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DRAFT National Park Service Air Quality Analysis Methods

September 2015

Natural Resource Report NPS/ARD/NRR—2015/XXX

ON THE COVER
Rocky Mountain National Park

DRAFT National Park Service Air Quality Analysis Methods

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Air Resources Division

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1. Introduction

Understanding air quality can be a challenge. Air easily crosses park boundaries affecting human health, visibility of park landscapes, and ecosystem health. Fortunately, nationwide monitoring networks in the U.S. are actively collecting information about ozone, visibility, nitrogen and sulfur deposition, as well as atmospheric mercury. The National Park Service Air Resources Division (ARD) estimates air quality conditions for all parks in the contiguous U.S. by looking at these data from across the country. ARD also evaluates air quality trends and provides both deposition and visibility composition information for parks where representative monitoring data are available. A consistent service-wide approach to these analyses allows ARD to provide specific air quality information for over 350 national park units.

This document summarizes the data analysis methods used by the ARD to evaluate air quality for NPS units. These evaluations are useful for park planning, research, and for assessing the effectiveness of efforts to reduce air pollution. Park specific status and trends are available at http://www.nature.nps.gov/air/data/products/parks/index.cfm.

2. Status Assessment

2.1. Overview

Air quality status assessments are based on the most recent 5-year average of current conditions compared to ARD benchmarks for specific measures of ozone, visibility, and atmospheric deposition. ARD uses six specific measures to evaluate air quality conditions at NPS units:

Table 1. Indicators and Specific Measures for Air Quality Status Assessments

Indicator of Air Quality	***Specific Measure***
Ozone	Human health: 4th-highest daily maximum 8-hour concentration
	Vegetation health: 3-month maximum 12-hour W126
Visibility	Visibility on mid-range days minus natural visibility condition on mid-range days
Atmospheric deposition	Sulfur wet deposition
	Nitrogen wet deposition
	Mercury wet deposition and predicted methylmercury concentration

For each of the specific measures of air quality identified above, except predicted methylmercury concentration, data from national air quality monitoring networks are evaluated with an Inverse Distance Weighted (IDW) interpolation method[1] to derive conditions for all locations in the contiguous U.S. Interpolated data are useful for assessing current conditions because many parks do not have on-site or nearby representative air quality monitors.

Monitoring data are too sparse for the geospatial estimation method in Alaska and the Pacific Islands. For this reason, on-site or nearby representative monitor data[2] are used to derive measured averages for Denali NP & PRES, Gates of the Arctic NP & PRES, Katmai NP & PRES, Virgin Islands Coral Reef NM, Virgin Islands NP, Christiansted NHS, Haleakala NP, Hawaii Volcanoes NP, Kenai Fjords NP, Klondike Gold Rush NHP, Lake Clark NP & PRES, Salt River Bay NHP & Ecological PRES, and San Juan NHS.

[1] See Appendix A for IDW methods.

[2] See Appendix B for a list of representative monitoring sites for NPS units.

The conditions are compared to established benchmarks to assigned one of three status categories:

- Warrants Significant Concern,
- Warrants Moderate Concern, or
- Resource is in Good Condition.

Benchmarks for specific measures of air quality have been established using regulatory standards and best available scientific evidence.

In the air quality summary tables, the status is indicated by the color of the circle, where red is *Warrants Significant Concern*, yellow is *Warrants Moderate Concern*, and green is *Resource is in Good Condition*.

The procedures for assessing conditions and assigning status categories are described in the following sections.

2.2. Ozone Status

2.2.1. Human Health Risk

Breathing ground-level ozone can result in a number of human health effects including chest pain, respiratory irritation, and reduced lung function. The primary National Ambient Air Quality Standard (NAAQS) for ground-level ozone is set by the EPA, and is based on human health effects. The current NAAQS for ozone is a 4th-highest daily maximum 8-hour ozone concentration[3] of 75 ppb. The ARD recommends a benchmark for *Good Condition* ozone status of 60 part per billion (ppb) or less, which is 80% of the human health-based NAAQS.

Current condition for human health risk from ozone is measured using the 4th-highest daily maximum 8-hour ozone concentration in ppb. Annual 4th-highest daily maximum 8-hour ozone concentrations are averaged over a 5-year period at all monitoring sites. Note that prior to 2012, this included monitoring data from the Clean Air Status and Trends Network (CASTNET) and Air Quality System (AQS). Beginning in 2012, all ozone monitoring data are acquired from AQS. For 5-year average calculations, at least 3 of the 5 years must have equal to or greater than 75% valid days[4] during the calendar year or ozone season.

[3] 4th-highest daily maximum 8-hour ozone concentration calculations are based on EPA's data reporting and handling conventions found in 40 CFR Part 50, Appendix P to Part 50 - Interpretation of the Primary and Secondary National Ambient Air Quality Standards for Ozone (40 C.F.R. 50 App. P).

[4] A day is considered valid when 8-hour averages are available for at least 75% of possible hours in the day (i.e., at least 18 of the 24 averages). In the event that less than 75% of the 8-hour averages are available, a day is also counted as a valid day if the daily maximum 8-hour average concentration for that day is greater than the level of the ambient standard.

Five-year averages are interpolated for all ozone monitoring locations with an IDW estimation method to estimate 5-year average values for the contiguous U.S. The ozone condition for human health risk at an individual park is the maximum estimated value within park boundaries derived from this national analysis. A resulting condition greater than or equal to 76 ppb is assigned a *Warrants Significant Concern* status. An ozone condition from 61–75 ppb is assigned *Warrants Moderate Concern* status. Resource is in *Good Condition* if the ozone condition is less than 60 ppb.

Table 2. Benchmarks for Human Health Ozone Status

Status Category	***Ozone concentration[1] (ppb)***
Warrants Significant Concern	≥ 76
Warrants Moderate Concern	61–75
Resource is in Good Condition	≤ 60

[1] Estimated or measured five-year average of annual 4th-highest daily maximum 8-hour

Status Adjustments: In instances where the NPS unit falls within an area designated by the EPA as "nonattainment" (not meeting) for the ground-level ozone standards of an 8-hour average concentration of 75 ppb[5], the ozone condition is elevated to the *Warrants Significant Concern* category. See Appendix C for NPS units that are part of non-attainment areas

2.2.2. Vegetation Health Risk

In addition to being a concern to the health of park staff and visitors, long-term exposures to ground-level ozone can cause injury to ozone-sensitive plants[6] (Bell *In Review*). The W126 metric[7] is a biologically relevant measure that focuses on plant response to ozone exposure. This measure is a better predictor of vegetation response than the metric used for the human health standard. The W126 preferentially weighs 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 in “parts per million-hours” (ppm-hrs).

[5] EPA nonattainment area designation shapefiles are obtained from: http://www.epa.gov/airquality/greenbook/gis_download.html.

[6] For a list of ozone-sensitive plants in NPS units visit: https://irma.nps.gov/NPSpecies/Reports/Systemwide/Ozone-Sensitive%20Species%20in%20a%20Park.

[7] See Appendix D for calculation methods for the ozone W126 statistic.

ARD benchmarks for the W126 metric are based on information in EPA's *Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards* (EPA 2014), which outlines use of the W126 metric for assessing plant response to ground-level ozone. This document also compiles the latest scientific evidence about impacts to vegetation from ground-level ozone. Research has found that for a W126 value of:

- ≤ 7 ppm-hrs, tree seedling biomass loss is ≤ 2 % per year in sensitive species; and
- ≥13 ppm-hrs, tree seedling biomass loss is 4–10 % per year in sensitive species.

The ARD recommends a W126 of < 7 ppm-hrs to protect most sensitive trees and vegetation.

Current condition for vegetation health risk from ozone is measured using the maximum 3-month 12-hour W126 in parts per million hours (ppm-hrs). Annual maximum 3-month 12-hour W126 values are averaged over a 5-year period at all monitoring sites with at least 3 years of complete annual data. Note that prior to 2012, this included monitoring data from the Clean Air Status and Trends Network (CASTNET) and Air Quality System (AQS). Beginning in 2012, all ozone monitoring data are acquired from AQS.

Five-year averages are interpolated for all ozone monitoring locations with an IDW estimation method to estimate 5-year average values for the contiguous U.S. The estimated current ozone condition for vegetation health risk at individual parks is the maximum value within park boundaries derived from this national analysis. A resulting condition greater than 13 ppm-hrs is assigned a *Warrants Significant Concern* status. A current ozone condition from 7–13 ppm-hrs is assigned *Warrants Moderate Concern* status. Resource is in *Good Condition* if the current ozone condition is less than 7 ppm-hrs.

Table 3. Benchmarks for Vegetation Health Ozone Status

Status Category	***W126[1] (ppm-hrs)***
Warrants Significant Concern	> 13
Warrants Moderate Concern	7–13
Resource is in Good Condition	< 7

[1] Estimated or measured 5-year average of the maximum 3-month 12-hour W126.

Status Adjustments: There are currently no adjustments for vegetation health ozone status.

2.3. Visibility Status

Pollutant particles in the atmosphere – from both natural and human-caused sources (e.g., power plants, dust) – scatter and absorb light, creating a haze that impairs how far and how well we can see scenic views. Visibility is often measured using the Haze Index[8] in deciviews (dv). The Clean Air Act established a national goal to return visibility to "natural conditions[9]" in Class I areas and the ARD recommends a visibility benchmark of less than 2 dv above natural conditions for all NPS units, regardless of Class designation, consistent with the Clean Air Act goal.

Visibility condition is evaluated using the average haze index on the on mid-range days (40^{th} to 60^{th} percentile). Annual average measurements for visibility on mid-range days are averaged over a 5-year period and subtracted from the estimated natural visibility condition on mid-range days at each Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring site with at least 3-years of complete annual data. The difference between 5-year average visibility and natural visibility on mid-range days estimate the human contributions to visibility impairment on average days. These values are then interpolated across all monitoring locations using an IDW method to estimate 5-year average values for the contiguous U.S. The estimated current visibility condition for individual parks is the maximum value within park boundaries derived from this national analysis. A resulting condition greater than 8 dv is assigned a *Warrants Significant Concern* status. A current visibility condition from 2–8 dv is assigned *Warrants Moderate Concern* status. Resource is in *Good Condition* if the current visibility condition is less than 2 dv.

[8] Haze Index (HI) measures visibility impairment due to haze by correlating incremental changes in haziness to corresponding changes in perceived visibility. The haze index (HI) is calculated in units of deciviews (dv) directly from the total light extinction (b_{ext} expressed in inverse megameters [Mm-1] as follows: HI = 10 ln (bext/10). (EPA-454/B-03-005)

[9] 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). See Appendix E for estimated average natural visibility on mid-range days in NPS units.

