised in 2008 in order to be more protective of human health. To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 75 parts per billion (ppb). To derive an estimate of the current ozone condition at parks, the five-year average of the annual 4th-highest 8-hour ozone concentration is determined for each park from the interpolated values described above. If the resulting five-year average is greater than or equal to 76 ppb then the condition *Significant Concern* is assigned to that park. *Moderate* condition for ozone is assigned to parks with average five-year 4th-highest 8-hour ozone concentrations from 61 to 75 ppb (concentrations greater than 80 percent of the standard). *Good* condition for ozone is assigned to parks with average five-year ozone concentrations less than 61 ppb (concentrations less than 80 percent of the standard).

| Ozone Condition | Ozone concentration ¹ |
|---------------------|----------------------------------|
| Significant Concern | ≥ 76 ppb |
| Moderate | 61-75 ppb |
| Good | ≤ 60 ppb |

¹ "Ozone concentration" represents the 4th-highest daily maximum 8-hour average ozone concentration averaged over five years.

In addition to the standard, vegetation sensitivity is considered for ozone condition. Data show that some plant species² are more sensitive to ozone than humans and the ozone standard is not protective of some vegetation. Ozone injury to vegetation has been documented at a number of parks, including Great Smoky Mountains NP, Shenandoah NP, and Sequoia/Kings Canyon NPs. A risk assessment completed in 2004 rated parks at low, moderate, or high risk for ozone injury to vegetation, based on presence of sensitive plant species, ozone exposures³, and environmental conditions, i.e., soil moisture. For ozone condition assessment, parks that were evaluated at high risk are moved into the next condition category (e.g., a park with an average ozone concentration of 72 ppb, but judged to be at high risk for vegetation injury, would move from the category *Moderate* for ozone to *Significant Concern*).

Atmospheric Deposition Condition

Park scores for current condition of atmospheric deposition were based on wet deposition because dry deposition data is not available for most areas. Wet deposition for sites within the continental USA is calculated by multiplying N or S concentrations in precipitation by a normalized precipitation amount.⁴ (For sites outside the continental US, where interpolations cannot be calculated and normalized precipitation amounts are not available, five-year averages of on-site deposition are used. Deposition data are obtained from the National Atmospheric Deposition Program.) Several factors are considered in rating deposition condition, including natural background deposition estimates and deposition effects on ecosystems. Estimates of natural background deposition for total deposition are approximately 0.25 kilograms per hectare per year (kg/ha/yr) in the West and 0.50 kg/ha/yr in the East for either N or S. For wet deposition only, this is roughly equivalent to 0.13 kg/ha/yr in the West and 0.25 kg/ha/yr in the East.⁵ Certain sensitive ecosystems respond to levels of deposition on the order of 3 kg/ha/yr total deposition, or about 1.5 kg/ha/yr wet deposition.⁶

Evidence is not currently available that indicates that wet deposition amounts less than 1 kg/ha/yr cause ecosystem harm. Therefore, parks with wet deposition less than 1 kg/ha/yr are considered to be in *Good* condition for deposition; parks with from 1-3 kg/ha/yr are considered to be in *Moderate* condition; parks with greater than 3 kg/ha/yr are considered to have a *Significant Concern* for deposition.

² Lists of ozone sensitive species, by park, are available from NPSpecies (<https://science1.nature.nps.gov/npspecies/>).

³ The ozone risk assessment for injury to vegetation was based on ozone exposures over the growing seasons from 1995-1999. The ozone exposure metrics are described in the ozone risk assessments at <http://www2.nature.nps.gov/air/Pubs/ozonerisk.htm>.

⁴ Normalized 30-year precipitation values from the PRISM database are used to calculate deposition in order to minimize interannual variation in deposition caused by interannual fluctuations in precipitation (<http://www.ocs.orst.edu/prism/>).

⁵ The proportion of wet to dry deposition varies by location; in most areas, wet deposition is at least one-half of total deposition.

⁶ Fenn et al. 2003 *BioScience* 53: 404-420; Krupa 2002 *Environmental Pollution* 124: 179-221

| Deposition Condition | Wet Deposition (kg/ha/yr) |
|-----------------------------|----------------------------------|
| Significant Concern | > 3 |
| Moderate | 1-3 |
| Good | < 1 |

Scores for parks with ecosystems potentially sensitive to N or S⁷ were adjusted up one category (e.g., a park with N deposition from 1-3 kg/ha/yr that contains N-sensitive ecosystems would be assigned the deposition condition *Significant Concern*).

Visibility Condition

Individual park scores for visibility are based on the deviation of the current Group 50 visibility conditions from estimated Group 50 natural visibility conditions⁸, where Group 50 is defined as the mean of the visibility observations falling within the range from the 40th through the 60th percentiles. For parks within the continental US, current visibility is estimated from the interpolation of the five-year averages of the Group 50 visibility. For sites outside the continental US, five-year averages are computed from on-site data. Visibility in this calculation is expressed in terms of a Haze Index⁹ in deciviews (dv). As the Haze Index increases, the visibility worsens. The visibility condition is expressed as

$$\text{Visibility Condition} = \text{current Group 50 visibility} - \text{estimated Group 50 visibility under natural conditions.}$$

Good condition is assigned to parks with a visibility condition estimate of less than two dv above estimated natural conditions. Parks with visibility condition estimates ranging two to eight dv above natural conditions are considered to be in *Moderate* condition, and parks with visibility condition estimates greater than eight dv above natural conditions are considered to have a *Significant Concern*. The dv ranges of these categories, while somewhat subjective, were chosen to reflect as nearly as possible the variation in visibility conditions across the monitoring network.

| Visibility Condition | Current Group 50 – Estimated Group 50 Natural (dv) |
|-----------------------------|---|
| Significant Concern | > 8 |
| Moderate | 2-8 |
| Good | < 2 |

⁷ Ecosystems that are considered potentially sensitive to N or S deposition include high-elevation ecosystems in the West, upland areas in the East, areas on granitic bedrock, coastal and estuarine waters, arid ecosystems, and some grasslands.

⁸ The natural visibility conditions are those estimated to exist in a given area in the absence of human-caused visibility impairment (EPA-454/B-03-005).

⁹ The Haze Index is a measure of visibility derived from calculated light extinction (EPA-454/B-03-005).