



## Rating Air Quality Conditions

Revised September 28, 2011

The National Park Service (NPS) Air Resources Division (ARD) has developed guidance for assessing the condition of air quality within NPS units. The guidance is used in ARD's annual report, "Air Quality in National Parks," available at <http://www.nature.nps.gov/air/who/npsPerfMeasures.cfm>. This current revision of the guidance provides information to evaluate ozone as it relates to plant response and replaces guidance dated January 2010.

To assess air quality 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 ARD 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.) The interpolated values are then used to determine an index for each type of air quality data collected (ozone concentrations and exposures, wet deposition, and visibility). Park air quality interpolated values can then be assigned one of three condition categories for each air quality index:

*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 human health standard is generally used as a benchmark for rating current ozone condition. EPA revised this standard in 2008 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).<sup>1</sup> To derive an estimate of the current ozone condition at parks, the five-year average of the annual 4<sup>th</sup>-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 4<sup>th</sup>-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).

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<sup>1</sup> EPA periodically reviews and revises the ozone standards. If EPA revises the standard in the future, NPS will revise this guidance accordingly.

Ozone Condition (Human Health)	Ozone concentration <sup>2</sup>
Significant Concern	≥ 76 ppb
Moderate	61-75 ppb
Good	≤ 60 ppb

Although the human health standard is the basis for this condition assessment approach, vegetation sensitivity should also be incorporated into the park air quality rating. Data show that some plant species<sup>3</sup> are more sensitive to ozone than humans and the ozone standard is not considered 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 exposures<sup>4</sup>, 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*).

NPS has developed an additional method for rating ozone condition that focuses solely on plant response. This method is based on EPA's proposed approach for a secondary ozone standard designed to protect vegetation. EPA has proposed using the metric W126<sup>5</sup> as the form of the standard. The W126 measures cumulative ozone exposure over the growing season and is a better predictor of plant response than the 8-hour human health standard metric. A similar metric, the SUM06<sup>6</sup>, also measures cumulative exposure. Thresholds for both W126 and SUM06 condition are presented below and are based on recommendations from an expert workgroup. This workgroup noted that a W126 range of 7–13 ppm-hrs would be protective for growth effects to tree seedlings in natural forest stands; a W126 of 5–9 ppm-hrs would protect plants in natural ecosystems against foliar injury (Heck and Cowling 1997<sup>7</sup>; EPA 2007<sup>8</sup>).

Ozone Condition (Ecological)	Ozone Exposure <sup>9</sup> – W126	Ozone Exposure <sup>9</sup> – SUM06
Significant Concern	> 13 ppm-hrs	> 15 ppm-hrs
Moderate	7-13 ppm-hrs	8-15 ppm-hrs
Good	< 7 ppm-hrs	< 8 ppm-hrs

<sup>2</sup> “Ozone concentration” represents the 4th-highest daily maximum 8-hour average ozone concentration averaged over five years.

<sup>3</sup> Lists of ozone sensitive species, by park, are available from NPSpecies:

<https://irma.nps.gov/App/Species/Welcome>

<sup>4</sup> 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://www.nature.nps.gov/air/permits/aris/networks/ozonerisk.cfm>.

<sup>5</sup> The W126 preferentially weights the higher ozone concentrations most likely to affect plants and sums all weighted concentrations during daylight hours over three months during the growing season, giving a cumulative metric expressed in parts per million-hours (ppm-hrs).

<sup>6</sup> The SUM06 sums all hourly ozone concentrations ≥ 0.060 ppm during the daylight hours over three months during the growing season, giving a cumulative metric expressed in ppm-hrs.

<sup>7</sup> Heck, W., Cowling, E.B. 1997. The need for a long-term cumulative secondary ozone standard—an ecological perspective. *Environmental Management* (January): 23–33.

<sup>8</sup> EPA 2007. Policy Assessment of Scientific and Technical Information: OAQPS Staff Paper. EPA-452/R-07-007.

<sup>9</sup> Ozone exposures for W126 and SUM06 represent 5-yr averages

### Atmospheric Deposition of Nitrogen and Sulfur Condition

Park interpolated values for conditions of atmospheric deposition of nitrogen (N) and sulfur (S) compounds 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.<sup>10</sup> (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.<sup>11</sup> 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.<sup>12</sup>

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 be in *Moderate* condition; parks with greater than 3 kg/ha/yr are considered to have a *Significant Concern* for deposition.

<b>Deposition Condition</b>	<b>Wet Deposition of N or S (kg/ha/yr)</b>
Significant Concern	> 3
Moderate	1-3
Good	< 1

Interpolated values for parks with ecosystems potentially sensitive to N or S<sup>13</sup> 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*).

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<sup>10</sup> 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/>).

<sup>11</sup> The proportion of wet to dry deposition varies by location; in most areas, wet deposition is at least one-half of total deposition.

<sup>12</sup> Fenn et al. 2003 *BioScience* 53: 404-420; Krupa 2002 *Environmental Pollution* 124: 179-221

<sup>13</sup> 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.

### Visibility Condition

Individual park conditions for visibility are based on the deviation of the current Group 50 visibility conditions from estimated Group 50 natural visibility conditions<sup>14</sup>, where Group 50 is defined as the mean of the visibility observations falling within the range from the 40<sup>th</sup> through the 60<sup>th</sup> 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 Index<sup>15</sup> 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.

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

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<sup>14</sup> 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).

<sup>15</sup> The Haze Index is a measure of visibility derived from calculated light extinction (EPA-454/B-03-005).