Table 4. Benchmarks for Visibility Status	
Status Category	***Visibility[1] (dv)***
Warrants Significant Concern	> 8
Warrants Moderate Concern	2–8
Resource is in Good Condition	< 2
[1] Estimated or measured 5-year average of visibility on mid-range days minus natural condition of mid-range days.	

Status Adjustments: Visibility status assessments are solely based on interpolated or measured 5-year average haze index values without any adjustments.

2.4. Atmospheric Deposition Status

2.4.1. Nitrogen and Sulfur Wet Deposition

Atmospheric deposition of nitrogen and sulfur compounds can acidify sensitive lakes, streams, and soils, disrupt soil nutrient cycling, and affect biodiversity. Wet deposition is used as a surrogate for total deposition, because wet deposition is the only nationally available monitored source of nitrogen and sulfur deposition data. While ecosystems respond to total (wet and dry) deposition together, ARD selected a wet deposition threshold of 1.0 kg/ha/yr as the level below which natural ecosystems are likely protected from harm, based on studies linking early stages of aquatic health decline correlated with 1.0 kg/ha/yr wet deposition of nitrogen both in the Rocky Mountains (Baron et al, 2011), and in the Pacific Northwest (Schibely et al 2014).

Wet deposition for sites within the contiguous U.S. was calculated by multiplying nitrogen[10] or sulfur[11] concentrations in precipitation by a normalized precipitation[12]. Annual nitrogen and sulfur

[10] Wet nitrogen deposition includes nitrate (NO_3^-) and ammonium (NH_4^+).Total wet nitrogen is estimated using molecular weight ratios to calculate the nitrogen portions of NO_3^- (NO_3^- * 0.22581) and NH_4^+ (NH_4^+ * 0.77778).

[11] Wet sulfur deposition includes sulfate (SO_4^{2-}). Total sulfur is estimated using molecular weight ratios to calculate the sulfur portion (SO_4^{2-} * 0.3338).

[12] Normalized 30-year (1981–2010) precipitation values from the PRISM Climate Group (2014) are used to calculate deposition to minimize interannual variation in deposition caused by fluctuations in precipitation (http://www.ocs.orst.edu/prism/). Note that the PRISM data are resampled to match the resolution of the IDW (i.e. 2.5 km).

wet deposition measurements are averaged over a 5-year period at all National Atmospheric Deposition Program – National Trends Network (NADP-NTN) monitoring sites with at least 3 years of annual data that meet the following meteorological season completeness criteria[13]:

- Seasonal criterion 1: Percentage of time during the meteorological season for which valid samples are available ≥ 50%.
- Seasonal criterion 2: Percentage of time during the meteorological season for which valid precipitation amounts are available ≥ 75%.
- Seasonal criterion 3: Percentage of the total measured precipitation associated with valid samples ≥ 50% for the meteorological season.

Five-year averages are then interpolated across all monitoring locations using an IDW method to estimate 5-year average values for the contiguous U.S. For individual parks, minimum and maximum values within park boundaries are reported from this national analysis. To maintain the highest level of protection in the park, the maximum value is assigned a condition status. A resulting condition greater than 3 kg/ha/yr is assigned a *Warrants Significant Concern* status. A current nitrogen or sulfur condition from 1–3 kg/ha/yr is assigned *Warrants Moderate Concern* status. Resource is in *Good Condition* if the current nitrogen or sulfur condition is less than less than 1 kg/ha/yr.

Status Adjustments: Park status is adjusted based on results from national assessment reports that identified ecosystems and resources at risk to acidification and excess nitrogen enrichment in national parks. These reports provide a relative risk assessment of acidification and nutrient enrichment impacts from atmospheric nitrogen and sulfur deposition for parks in 32 inventory & monitoring networks. If park ecosystems are ranked "very high" in sensitivity[14] to acidification or nutrient enrichment effects from atmospheric deposition relative to all Inventory & Monitoring parks (Sullivan et al. 2011a; Sullivan et al. 2011b), the condition category is adjusted to the next worse condition category (see Appendix F for a list of parks with status adjustments).

2.4.2. Mercury/Toxics Deposition

Elevated levels of mercury and other airborne toxic pollutants like pesticides in aquatic and terrestrial food webs can act as neurotoxins in biota that accumulate fat and/or muscle-loving contaminants. The ARD assesses mercury/toxics status according to the mercury risk status assessment matrix. In

[13] Meteorological season completeness criteria are based on completeness criteria 1, 2, and 3 used in Lehmann et al. 2005.

[14] Ecosystem sensitivity ratings to acidification from atmospheric deposition were based on percent sensitive vegetation types, number of high-elevation lakes, length of low-order streams, length of high-elevation streams, average slope, and acid-sensitive areas within the park (Sullivan et al. 2011a). Ratings for nutrient enrichment effects from atmospheric nitrogen deposition were based on percent sensitive vegetation types and number of high-elevation lakes within the park (Sullivan et al. 2011b).

certain instances, in-park data on mercury and/or other toxic contaminants in biota can be applied to adjust the status.

The ARD mercury status assessment matrix is the resultant product of two conditions:

(1) estimated 3-year average mercury wet deposition; and

(2) predicted surface water methylmercury concentrations at NPS Inventory & Monitoring parks.

The 1st layer represents atmospheric wet mercury inputs while the 2nd layer represents the landscape sensitivity to mercury methylation. It is important to consider both mercury deposition inputs and ecosystem susceptibility to mercury methylatation when assessing mercury status because atmospheric inputs of elemental or inorganic mercury must be methylated before it is biologically available and able to accumulate in food webs. Thus, mercury condition cannot be assessed according to mercury wet deposition (1st layer) alone. Other factors like environmental conditions conducive to mercury methylation (e.g., dissolved organic carbon, wetlands, pH) must also be considered (2nd layer).

Conditions of atmospheric deposition are based on wet deposition in micrograms per meter squared per year ($\mu g/m^2/yr$). Dry deposition data are not available for most areas. Wet deposition for sites within the contiguous U.S. was calculated by multiplying mercury concentrations in precipitation by a normalized precipitation[15]. Annual mercury wet deposition measurements are averaged over a 3-year period at all National Atmospheric Deposition Program – Mercury Deposition Network (NADP-MDN) monitoring sites with at least 3 years of annual data. The same meteorological season completeness criteria are applied to mercury annual data as for nitrogen and sulfur (see section 2.3.2).

Three-year averages are then interpolated across all monitoring locations using an IDW method to estimate 3-year average values for the contiguous U.S. For individual parks, minimum and maximum values within park boundaries are reported from this national analysis. Only the maximum value is assigned a Very Low to Very High rating (see Table 5).

[15] Normalized 30-year (1981–2010) precipitation values from the PRISM database are used to calculate deposition to minimize interannual variation in deposition caused by fluctuations in precipitation (http://www.ocs.orst.edu/prism/). Note that the PRISM data are resampled to match the resolution of the IDW (i.e. 2.5 km).

Table 5. Ratings for Mercury Deposition	
Rating	***Mercury Deposition (µg/m^2/yr)***
Very Low	< 3
Low	≥ 3 and < 6
Moderate	≥ 6 and < 9
High	≥ 9 and < 12

Conditions of predicted methylmercury concentration (nanograms per liter [ng/L]) in surface water are obtained from a model that predicts surface water methylmercury concentrations for hydrologic units throughout the U.S. based on relevant water quality characteristics (pH, sulfate, and total organic carbon) and wetland abundance (USGS 2015). The predicted methylmercury concentration at a park is the highest value derived from the hydrologic units that intersect the park. This highest value is then assigned a rating from Very Low to Very High (see Table 6).

Table 6. Predicted Methylmercury Concentration	
Rating	***Predicted Methylmercury Concentration (ng/L)***
Very Low	< 0.038
Low	≥ 0.038 and < 0.053
Moderate	≥ 0.053 and < 0.075
High	≥ 0.075 and < 0.12

Ratings for mercury wet deposition and predicted methylmercury concentration are then considered concurrently in the mercury status assessment matrix displayed below to identify one of three park-

specific mercury/toxics status categories: *Resource is in Good Condition* (green circles), *Warrants Significant Concern* (yellow circles), and *Warrants Significant Concern* (red circles).

Table 7. Mercury Status Assessment Matrix

		Mercury wet deposition rating				
		Very Low	Low	Moderate	High	Very High
Predicted methylmercury concentration rating	Very Low					
	Low					
	Moderate					
	High					
	Very High					

Mercury wet deposition or predicted methylmercury concentration ratings may not be reported due to spatial gaps in NADP-MDN sites and/or incompleteness of predicted methylmercury concentrations. If an NPS unit does not have a rating for either category, a mercury status is not assigned unless the status adjustment guidelines apply (see below).

Status Adjustments: The presence of in-park data on either mercury or toxics in food webs may influence the overall rating for toxics/mercury condition, particularly if the mercury risk assessment value is not available. An assessment of previous and current studies and availability of fish consumption guidelines serve as the basis for adjusting mercury status. Data on biota must be credible and available within a minimum of three biotic compartments (e.g., fish, songbirds, dragonfly larvae), with an ideal sample size of N=15 or more per compartment and multiple sampling sites (N>3 per 1000 square miles). Levels in biota must be compared relative to health thresholds or other NPS units. (See Appendix G for a list of parks with status adjustments.) Toxics/mercury status cannot be assessed on fish consumption guidance alone.

Where mercury status is undetermined, the same guidance applies when assessing non-mercury toxic contaminants (PCBs, DDT) in biota and the resultant toxics/mercury status.

3. Trend Assessment

A non-parametric regression technique called the Kendall-Theil method[16] is used to determine statistically significant trends. Short-term trends are computed from data collected over a 10-year period at on-site or nearby representative monitors (see Appendix B for a list of representative sites). Short-trends are calculated for sites that have at least 6 years of annual data and an annual value for the end year of the reporting period.

Long-term trends are computed from entire monitoring record at on-site monitors or nearby representative monitors. Long-term trends are calculated for sites that have at least 60 percent of annual data, no data gaps greater than 4 years, and an annual value for the reporting end year.

In air quality summary tables, only the short-term trends are reported and are represented by arrows. All improving (up arrows) and deteriorating (down arrows) trends have at least 90% probability of being correct (those with p-values ≤ 0.10). Statistically significant (p-value ≤ 0.10) trends with zero slope are represented by flat arrows. Parameters with no statistically significant trend (p-value ≥ 0.10) are also represented by flat arrows.

3.1. Ozone Trends

Annual fourth-highest daily maximum 8-hour average ozone concentrations (ppb) are used to calculate human health based ozone trends. Trends for vegetation-based ozone trends use annual 3-month maximum 12-hour W126 statistic. For a year to be considered in the trend analysis it must have equal to or greater than 75% valid days[17] during the calendar year or ozone season.

Ozone trends are computed for parks with a representative ozone monitor that is within 10 km of park boundaries. Monitors operated by NPS take precedence over other nearby monitors. In cases where the park has more than one monitor operated by the NPS, the monitor with the longest monitoring history is selected to represent the park. There are a handful of representative monitors that are no longer the closest monitor within a 10 km radius but are retained as the representative monitor to maintain a consistent historic record of status and trends. See Appendix B for a list of ozone representative monitoring sites.

3.2. Visibility

[16] Kendal-theil methods for computing the trend line and test for significance are explained in *Statistical Methods in Water Resources* section "10.1 Kendall-Theil Robust Line" available at http://pubs.usgs.gov/twri/twri4a3/.

[17] A day is considered valid when 8-hour averages are available for at least 75% of possible hours in the day (i.e., at least 18 of the 24 averages). In the event that less than 75% of the 8-hour averages are available, a day is also counted as a valid day if the daily maximum 8-hour average concentration for that day is greater than the level of the ambient standard.

Visibility trends are computed from the Haze Index values on the 20% haziest days and the 20% clearest days, consistent with visibility goals in the Clean Air Act and Regional Haze Rule, which include improving visibility on the haziest days and allowing no deterioration on the clearest days. Although this legislation provides special protection for NPS areas designated as Class I, the NPS applies these standard visibility metrics to all units of the NPS. If the Haze Index trend on the 20% clearest days is deteriorating, the overall visibility trend is reported as deteriorating. Otherwise, the Haze Index trend on the 20% haziest days is reported as the overall visibility trend.

Trends are computed for parks with assigned representative monitors. The same monitors that are selected to represent Class I areas as part of the Regional Haze rule are used to calculate visibility trends for Class I parks. An IMPROVE monitoring site considered being representative of a Class II park has to be between within +/- 100 feet or 10% of maximum and minimum elevation of the park and at a distance of no more than 150 kilometers. IMPROVE representative monitors are not assigned to parks with a land-use status of urban.[18]

3.3. Atmospheric Deposition Trends

3.3.1. Nitrogen and Sulfur

Wet deposition trends are evaluated using pollutant concentrations in precipitation (micro equivalents/liter) so that yearly variations in precipitation amounts do not influence trend analyses. For sulfur wet deposition trends, sulfate concentrations measured in precipitation are trended over a ten-year period and entire data record for each reporting year. For nitrogen wet deposition trends, total nitrogen in precipitation is estimated using molecular weight ratios to calculate the nitrogen portions of nitrate and ammonium[19]. The resulting ratios are summed to estimate total annul nitrogen concentration in precipitation and trended over a 10-year period and entire data record for each reporting year. The following meteorological season completeness criteria are applied to annual data:

- Seasonal criterion 1: Percentage of time during the meteorological season for which valid samples are available ≥ 50%.
- Seasonal criterion 2: Percentage of time during the meteorological season for which valid precipitation amounts are available ≥ 75%.
- Seasonal criterion 3: Percentage of the total measured precipitation associated with valid samples ≥ 50% for the meteorological season.

Nitrogen and sulfur trends are computed for parks with a representative NADP-NTN wet deposition monitor that is within 16 km of park boundaries. Gates of the Arctic NP & PRES is an exception to

[18] National Land Cover Database 2011 edition retrieved from http://www.mrlc.gov/nlcd06_data.php was used to categorize NPS units as urban, suburban, and rural.

[19] Total nitrogen is estimated using molecular weight ratios to calculate the nitrogen portions of NO and NH4 (NH4 * 0.77778). (NO3* 0.22581)

the distance criteria due to the fact that the representative monitor (NADP-NTN ID: AK06) is operated by NPS but located 26 km outside park boundaries for accessibility reasons. See Appendix B for a list of NADP-NTN representative monitoring sites.

3.3.2. Mercury

Wet mercury deposition trends are evaluated using pollutant concentrations in precipitation (micro equivalents/liter) so that yearly variations in precipitation amounts do not influence trend analyses. Total mercury in precipitation is trended over a 10-year period and entire data record for each reporting year. The same meteorological season completeness criteria are applied to mercury annual data as for nitrogen and sulfur (see section 3.2.1).

Mercury trends are computed for parks with a representative NADP-MDN wet deposition monitor that is within 16 km of park boundaries. See Appendix B for a list of NADP-MDN representative monitoring sites.

4. Degree of Confidence in Status and Trend Assessments

Degree of confidence is based on how well the nearest monitoring site(s) represents air quality reported for a park. The representativeness of a monitor depends on the pollutant, network, distance from the park, and local site characteristics. The degree of confidence is rated as either High or Medium: the confidence is High if estimates are based on interpolated data from on-site or nearby monitors, and Medium if estimates are based on interpolated data from more distant monitors. On the air quality summary table, the degree of confidence is represented by the thickness of the outside line of the condition/trend symbol and represents confidence in the condition only.

For toxics/mercury status assessments that are solely based on the predicted methylmercury concentrations and mercury deposition, low confidence is applied. High confidence is applied to the condition in select NPS units where credible data exists in multiple biotic components (e.g., fish, songbirds, dragonfly larvae), with an ideal sample size of N=15 or more per compartment and multiple sampling sites (N>3 per 1000 square miles).

For the mercury/toxics status, the degree of confidence is low when the assessment of status is solely based on the mercury estimated wet deposition and predicted methylmercury concentration. In select NPS units where data exists in multiple biotic components across numerous sites (N>3 per 1,000 square mile), the degree of confidence is adjusted to High.

In the air quality summary tables, the degree of confidence is represented by the thickness of the outside line of the status/trend symbol.

The degree of confidence for all available trend analyses is rated High because trends are only computed for parks with an on-site or nearby monitor.

5. Reporting Overall Air Quality Status and Trend

Ozone, total (nitrogen and sulfur) wet deposition, and visibility indicators are rolled into a single score for an overall air quality condition and trend within an NPS unit.

5.1. Overall Air Quality Status

Ozone (4th-highest daily maximum 8-hour concentration and 3-month maximum 12-hour W126), wet deposition (nitrogen and sulfur wet deposition), and visibility status assessments are rolled into a single score for an overall air quality status within an NPS unit.

To determine the combined condition status, each *Warrants Significant Concern* (red) symbol is assigned zero points, each *Warrants Moderate Concern* (yellow) symbol is assigned 50 points, and each *Resource is in Good Condition* (green) symbol, 100 points. Calculate the average, and apply the scale below to determine the resulting condition status.

NPS units that are in EPA designated ozone or particulate matter nonattainment areas are automatically placed in the *Warrants Significant Concern* condition category (see Appendix H: Overall Air Quality Condition Adjustments).

Status Score	***Overall Air Quality Status***	***Overall Air Quality Status Symbol Color***
0–33	Warrants Significant Concern	
34–66	Warrants Moderate Concern	
67–100	Resource is in Good Condition	

5.2. Overall Air Quality Trend

To determine the overall trend, subtract the total number of deteriorating trend (up arrow) symbols from the total number of improving trend (up arrow) symbols. If the result is 3 or greater, the overall trend is improving (up arrow). If the result is -3 or lower, the overall trend is deteriorating (down arrow). If the result is between 2 and -2, the overall trend is unchanging (horizontal double-headed arrow). If there are no trends reported for any of the specific measures, the overall condition symbol will not show a trend arrow. If the result does not appear to be consistent with known conditions, provide a brief rationale for an adjustment in space provided.

Trend Score	*Overall Air Quality Trend*	*Overall Air Quality Trend Symbol*
≤ - 3	Deteriorating Trend	
-2 to < 2	Unchanging	
≥ 3	Improving Trend	

5.3. Degree of Confidence for Overall Condition Assessment

Overall degree of confidence in the condition assessments is assigned a High rating only when all three indicators (ozone, wet deposition, and visibility) have High ratings. In all other instances, the overall degree of confidence is rated as Medium.

6. Looking at Composition

6.1. Visibility

Speciated fine particulate matter and total mass are measured every third day at IMPROVE monitoring sites situated to represent air quality at 155 class I area and other rural environments. These data are used to estimate the contribution of the major chemical species to ambient particulate matter and in turn their contribution to visibility impairment. The particulate matter constituents are ammonium sulfate, ammonium nitrate organic mass, elemental carbon, fine soil, fine sea salt and coarse mass. Visibility impairment is reported as either light extinction or deciview. Light extinction has units of inverse megameters [1/Mm] and is a measure of the loss of image forming light from scenic features to the observer due to scattering and absorption by particles and gases per unit length. Light extinction is dependent on the optical properties of the particulate matter and varies by its chemical constituents. For example, a given quaintly of ammonium sulfate will scatter more light than the same quantity of soil particles. Light extinction is not proportional to visibility impairment one observes; however, the deciview metric is. Deciview is a transformation of light extinction and a deciview of 0 is scene with no particulate impairment and a change of 1 deciview is perceptible under some conditions.

Composition and visibility data are grouped by haziest days (i.e. days with the highest 20% of aerosol calculated light extinction) and clearest days (i.e. days with the lowest 20% of aerosol calculated light extinction) in each year and average over one or five-year periods. The average clearest and haziest days are compared to the respective natural visibility conditions on clearest and haziest days. The natural condition estimates are climatological values and do not contain contributions from random events such as wildfires and dust storms. In some years these will obscure the haze values on the haziest days.

6.2. Nitrogen and Sulfur Deposition

The composition of inorganic nitrogen deposition (kg/ha/yr) is reported as the sum of annual and 5-yr average wet and dry chemical components. Wet nitrogen deposition data on ammonium and nitrate are from representative NADP/NTN sites and are based on the measured precipitation amount at the monitoring site. Dry nitrogen deposition data on nitric acid, ammonium, and nitrate are modeled from measurements at representative CASTNET sites. All components are converted to nitrogen and then summed.

The composition of sulfur deposition (kg/ha/yr) is reported as the sum of annual and 5-yr average wet and dry chemical components. Wet sulfur deposition is determined by converting sulfate deposition to sulfur from representative NADP/NTN sites and is based on the measured precipitation amount at the monitoring site. Dry sulfur deposition data on sulfur dioxide and sulfate are modeled from measurements at representative CASTNET sites. All components are converted to sulfur and then summed.

7. Air Atlas

7.1. Ozone Estimates for Parks

Ground-level ozone is evaluated by calculating the annual 4th-highest daily maximum 8-hour concentrations, W126, and SUM06 metrics from monitoring sites across the country. Each of these calculated parameters is averaged over a 5-year period at all monitoring sites with at least 3-years of complete annual data. Same data completeness criteria are used for Air Atlas analyses as used for ozone status assessments (see section 2.2). Five-year averages are then interpolated across all monitoring locations using an IDW method to estimate 5-year average values for the contiguous U.S. For individual parks, the maximum values within park boundaries are reported from this national analysis. Outside the contiguous U.S., on-site or nearby representative monitor data, if available, are used to derive measured 5-year averages for parks.

7.2. Visibility Estimates for Parks

Visibility is evaluated using the average haze index on the 20% clearest, mid-range (40^{th} to 60^{th} percentile), and 20% haziest days. Annual average measurements for visibility in these categories are averaged over a 5-year period at each visibility monitoring site with at least 3-years of complete annual data. Five-year averages are then interpolated across all monitoring locations using an IDW method to estimate 5-year average values for the contiguous U.S. For individual parks, the maximum values within park boundaries are reported from this national analysis. Outside the contiguous U.S., on-site or nearby representative monitor data, if available, are used to derive measured 5-year averages for parks.

7.3. Wet Deposition Estimates for Parks

Wet deposition of ammonium (NH_4^+), nitrate (NO_3^-), and sulfate (SO_4^{2-}), as well as total wet nitrogen and sulfur, are calculated by multiplying concentrations in precipitation by normalized precipitation. Annual wet deposition is averaged over a 5-year period at monitoring sites with at least 3 years of annual data. Same data completeness criteria are used for Air Atlas analyses as used for atmospheric deposition status assessments (see section 2.4). Five-year averages are then interpolated across all monitoring locations using an IDW method to estimate 5-year average values for the contiguous U.S. For individual parks, minimum and maximum values within park boundaries are reported from this national analysis. Outside the contiguous U.S., on-site or nearby representative monitor data, if available, are used to derive measured 5-year averages for parks.

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Appendix A: Geospatial Estimation Method

Due to variable distribution of air quality monitoring sites across the United States, there is a need to use spatial interpolation to estimate air quality measures in non-monitored locations or locations with multiple monitors. ARD uses Inverse Distance Weighting (IDW) to estimate air quality measures for NPS units within the contiguous United States based on available monitoring data within proximity of NPS boundaries.

IDW is a method of interpolation that uses a weighted average from a set of 12 nearby air quality monitoring sites to estimate air quality conditions at non-monitored park locations. The weights are a decreasing function of distance. The monitor's influence on estimated values diminishes with the inverse distance-squared (i.e., $1/distance^2$) from locations within a park. The closer a monitoring site is to park boundaries, the more influence, or weight, it has in the averaging process. For example, if a park has an air quality monitoring site within park boundaries, that monitor will have more influence than monitoring sites outside park boundaries. The output is a continuous raster surface with a 2.5 km resolution covering the contiguous United States.

Because inverse distance weighting is a deterministic technique, it does not take into account the arrangement of the monitoring sites. Therefore, the results in urban areas where monitors are clustered or in rural areas where monitors are sparse may be less representative of the air quality within a park.

Appendix B: List of Representative Monitors

Table B. Representative air quality monitors for units in the NPS.

Park Name	Ozone	Visibility	Wet Nitrogen & Sulfur	Dry Nitrogen & Sulfur	Mercury
Abraham Lincoln Birthplace NHP	–	MACA1	–		–
Acadia NP	230090102	ACAD1	ME98	ACA416	ME98
Adams NHP	250250041	–	–		–
Agate Fossil Beds NM	311651001	WICA1	–		–
Allegheny Portage Railroad NHS	420210011	FRRE1	PA13		PA13
Antietam NB	240430009	–	–		–
Appomattox Court House NHP	–	JARI1	–		–
Arches NP	–	CANY1	–		–
Arlington House, The Robert E. Lee N MEM	510130020	WASH1	–		–
Assateague Island NS	240471001	BRIG1	MD18		–
Aztec Ruins NM	350450009	–	–		–
Badlands NP	460710001	BADL1	–		–
Bandelier NM	–	BAND1	NM07		–
Bent's Old Fort NHS	–	–	CO01		–
Big Bend NP	480430101	BIBE1	TX04	BBE401	–
Big Cypress N PRES	–	EVER1	–		FL97
Big Hole NB	–	SULA1	–		–
Big South Fork NRRA	–	MACA1	–		–
Big Thicket N PRES	483739991	–	–		–
Bighorn Canyon NRA	–	NOCH1	–		–
Biscayne NP	120860029	EVER1	–		–
Black Canyon Of The Gunnison NP	–	WEMI1	–		–
Blue Ridge PKWY	370110002	SHRO1	NC45		–
Booker T Washington NM	–	JARI1	–		–
Boston African American NHS	250250042	–	–		–
Boston Harbor Islands NRA	250250041	–	–		–
Boston NHP	250250042	–	–		–
Brown V Board Of Education NHS	201770013	–	–		KS03
Bryce Canyon NP	–	BRCA1	UT99		–
Buffalo NR	–	UPBU1	AR16		–
Cabrillo NM	60731010	–	–		–
Canaveral NS	–	–	FL99		–
Canyon De Chelly NM	–	PEFO1	–		–
Canyonlands NP	490370101	CANY1	UT09	CAN407	–

Table B. Representative air quality monitors for units in the NPS.

Park Name	Ozone	Visibility	Wet Nitrogen & Sulfur	Dry Nitrogen & Sulfur	Mercury
Cape Cod NS	250010002	CACO1	MA01		MA01
Cape Hatteras NS	–	SWAN1	–		–
Cape Lookout NS	–	SWAN1	–		–
Capitol Reef NP	–	CAPI1	–		–
Capulin Volcano NM	–	–	NM12		–
Carl Sandburg Home NHS	–	GRSM1	–		–
Carlsbad Caverns NP	350153001	GUMO1	–		–
Carter G. Woodson Home NHS	110010043	WASH1	–		MD99
Castle Clinton NM	340170006	–	–		–
Catoctin Mountain Park	–	–	MD07		–
Cedar Breaks NM	–	BRCA1	–		–
Chaco Culture NHP	–	BAND1	–		–
Chamizal N MEM	481410044	–	–		–
Channel Islands NP	61112003	–	–		–
Charles Young Buffalo Soldiers NM	390570006	–	–		–
Chattahoochee River NRA	131350002	–	–		–
Chesapeake & Ohio Canal NHP	110010043	WASH1	–		–
Chickamauga & Chattanooga NMP	470654003	–	–		–
Chiricahua NM	40038001	CHIR1	AZ98	CHA467	–
Christiansted NHS	–	VIIS1	–		–
City Of Rocks N RES	–	JARB1	–		–
Clara Barton NHS	510595001	WASH1	–		–
Colorado NM	80771001	CANY1	–		–
Congaree NP	450790021	ROMA1	–		SC19
Constitution Gardens	510130020	WASH1	–		–
Coronado N MEM	–	CHIR1	–		–
Cowpens NB	450210002	–	–		–
Crater Lake NP	–	CRLA1	–		–
Craters Of The Moon NM & PRES	160230101	CRMO1	ID03		ID03
Cumberland Gap NHP	470259991	GRSM1	TN04		–
Curecanti NRA	–	WEMI1	–		–
Cuyahoga Valley NP	391530020	–	–		–
Dayton Aviation Heritage NHP	390230003	–	–		–
De Soto N MEM	120814012	CHAS1	–		–
Death Valley NP	60270101	DEVA1	–	DEV412	–
Delaware Water Gap NRA	340410007	–	PA72		PA72
Denali NP & PRES	20680003	DENA1	AK03	DEN417	–
Devils Postpile NM	–	KAIS1	–		–
Devils Tower NM	–	THBA1	–		–

Table B. Representative air quality monitors for units in the NPS.

Park Name	Ozone	Visibility	Wet Nitrogen & Sulfur	Dry Nitrogen & Sulfur	Mercury
Dinosaur NM	490471002	FLTO1	–		–
Dry Tortugas NP	–	EVER1	–		–
Edgar Allan Poe NHS	421010004	–	–		–
Eisenhower NHS	–	–	PA00		PA00
El Malpais NM	–	BALD1	–		–
Everglades NP	–	EVER1	FL11	EVE419	FL11
Fire Island NS	361030009	–	–		–
First Ladies NHS	391510016	–	–		–
First State NHP	100031010	–	–		–
Flight 93 N MEM	–	FRRE1	–		–
Florissant Fossil Beds NM	–	GRSA1	–		–
Ford's Theatre NHS	110010043	WASH1	–		–
Fort Bowie NHS	–	CHIR1	AZ98		–
Fort Larned NHS	–	CEBL1	–		–
Fort McHenry NM & Historic Shrine	245100054	–	–		–
Fort Point NHS	60750005	–	–		–
Fort Pulaski NM	130510021	–	–		–
Fort Raleigh NHS	–	SWAN1	–		–
Fort Smith NHS	401359021	–	–		–
Fort Sumter NM	–	ROMA1	–		–
Fort Union NM	–	BAND1	–		–
Fort Union Trading Post NHS	–	MELA1	–		–
Fort Washington Park	510590030	WASH1	–		MD99
Fossil Butte NM	–	BOLA1	–		–
Franklin Delano Roosevelt Memorial	510130020	WASH1	–		–
Frederick Douglass NHS	110010041	WASH1	–		MD99
Frederick Law Olmsted NHS	250250042	–	–		–
Fredericksburg & Spotsylvania NMP	–	WASH1	–		–
Gates Of The Arctic NP & PRES	–	GAAR1	AK06		–
Gateway NRA	360850067	–	–		–
Gauley River NRA	–	JARI1	–		–
General Grant N MEM	360610135	–	–		NY06
George Rogers Clark NHP	180839991	–	IN22		–
George Washington Birthplace NM	–	WASH1	–		–
George Washington Carver NM	–	ELDO1	–		–
George Washington Memorial PKWY	510130020	WASH1	–		–
Gettysburg NMP	420019991	–	PA00		PA00
Gila Cliff Dwellings NM	–	GICL1	NM01		–
Glacier Bay NP & PRES	–	–	–		AK05

Table B. Representative air quality monitors for units in the NPS.

Park Name	Ozone	Visibility	Wet Nitrogen & Sulfur	Dry Nitrogen & Sulfur	Mercury
Glacier NP	300298001	GLAC1	MT05	GLR468	MT05
Glen Canyon NRA	–	CANY1	–		–
Golden Gate NRA	60750005	–	–		–
Governors Island NM	340170006	–	–		–
Grand Canyon NP	40058001	GRCA2	AZ03	GRC474	–
Grand Teton NP	560390008	YELL2	WY94		–
Grant-Kohrs Ranch NHS	–	MONT1	–		–
Great Basin NP	320330101	GRBA1	NV05	GRB411	–
Great Sand Dunes NP & PRES	–	GRSA1	–		–
Great Smoky Mountains NP	470090101	GRSM1	TN11	GRS420	TN11
Greenbelt Park	240330030	WASH1	MD99		MD99
Guadalupe Mountains NP	–	GUMO1	TX22		–
Guilford Courthouse NMP	370810013	–	–		–
Gulf Islands NS	121130015	BRIS1	–		–
Haleakala NP	–	HACR1	–		–
Hamilton Grange N MEM	360610135	–	–		NY06
Hampton NHS	240051007	–	–		–
Hawaii Volcanoes NP	–	HAVO1	–	HVT424	–
Herbert Hoover NHS	–	LASU2	–		–
Honouliuli National Monument	150030010	–	–		–
Hopewell Furnace NHS	–	–	PA60		PA60
Horseshoe Bend NMP	–	BIRM1	–		–
Hovenweep NM	–	MEVE1	–		–
Independence NHP	421010004	–	–		–
Indiana Dunes NL	181270024	–	IN34		IN34
Isle Royale NP	–	ISLE1	–		–
James A Garfield NHS	390850003	–	–		–
Jean Lafitte NHP & PRES	220550007	BRIS1	–		–
Jefferson National Expansion Memorial	295100085	–	–		–
John D Rockefeller Jr Memorial PKWY	–	YELL2	–		–
John Day Fossil Beds NM	–	STAR1	–		–
John F Kennedy NHS	250250042	–	–		–
John Muir NHS	60130002	–	–		–
Joshua Tree NP	60719002	JOSH1	CA67	JOT403	–
Katmai NP & PRES	–	TUXE1	AK97		–
Kenai Fjords NP	–	TUXE1	–		–
Kennesaw Mountain NBP	130670003	–	–		–
Keweenaw NHP	–	ISLE1	MI99		–
Kings Mountain NMP	450210003	–	–		–

Table B. Representative air quality monitors for units in the NPS.

Park Name	Ozone	Visibility	Wet Nitrogen & Sulfur	Dry Nitrogen & Sulfur	Mercury
Klondike Gold Rush NHP	530330080	OLYM1	–		–
Korean War Veterans Memorial	110010043	WASH1	–		–
Lake Chelan NRA	–	NOCA1	–		–
Lake Clark NP & PRES	–	TUXE1	–		–
Lake Mead NRA	320030601	GRCA2	–		–
Lassen Volcanic NP	60893003	LAVO1	CA96	LAV410	–
Lava Beds NM	–	LABE1	–		–
Lincoln Home NHS	171670014	–	–		–
Lincoln Memorial	110010043	WASH1	–		–
Little Bighorn Battlefield NM	–	–	MT00		–
Little Rock Central High School NHS	51190007	–	–		–
Longfellow NHS	250250042	–	–		–
Lowell NHP	250170009	–	–		–
Lyndon Baines Johnson Memorial Grove N MEM	510130020	WASH1	–		–
Maggie L Walker NHS	510870014	–	–		–
Mammoth Cave NP	210610501	MACA1	KY10	MAC426	KY10
Manassas NBP	511530009	–	–		–
Manzanar NHS	–	OWVL1	–		–
Marsh - Billings - Rockefeller NHP	–	PMRF1	–		–
Martin Luther King Jr NHS	131210055	–	–		–
Martin Luther King, Jr. Memorial	110010043	WASH1	–		–
Mary McLeod Bethune Council House NHS	110010043	–	–		MD99
Mesa Verde NP	80830006	MEVE1	CO99	MEV405	CO99
Minuteman Missile NHS	–	BADL1	SD08		–
Mississippi NRRA	–	–	–		MN98
Missouri NRR	–	BLMO1	–		–
Mojave N PRES	60711001	JOSH1	–		–
Monocacy NB	240210037	–	–		–
Mount Rainier NP	530530012	MORA1	WA99	MOR409	–
Mount Rushmore N MEM	–	WICA1	–		–
Muir Woods NM	60410001	–	–		–
Natchez NHP	280010004	–	–		–
Natchez Trace PKWY	280810005	SIPS1	MS10		–
National Mall	110010043	–	–		–
National Mall & Memorial Parks	110010043	WASH1	–		–
Natural Bridges NM	–	CANY1	–		–
Navajo NM	–	GRCA2	–		–
New Bedford Whaling NHP	250051006	–	–		–

Table B. Representative air quality monitors for units in the NPS.

Park Name	Ozone	Visibility	Wet Nitrogen & Sulfur	Dry Nitrogen & Sulfur	Mercury
New River Gorge NR	–	JARI1	WV04		–
Nez Perce NHP	–	HECA1	–		–
Nicodemus NHS	–	CEBL1	–		–
North Cascades NP	–	NOCA1	WA19	NCS415	–
Ocmulgee NM	130210012	–	–		–
Olympic NP	530090013	OLYM1	WA14	OLY421	WA03
Organ Pipe Cactus NM	–	ORPI1	AZ06		–
Ozark NSRs	–	MING1	–		–
Palo Alto Battlefield NHP	480610006	–	–		–
Pea Ridge NMP	–	HEGL1	–		–
Pecos NHP	–	BAND1	–		–
Pennsylvania Avenue NHS	110010043	WASH1	–		–
Petersburg NB	510360002	–	–		–
Petrified Forest NP	40170119	PEFO1	AZ97	PET427	–
Petroglyph NM	350010027	BOAP1	–		–
Pictured Rocks NL	–	SENE1	–		–
Pinnacles NP	60690003	PINN1	CA66	PIN414	–
Pipestone NM	–	BLMO1	–		–
Piscataway Park	510590030	WASH1	–		MD99
Point Reyes NS	–	PORE1	–		–
President's Park (White House)	110010043	WASH1	–		–
Prince William Forest Park	511790001	–	–		–
Pullman NM	170310032	–	–		–
Redwood NSP	–	REDW1	–		CA20
Richmond NBP	510870014	WASH1	–		–
Rock Creek Park	110010043	WASH1	–		–
Rocky Mountain NP	80690007	ROMO1	CO98	ROM406	–
Roger Williams N MEM	440071010	–	–		–
Rosie the Riveter WWII Home Front NHP	60131004	–	–		–
Ross Lake NRA	–	NOCA1	WA19		–
Saguaro NP	40190021	SAGU1	–		–
Saint Croix NSR	–	–	WI37		–
Saint Paul's Church NHS	360050133	–	–		NY06
Salem Maritime NHS	250092006	–	–		–
Salinas Pueblo Missions NM	–	WHIT1	–		–
Salt River Bay NHP & Ecological PRES	–	VIIS1	–		–
San Francisco Maritime NHP	60750005	–	–		–
Santa Monica Mountains NRA	60370113	–	–		–
Saratoga NHP	360910004	–	–		–

Table B. Representative air quality monitors for units in the NPS.

Park Name	Ozone	Visibility	Wet Nitrogen & Sulfur	Dry Nitrogen & Sulfur	Mercury
Saugus Iron Works NHS	250092006	–	–		–
Scotts Bluff NM	–	CRES1	–		–
Sequoia & Kings Canyon NPs	61070009	SEQU1	CA75	SEK430	CA75
Shenandoah NP	511130003	SHEN1	VA28	SHN418	VA28
Sleeping Bear Dunes NL	260190003	SENE1	–		MI29
Springfield Armory NHS	250130008	–	–		–
Statue Of Liberty NM	340170006	–	–		–
Steamtown NHS	420692006	–	–		–
Sunset Crater Volcano NM	–	SYCA1	–		–
Tallgrass Prairie N PRES	–	TALL1	–		–
Thaddeus Kosciuszko N MEM	421010004	–	–		–
Theodore Roosevelt Birthplace NHS	360610135	–	–		–
Theodore Roosevelt Island Park	510130020	WASH1	–		–
Theodore Roosevelt NP	380070002	THRO1	ND00	THR422	–
Thomas Edison NHP	340130003	–	–		–
Timucuan Ecological & Historic PRES	120310077	–	–		–
Tonto NM	40070010	TONT1	–		–
Tule Springs Fossil Beds NM	320030075	–	–		–
Tumacácori NHP	–	SAGU1	–		–
Tupelo NB	280810005	–	–		–
Upper Delaware SRR	–	–	PA72		PA72
Valley Forge NHP	420910013	–	–		–
Vietnam Veterans Memorial	510130020	WASH1	–		–
Virgin Islands Coral Reef NM	–	–	VI01		–
Virgin Islands NP	–	VIIS1	VI01	VII423	–
Voyageurs NP	271370034	VOYA2	MN32	VOY413	–
Walnut Canyon NM	–	SYCA1	–		–
Washington Monument	110010043	–	–		–
Whiskeytown NRA	–	TRIN1	–		–
White Sands NM	–	BOAP1	–		–
William Howard Taft NHS	390610040	–	–		–
Wilson's Creek NB	–	HEGL1	–		–
Wind Cave NP	460330132	WICA1	SD04	WNC429	–
Wolf Trap NP for the Performing Arts	510595001	–	–		–
Wright Brothers N MEM	–	SWAN1	–		–
Wupatki NM	–	IKBA1	–		–
Yellowstone NP	560391011	YELL2	WY08	YEL408	WY08
Yosemite NP	60430003	YOSE1	CA99	YOS404	–
Zion NP	490530130	ZICA1	–		–

Appendix C: Ozone Status Adjustment

Where the NPS unit falls within an area designated by the EPA as "nonattainment" (not meeting) the ground-level ozone standards of an 8-hour average concentration of 75 ppb, the ozone condition is adjusted to the *Warrants Significant Concern* status. The overall air quality status is also automatically placed in the *Warrants Significant Concern* category for NPS units that are in ozone non-attainment areas.

Table C. NPS units in EPA designated 8-hour ozone nonattainment areas (2008 Standard)
African Burial Ground NM
Antietam NB
Arlington House, The Robert E. Lee N MEM
Big Thicket N PRES
Cabrillo NM
Carter G. Woodson Home NHS
Castle Clinton NM
Catoctin Mountain Park
César E. Chávez NM
Channel Islands NP
Chattahoochee River NRA
Chesapeake & Ohio Canal NHP
Clara Barton NHS
Constitution Gardens
Cuyahoga Valley NP
Delaware Water Gap NRA
Devils Postpile NM
Edgar Allan Poe NHS
Eugene O'Neill NHS
Federal Hall N MEM
Fire Island NS
First State NHP
Ford's Theatre NHS
Fort McHenry NM & Historic Shrine
Fort Necessity NB
Fort Point NHS
Fort Washington Park
Franklin Delano Roosevelt Memorial
Frederick Douglass NHS
Friendship Hill NHS
Gateway NRA
General Grant N MEM
George Washington Memorial PKWY
Golden Gate NRA
Governors Island NM
Great Smoky Mountains NP
Greenbelt Park
Hamilton Grange N MEM

Table C. NPS units in EPA designated 8-hour ozone nonattainment areas (2008 Standard)
Hampton NHS
Harpers Ferry NHP
Hopewell Furnace NHS
Independence NHP
Indiana Dunes NL
James A Garfield NHS
Jefferson National Expansion Memorial
John Muir NHS
Joshua Tree NP
Kennesaw Mountain NBP
Korean War Veterans Memorial
Lincoln Memorial
Lyndon Baines Johnson Memorial Grove N MEM
Manassas NBP
Martin Luther King Jr NHS
Martin Luther King, Jr. Memorial
Mary McLeod Bethune Council House NHS
Mojave N PRES
Monocacy NB
Morristown NHP
Muir Woods NM
National Mall
National Mall & Memorial Parks
National World War II Memorial
Pennsylvania Avenue NHS
Piscataway Park
Point Reyes NS
Port Chicago Naval Magazine N MEM
President's Park (White House)
Prince William Forest Park
Rock Creek Park
Rocky Mountain NP
Rosie the Riveter WWII Home Front NHP
Sagamore Hill NHS
Saint Paul's Church NHS
San Francisco Maritime NHP
Santa Monica Mountains NRA
Sequoia & Kings Canyon NPs
Statue Of Liberty NM
Thaddeus Kosciuszko N MEM
Theodore Roosevelt Birthplace NHS
Theodore Roosevelt Island Park
Thomas Edison NHP
Thomas Stone NHS
Ulysses S Grant NHS
Valley Forge NHP
Vietnam Veterans Memorial

Table C. NPS units in EPA designated 8-hour ozone nonattainment areas (2008 Standard)
Washington Monument
Weir Farm NHS
William Howard Taft NHS
Wolf Trap NP for the Performing Arts
Yosemite NP

Appendix D: Calculation of the Ozone W126 Statistic

In January 2010, the EPA proposed a secondary ozone standard. The proposed standard will be based upon a cumulative sum of hourly ozone values, where the hourly values are weighted according to their concentrations. The weighted value is usually referred to as the W126 statistic. Each hourly index value is computed by multiplying the hourly concentration (O3) by the weighting function as given by the following equation:

$$W126 = O_3 * \left(\frac{1}{1 + \left(4403 * e^{-126 * O_3}\right)} \right)$$

The hourly index values are then summed over the daylight hours from 8 a.m. to 8 p.m. for each 3-month period during the local ozone season. For a month to be valid, it must have hourly ozone values available for at least 75% of possible hours. The W126 index is then adjusted for missing hourly data by multiplying it by the ratio of the number of possible hours to the available hours. Months with fewer than 75% of possible hourly ozone measurements are not considered. For each year, the three-month period with the highest cumulative W126 value is selected. The resulting number is the summary statistic used for the vegetative health ozone status, and it is expressed in ppm-hours.

Appendix E: Visibility Natural Conditions

Natural visibility conditions are those estimated to exist in a given area in the absence of human-caused visibility impairment. The Clean Air Act established a goal of restoring visibility in all Class I areas to natural conditions (EPA-454/B-03-005).

Visibility natural conditions for NPS Class I areas and parks outside the contiguous U.S. are the recommended estimated natural conditions on mid-range days (Group 50) from representative IMPROVE monitoring sites based on Regional Rule Haze Guidance (EPA 2003). The IDW estimation method was used to interpolate natural conditions for Class II parks. The estimated natural condition on mid-range days for individual Class II parks in the contiguous U.S., is the average value within park boundaries derived from this national analysis.

Table E. Estimated Visibility Natural Conditions for NPS units

Park Name	Estimated Visibility Natural Condition on Mid-Range Days
Abraham Lincoln Birthplace NHP	7.5
Acadia NP	7.2
Adams NHP	7.7
African Burial Ground NM	8.4
Agate Fossil Beds NM	3.6
Alibates Flint Quarries NM	4.2
Allegheny Portage Railroad NHS	7.4
Amistad NRA	3.8
Andersonville NHS	7.5
Andrew Johnson NHS	7.2
Antietam NB	7.4
Appomattox Court House NHP	7.3
Apostle Islands NL	6.9
Arches NP	3.0
Arlington House, The Robert E. Lee N MEM	7.9
Arkansas Post N MEM	7.4
Assateague Island NS	7.6
Aztec Ruins NM	2.8
Badlands NP	4.7
Bandelier NM	3.0
Bent's Old Fort NHS	3.0
Big Bend NP	3.7
Bighorn Canyon NRA	3.1
Big Cypress N PRES	7.2
Big Hole NB	3.3
Biscayne NP	7.1
Big South Fork NRRA	7.4

Table E. Estimated Visibility Natural Conditions for NPS units

Park Name	Estimated Visibility Natural Condition on Mid-Range Days
Big Thicket N PRES	7.0
Black Canyon Of The Gunnison NP	2.9
Blue Ridge PKWY	7.2
Bluestone NSR	7.2
Boston African American NHS	7.6
Boston Harbor Islands NRA	7.7
Boston NHP	7.6
Booker T Washington NM	7.3
Bryce Canyon NP	2.8
Brices Cross Roads NBS	7.5
Brown V Board Of Education NHS	7.1
Buffalo NR	7.2
Cabrillo NM	4.6
Canyon De Chelly NM	3.0
Castle Clinton NM	8.4
Cape Cod NS	8.6
Casa Grande Ruins NM	4.2
Cape Hatteras NS	7.7
Cape Lookout NS	7.6
Canaveral NS	7.6
Canyonlands NP	3.0
Capitol Reef NP	3.1
Cane River Creole NHP	7.4
Carl Sandburg Home NHS	6.6
Castillo De San Marcos NM	7.7
Catoctin Mountain Park	7.4
Carlsbad Caverns NP	3.1
Capulin Volcano NM	2.7
Carter G. Woodson Home NHS	7.9
Cedar Creek & Belle Grove NHP	7.0
Cedar Breaks NM	3.3
César E. Chávez NM	4.2
Chamizal N MEM	3.3
Chattahoochee River NRA	7.4
Chickamauga & Chattanooga NMP	7.4
Chaco Culture NHP	2.7
Chickasaw NRA	6.1
Chiricahua NM	3.5
Channel Islands NP	4.5

Table E. Estimated Visibility Natural Conditions for NPS units

Park Name	Estimated Visibility Natural Condition on Mid-Range Days
Chesapeake & Ohio Canal NHP	7.4
Charles Pinckney NHS	8.3
Christiansted NHS	6.7
Little Rock Central High School NHS	7.2
Charles Young Buffalo Soldiers NM	7.4
City Of Rocks N RES	3.4
Clara Barton NHS	7.9
Constitution Gardens	7.9
Colorado NM	2.7
Colonial NHP	7.5
Congaree NP	7.7
Coronado N MEM	3.9
Cowpens NB	7.1
Crater Lake NP	2.7
Craters Of The Moon NM & PRES	3.8
Cumberland Gap NHP	7.3
Cumberland Island NS	7.7
Curecanti NRA	2.5
Cuyahoga Valley NP	7.5
Dayton Aviation Heritage NHP	7.4
Denali NP & PRES	3.2
Devils Postpile NM	3.5
De Soto N MEM	7.6
Devils Tower NM	3.9
Death Valley NP	4.2
Delaware Water Gap NRA	7.6
Dinosaur NM	2.5
Dry Tortugas NP	7.3
Ebey's Landing NH RES	5.2
Edgar Allan Poe NHS	7.8
Thomas Edison NHP	8.3
Effigy Mounds NM	7.1
Eisenhower NHS	7.4
El Malpais NM	3.0
El Morro NM	3.0
Eleanor Roosevelt NHS	6.9
Eugene O'Neill NHS	6.6
Everglades NP	7.1
Federal Hall N MEM	8.4

Table E. Estimated Visibility Natural Conditions for NPS units

Park Name	Estimated Visibility Natural Condition on Mid-Range Days
Fire Island NS	7.8
First Ladies NHS	7.5
Florissant Fossil Beds NM	2.5
Flight 93 N MEM	7.4
Fort Bowie NHS	3.5
Fossil Butte NM	2.7
Fort Caroline N MEM	7.7
Fort Davis NHS	3.4
Fort Donelson NB	7.5
Fort Frederica NM	7.7
Fort Laramie NHS	3.2
Fort Larned NHS	5.4
Fort Matanzas NM	7.7
Fort McHenry NM & Historic Shrine	7.6
Fort Necessity NB	7.3
Fort Point NHS	8.2
Fort Pulaski NM	7.8
Fort Raleigh NHS	7.6
Fort Scott NHS	7.2
Fort Smith NHS	7.1
Fort Stanwix NM	6.9
Fort Sumter NM	8.3
Ford's Theatre NHS	7.9
Fort Union NM	2.6
Fort Union Trading Post NHS	4.6
Fort Vancouver NHS	5.6
Fort Washington Park	7.8
Franklin Delano Roosevelt Memorial	7.9
Frederick Douglass NHS	7.9
Friendship Hill NHS	7.2
Frederick Law Olmsted NHS	7.6
Fredericksburg & Spotsylvania NMP	7.1
First State NHP	7.7
Gates Of The Arctic NP & PRES	4.1
Gauley River NRA	7.2
Gateway NRA	8.3
General Grant N MEM	8.4
George Rogers Clark NHP	7.5
Gettysburg NMP	7.4

Table E. Estimated Visibility Natural Conditions for NPS units

Park Name	Estimated Visibility Natural Condition on Mid-Range Days
George Washington Birthplace NM	7.5
Gila Cliff Dwellings NM	2.6
Glacier NP	4.5
Glen Canyon NRA	3.1
Golden Gate NRA	8.2
Governors Island NM	8.4
Golden Spike NHS	3.2
Great Basin NP	2.9
Grand Canyon NP	2.9
Greenbelt Park	7.8
Grant-Kohrs Ranch NHS	3.2
Grand Portage NM	6.8
Great Sand Dunes NP & PRES	3.0
Great Smoky Mountains NP	7.5
Great Smoky Mountains NP	7.5
Grand Teton NP	2.5
Guilford Courthouse NMP	7.3
Gulf Islands NS	7.5
Guadalupe Mountains NP	3.1
George Washington Carver NM	7.2
George Washington Memorial PKWY	7.8
Harpers Ferry NHP	7.4
Hagerman Fossil Beds NM	3.5
Hamilton Grange N MEM	8.4
Haleakala NP	1.8
Hampton NHS	7.6
Hawaii Volcanoes NP	4.5
Herbert Hoover NHS	7.5
Horseshoe Bend NMP	7.6
Hopewell Culture NHP	7.4
Home Of Franklin D Roosevelt NHS	6.9
Hopewell Furnace NHS	7.6
Homestead NM of America	7.0
Hot Springs NP	7.2
Hovenweep NM	2.9
Harry S Truman NHS	7.2
Hubbell Trading Post NHS	3.0
Independence NHP	7.8
Indiana Dunes NL	7.4

Table E. Estimated Visibility Natural Conditions for NPS units

Park Name	Estimated Visibility Natural Condition on Mid-Range Days
Isle Royale NP	6.6
James A Garfield NHS	7.5
Jewel Cave NM	3.7
Jefferson National Expansion Memorial	7.5
Jean Lafitte NHP & PRES	7.5
Jimmy Carter NHS	7.5
John Day Fossil Beds NM	4.6
John D Rockefeller Jr Memorial PKWY	2.7
John F Kennedy NHS	7.5
Johnstown Flood N MEM	7.4
John Muir NHS	7.2
Joshua Tree NP	4.0
Katmai NP & PRES	5.5
Kenai Fjords NP	5.5
Kennesaw Mountain NBP	7.4
Keweenaw NHP	6.7
Kings Mountain NMP	7.2
Klondike Gold Rush NHP	5.1
Knife River Indian Villages NHS	4.6
Korean War Veterans Memorial	7.9
Lava Beds NM	3.8
Lake Chelan NRA	4.1
Lake Clark NP & PRES	5.5
Lake Mead NRA	3.7
Lake Meredith NRA	4.2
Lake Roosevelt NRA	4.8
Lassen Volcanic NP	3.5
Lewis and Clark NHP	5.0
Little Bighorn Battlefield NM	3.4
Lincoln Boyhood N MEM	7.5
Lincoln Home NHS	7.5
Lincoln Memorial	7.9
Little River Canyon N PRES	7.5
Longfellow NHS	7.5
Lowell NHP	7.2
Lyndon Baines Johnson Memorial Grove N MEM	7.9
Lyndon B Johnson NHP	5.1
Marsh - Billings - Rockefeller NHP	6.5
Mammoth Cave NP	7.5

Table E. Estimated Visibility Natural Conditions for NPS units

Park Name	Estimated Visibility Natural Condition on Mid-Range Days
Martin Luther King Jr NHS	7.4
Mary McLeod Bethune Council House NHS	7.9
Manassas NBP	7.6
Manzanar NHS	4.3
Martin Van Buren NHS	6.7
Maggie L Walker NHS	7.3
Mesa Verde NP	2.8
Minidoka NHS	3.5
Minute Man NHP	7.3
Minuteman Missile NHS	4.7
Mississippi NRRA	7.0
Martin Luther King, Jr. Memorial	7.9
Missouri NRR	6.5
Montezuma Castle NM	3.6
Moores Creek NB	7.6
Mojave N PRES	4.0
Monocacy NB	7.5
Mount Rainier NP	5.3
Morristown NHP	8.1
Mount Rushmore N MEM	3.8
Muir Woods NM	8.8
Natural Bridges NM	3.0
National Mall & Memorial Parks	7.9
National Mall	7.9
Natchez NHP	7.4
Natchez Trace PKWY	7.5
Navajo NM	3.2
New Bedford Whaling NHP	8.5
Nez Perce NHP	4.1
New River Gorge NR	7.2
Nicodemus NHS	5.2
Niobrara NSR	5.0
Ninety Six NHS	7.3
North Cascades NP	4.1
National World War II Memorial	7.9
Obed WSR	7.4
Ocmulgee NM	7.5
Olympic NP	5.1
Oregon Caves NM & PRES	5.6

Table E. Estimated Visibility Natural Conditions for NPS units

Park Name	Estimated Visibility Natural Condition on Mid-Range Days
Organ Pipe Cactus NM	4.5
Ozark NSRs	7.4
Palo Alto Battlefield NHP	5.2
Pennsylvania Avenue NHS	7.9
Padre Island NS	5.2
Grand Canyon-Parashant NM	3.6
Pecos NHP	2.8
Petrified Forest NP	2.9
Pea Ridge NMP	7.2
Petersburg NB	7.4
Petroglyph NM	2.8
Perry's Victory & International Peace Memorial	7.4
Hohokam Pima NM	4.3
Pinnacles NP	5.4
Pipestone NM	7.1
Pictured Rocks NL	6.6
Piscataway Park	7.8
Pipe Spring NM	3.5
Port Chicago Naval Magazine N MEM	6.8
Poverty Point NM	7.5
Point Reyes NS	9.7
Prince William Forest Park	7.6
Pullman NM	7.4
Rainbow Bridge NM	3.2
Redwood NSP	7.6
Richmond NBP	7.3
Rio Grande WSR	3.6
River Raisin NB	7.4
Rock Creek Park	7.9
Ross Lake NRA	4.1
Rocky Mountain NP	2.9
Rosie the Riveter WWII Home Front NHP	8.0
Roger Williams N MEM	7.8
Russell Cave NM	7.5
San Antonio Missions NHP	5.1
Saint Croix NSR	6.9
Saint Croix Island IHS	7.6
San Francisco Maritime NHP	8.0
Saint-Gaudens NHS	6.5

Table E. Estimated Visibility Natural Conditions for NPS units

Park Name	Estimated Visibility Natural Condition on Mid-Range Days
Saguaro NP	3.8
Sagamore Hill NHS	8.1
Saugus Iron Works NHS	7.5
San Juan Island NHP	5.1
San Juan NHS	
Salem Maritime NHS	7.6
Santa Monica Mountains NRA	4.0
Sand Creek Massacre NHS	3.4
Saint Paul's Church NHS	8.4
Salinas Pueblo Missions NM	3.3
Saratoga NHP	6.1
Salt River Bay NHP & Ecological PRES	6.7
Scotts Bluff NM	3.6
Sequoia & Kings Canyon NPs	5.1
Shenandoah NP	6.5
Shiloh NMP	7.5
Sleeping Bear Dunes NL	6.8
Springfield Armory NHS	6.7
Steamtown NHS	7.3
Statue Of Liberty NM	8.4
Stones River NB	7.5
Sunset Crater Volcano NM	3.3
Tallgrass Prairie N PRES	6.9
Theodore Roosevelt Island Park	7.9
Thomas Jefferson Memorial	7.9
Thaddeus Kosciuszko N MEM	7.8
Theodore Roosevelt Birthplace NHS	8.4
Theodore Roosevelt Inaugural NHS	7.4
Theodore Roosevelt NP	4.7
Thomas Stone NHS	7.7
Timpanogos Cave NM	3.0
Timucuan Ecological & Historic PRES	7.7
Tonto NM	3.7
Tuskegee Airmen NHS	7.6
Tuskegee Institute NHS	7.6
Tumacácori NHP	3.9
Tupelo NB	7.5
Tule Springs Fossil Beds NM	3.9
Tuzigoot NM	3.4

Table E. Estimated Visibility Natural Conditions for NPS units

Park Name	Estimated Visibility Natural Condition on Mid-Range Days
Ulysses S Grant NHS	7.4
Upper Delaware SRR	7.3
Valley Forge NHP	7.6
Valles Caldera N PRES	2.6
World War II Valor in the Pacific NM	3.8
Vanderbilt Mansion NHS	6.9
Vicksburg NMP	7.5
Virgin Islands NP	6.7
Vietnam Veterans Memorial	7.9
Voyageurs NP	7.1
Washita Battlefield NHS	5.1
Walnut Canyon NM	3.3
Washington Monument	7.9
Weir Farm NHS	7.5
President's Park (White House)	7.9
Whiskeytown NRA	3.8
Whitman Mission NHS	4.5
White Sands NM	3.2
Wind Cave NP	3.7
President William Jefferson Clinton Birthplace Home NHS	7.2
Wilson's Creek NB	7.2
William Howard Taft NHS	7.5
Women's Rights NHP	7.1
Wolf Trap NP for the Performing Arts	7.8
Wright Brothers N MEM	7.6
Wupatki NM	3.3
Yellowstone NP	2.5
Yosemite NP	3.9
Yucca House NM	2.8
Zion NP	3.8

Appendix F: Nitrogen and Sulfur Deposition Status Adjustments

Park status is adjusted based on results from national assessment reports that identified ecosystems and resources at risk to acidification and excess nitrogen enrichment in national parks. These reports provide a relative risk assessment of acidification and nutrient enrichment impacts from atmospheric nitrogen and sulfur deposition for parks in 32 inventory & monitoring networks.

Ecosystem sensitivity ratings to acidification from atmospheric deposition were based on percent sensitive vegetation types, number of high-elevation lakes, length of low- order streams, length of high-elevation streams, average slope, and acid-sensitive areas within the park (Sullivan et al. 2011a). Ecosystem sensitivity ratings to nutrient enrichment effects were based on percent sensitive vegetation types and number of high-elevation lakes within the park (Sullivan et al. 2011b). If park ecosystems are ranked "Very High" in sensitivity to acidification or nutrient enrichment effects from atmospheric deposition relative to all inventory & monitoring parks, the condition category is adjusted to the next worse condition category. This adjustment does not apply to parks that already have a "Warrants Significant Concern" status solely based on wet deposition levels in the park.

Table F. NPS units with very high ecosystem sensitivity ranking for acidification or nutrient enrichment impacts

Park Name	Acidification	Nutrient Enrichment
Acadia NP	X	
Agate Fossil Beds NM		X
Allegheny Portage Railroad NHS	X	
Antietam NB	X	
Apostle Islands NL	X	
Arches NP		X
Big Bend NP		X
Big Cypress N PRES		X
Big South Fork NRRA	X	
Blue Ridge PKWY	X	
Bluestone NSR	X	
Buffalo NR	X	
Cabrillo NM		X
Canyonlands NP		X
Carl Sandburg Home NHS	X	
Carlsbad Caverns NP	X	X
Casa Grande Ruins NM		X

Table F. NPS units with very high ecosystem sensitivity ranking for acidification or nutrient enrichment impacts

Park Name	Acidification	Nutrient Enrichment
Catoctin Mountain Park	X	
Chaco Culture NHP		X
Chesapeake & Ohio Canal NHP	X	
Chickamauga & Chattanooga NMP	X	
Congaree NP		X
Coronado N MEM		X
Crater Lake NP	X	
Cumberland Gap NHP	X	
Curecanti NRA	X	X
Death Valley NP	X	X
Delaware Water Gap NRA	X	
Denali NP & PRES	X	
Dinosaur NM		X
Fort Davis NHS		X
Fort Necessity NB	X	
Fort Pulaski NM		X
Fort Union NM		X
Fossil Butte NM		X
Gates Of The Arctic NP & PRES	X	
Gauley River NRA	X	
Gila Cliff Dwellings NM		X
Glacier NP	X	
Golden Spike NHS		X
Grand Canyon NP	X	X
Grand Teton NP	X	X
Great Basin NP	X	
Great Sand Dunes NP & PRES	X	X
Great Smoky Mountains NP	X	
Guadalupe Mountains NP		X
Hagerman Fossil Beds NM		X
Haleakala NP	X	
Harpers Ferry NHP	X	

Table F. NPS units with very high ecosystem sensitivity ranking for acidification or nutrient enrichment impacts

Park Name	Acidification	Nutrient Enrichment
Hovenweep NM		X
John Day Fossil Beds NM		X
Johnstown Flood N MEM	X	
Joshua Tree NP		X
Katmai NP & PRES	X	
Lake Clark NP & PRES	X	
Lake Mead NRA		X
Lassen Volcanic NP	X	
Lava Beds NM		X
Little Bighorn Battlefield NM		X
Little River Canyon N PRES	X	
Manzanar NHS		X
Marsh - Billings - Rockefeller NHP	X	
Mojave N PRES		X
Montezuma Castle NM		X
Morristown NHP	X	
Mount Rainier NP	X	X
New River Gorge NR	X	
North Cascades NP	X	X
Obed WSR	X	
Olympic NP	X	X
Organ Pipe Cactus NM		X
Pecos NHP		X
Petrified Forest NP		X
Petroglyph NM		X
Pictured Rocks NL	X	
Rocky Mountain NP	X	X
Saguaro NP		X
Saint Croix NSR	X	X
Saint-Gaudens NHS	X	
Salinas Pueblo Missions NM		X
Scotts Bluff NM		X

Table F. NPS units with very high ecosystem sensitivity ranking for acidification or nutrient enrichment impacts

Park Name	Acidification	Nutrient Enrichment
Sequoia & Kings Canyon NPs	X	X
Shenandoah NP	X	
Tallgrass Prairie N PRES		X
Tonto NM		X
Upper Delaware SRR	X	
Voyageurs NP	X	
Washita Battlefield NHS		X
Wind Cave NP	X	X
Yellowstone NP	X	X
Yosemite NP	X	X

Appendix G: Mercury/Toxics Deposition Status Adjustments

The presence of in-park data on either mercury or toxics in food webs may influence the overall rating for toxics/mercury condition, particularly if the mercury risk assessment value is not available. An assessment of previous and current studies and availability of fish consumption guidelines serve as the basis for adjusting mercury status. Data on biota must be credible and available within a minimum of three biotic compartments (e.g., fish, songbirds, dragonfly larvae), with an ideal sample size of N=15 or more per compartment and multiple sampling sites (N>3 per 1000 square miles). Levels in biota must be compared relative to health thresholds or other NPS units.

Table G: NPS units with status and/or confidence adjustments for mercury/toxics deposition

Park Name
Acadia NP
Apostle Islands NL
Big Bend NP
Big Cypress N PRES
Cape Cod NS
Channel Islands NP
Chickasaw NRA
Congaree NP
Denali NP & PRES
Everglades NP
Gates Of The Arctic NP & PRES
Glacier Bay NP & PRES
Grand Portage NM
Guadalupe Mountains NP
Isle Royale NP
Katmai NP & PRES
Knife River Indian Villages NHS
Lake Clark NP & PRES
Mammoth Cave NP
Marsh - Billings - Rockefeller NHP
Mesa Verde NP
Mississippi NRRA
Mount Rainier NP
Noatak N PRES
Olympic NP
Pictured Rocks NL
Saint Croix NSR
Saint-Gaudens NHS
Sleeping Bear Dunes NL
Voyageurs NP
Wrangell - St Elias NP & PRES
Yellowstone NP

Appendix H: Overall Air Quality Status Adjustments

Where a NPS unit falls within a area designated by the EPA as "nonattainment" (not meeting) for the ground-level 2008 ozone primary standards of an 8-hour average concentration of 75 ppb, the overall air quality condition is automatically placed in the *Warrants Significant Concern* category. See Appendix C for a list of NPS units in ozone nonattainment areas.

The overall air quality condition category is also adjusted to the *Warrants Significant Concern* category when an NPS unit falls within an EPA designated nonattainment area for fine ($PM_{2.5}$) or coarse (PM_{10}) particulate matter standards (see table for standard levels).

Particulate Matter Primary Standard	***Concentration Level[1]***
1997 PM2.5 Annual Average	15
2006 PM2.5 24-Hour Average	35
1997 PM10 24-Hour Average	150
[1] Particulate matter concentrations are expressed in micrograms per cubic meter ($\mu g/m^3$).	

Table H. NPS units in EPA designated fine or coarse particulate matter nonattainment areas.

Park Name	1997 $PM_{2.5}$ Annual Average	2006 $PM_{2.5}$ 24-Hour Average	1997 PM_{10} 24-Hour Average
African Burial Ground NM	X	X	X
Allegheny Portage Railroad NHS	X	X	
Antietam NB	X		
Appalachian NST	X	X	
Arlington House, The Robert E. Lee N MEM	X		
Carter G. Woodson Home NHS	X		
Casa Grande Ruins NM			X
Castle Clinton NM	X	X	X
Catoctin Mountain Park	X		
César E. Chávez NM			X
Chamizal N MEM			X
Charles Young Buffalo Soldiers NM	X		
Chattahoochee River NRA	X		

Table H. NPS units in EPA designated fine or coarse particulate matter nonattainment areas.

Park Name	1997 $PM_{2.5}$ Annual Average	2006 $PM_{2.5}$ 24-Hour Average	1997 PM_{10} 24-Hour Average
Chesapeake & Ohio Canal NHP	X		
Chickamauga & Chattanooga NMP	X		
Clara Barton NHS	X		
Constitution Gardens	X		
Cuyahoga Valley NP	X	X	X
Dayton Aviation Heritage NHP	X		
Death Valley NP			X
Delaware Water Gap NRA		X	
Devils Postpile NM	X	X	X
Edgar Allan Poe NHS	X	X	
Eugene O'Neill NHS		X	
Federal Hall N MEM	X	X	X
Fire Island NS	X	X	
First Ladies NHS	X	X	
First State NHP	X	X	
Ford's Theatre NHS	X		
Fort McHenry NM & Historic Shrine	X		
Fort Point NHS		X	
Fort Washington Park	X		
Franklin Delano Roosevelt Memorial	X		
Frederick Douglass NHS	X		
Gateway NRA	X	X	
General Grant N MEM	X	X	X
George Washington Memorial PKWY	X		
Golden Gate NRA		X	
Golden Spike NHS		X	
Governors Island NM	X	X	X
Great Smoky Mountains NP	X	X	
Greenbelt Park	X		
Guilford Courthouse NMP	X		
Hamilton Grange N MEM	X	X	X
Hampton NHS	X		
Harpers Ferry NHP	X		
Hopewell Furnace NHS	X	X	
Independence NHP	X	X	

Table H. NPS units in EPA designated fine or coarse particulate matter nonattainment areas.

Park Name	1997 $PM_{2.5}$ Annual Average	2006 $PM_{2.5}$ 24-Hour Average	1997 PM_{10} 24-Hour Average
Indiana Dunes NL	X		X
James A Garfield NHS	X	X	
Jefferson National Expansion Memorial	X		
John Muir NHS		X	
Johnstown Flood N MEM	X	X	
Joshua Tree NP			X
Kennesaw Mountain NBP	X		
Korean War Veterans Memorial	X		
Lake Mead NRA			X
Lincoln Memorial	X		
Lyndon Baines Johnson Memorial Grove N MEM	X		
Manassas NBP	X		
Manzanar NHS			X
Martin Luther King Jr NHS	X		
Martin Luther King, Jr. Memorial	X		
Mary McLeod Bethune Council House NHS	X		
Mississippi NRRA			X
Mojave N PRES			X
Monocacy NB	X		
Morristown NHP	X	X	
Muir Woods NM		X	
National Mall	X		
National Mall & Memorial Parks	X		
Ocmulgee NM	X		
Pennsylvania Avenue NHS	X		
Piscataway Park	X		
Point Reyes NS		X	
Port Chicago Naval Magazine N MEM		X	
President's Park (White House)	X		
Prince William Forest Park	X		
River Raisin NB	X	X	
Rock Creek Park	X		
Rosie the Riveter WWII Home Front NHP		X	

Table H. NPS units in EPA designated fine or coarse particulate matter nonattainment areas.

Park Name	1997 $PM_{2.5}$ Annual Average	2006 $PM_{2.5}$ 24-Hour Average	1997 PM_{10} 24-Hour Average
Sagamore Hill NHS	X	X	
Saguaro NP			X
Saint Paul's Church NHS	X	X	
San Francisco Maritime NHP		X	
Santa Monica Mountains NRA	X	X	X
Sequoia & Kings Canyon NPs	X	X	X
Statue Of Liberty NM	X	X	X
Thaddeus Kosciuszko N MEM	X	X	
Theodore Roosevelt Birthplace NHS	X	X	X
Theodore Roosevelt Island Park	X		
Thomas Edison NHP	X	X	
Thomas Stone NHS	X		
Timpanogos Cave NM		X	X
Tule Springs Fossil Beds NM			X
Tumacácori NHP		X	X
Ulysses S Grant NHS	X		
Upper Delaware SRR	X	X	
Valley Forge NHP	X	X	
Vietnam Veterans Memorial	X		
Weir Farm NHS	X	X	
William Howard Taft NHS	X		
Wolf Trap NP for the Performing Arts	X		
Yosemite NP	X	X	X

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