National Park Service
U.S. Department of the Interior

Natural Resource Program Center

# Annual Data Summary 2007

## *Gaseous Pollutant Monitoring Program Ozone, Sulfur Dioxide, Particulate Matter, Meteorological Observations*

Natural Resource Report NPS/NRPC/ARD/NRR—2008/065

**ON THE COVER**
Arches National Park, Utah
Courthouse Towers
Photograph by Debbie Miller/NPS

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## *Gaseous Pollutant Monitoring Program Ozone, Sulfur Dioxide, Particulate Matter, Meteorological Observations*

Natural Resource Report NPS/NRPC/ARD/NRR—2008/065

John D. Ray, Ph.D.
National Park Service Air Resources Division, Gaseous Pollutant Monitoring Program
P.O. Box 25287
Denver, CO 80225

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U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Denver, Colorado

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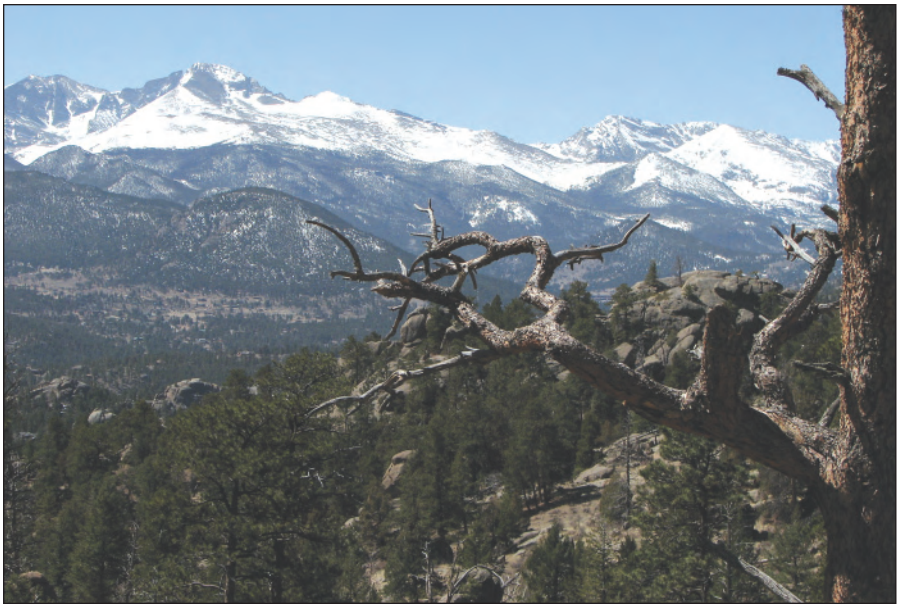
**Rocky Mountain National Park, Colorado**
**Longs Peak**
**Photo by Jessica Ward/ Air Resource Specialists, Inc.**



# Foreword

Air quality and meteorological data from National Park Service (NPS) monitoring sites for 2007 has been fully validated and made available to the Environmental Protection Agency (EPA), the parks, and the public. This report provides summary tables and graphics to help understand how the measured pollutant concentrations compare to National Ambient Air Quality Standards and to concentrations measured in previous years. Additional tables and graphs can be viewed and hourly data retrieved from the NPS Air Resources Division (ARD) Web site (*http://www.nature.nps.gov/air/monitoring/index.cfm/*).

### Report Changes in 2007

EPA proposed a new ozone standard in 2007 and promulgated a new standard on March 12, 2008 of 75 ppb. A section of this report has been devoted to a summary on parks that could possibly be affected by this lower, more protective standard. Under the new standard, many parks will likely be in non-attainment and fall under the State Implementation Plans for improving air quality. Park visitors should consider the possibility of adverse health effects due to poor air quality, especially if they are sensitive to respiratory stresses. More parks should consider issuing ozone advisories to alert visitors when high concentrations are present. Review the tables and summaries in this report to determine where your park stands in the ozone rankings.

### Proposed Monitoring Strategy

The ARD has looked at anticipated budgets for five years into the future and has started to adjust programs accordingly. Monitoring plans have been formulated around a new proposed monitoring strategy and updated objectives. Some monitoring will be eliminated, some types of monitoring will be expanded, new parameters will be added, and new tools will be applied to gathering data.

### Portable Ozone Monitoring Systems

The portable ozone monitoring systems (POMS) continue to be used and the program expanded. The self-contained ozone monitoring systems can be placed in a wide variety of locations because they use solar power and satellite data communications along with a small, low-power ozone analyzer. The NPS Inventory and Monitoring program is beginning to use more POMS to fill in baseline data at park locations that previously have not had air quality monitoring.

### Highlights in 2007

During 2007, 13 sites in or near 10 park units exceeded the 8-hour ozone standard, as indicated in the table below. An exceedance occurs when an 8-hour average ozone concentration is equal to or greater than 85 ppb. Five parks violated the ozone standard based on the 3-year averages. Thirteen monitors had one or more exceedances of the ozone standard during the year. Sequoia-Kings Canyon and Joshua Tree continue to have the most ozone exceedances. Of the parks that monitor sulfur dioxide, only Hawaii Volcanoes violated the sulfur dioxide standard. This is a result of toxic gas venting from Kilauea volcano rather than from anthropogenic sources.

| Park/Site | 4th Highest Daily Maximum 8-Hour Avg. $O_3$ Concentration (ppb) | Number of Exceedances |
|---|---|---|
| Acadia - Cadillac Mountain | 86 | 5 |
| Cuyahoga Valley | 90 | 9 |
| Death Valley | 85 | 6 |
| Great Smoky Mountains: | | |
| Clingmans Dome | 87 | 9 |
| Cove Mountain | 88 | 5 |
| Look Rock | 88 | 11 |
| Guilford Courthouse | 86 | 4 |
| Indiana Dunes - Ammunition Bunker | 85 | 4 |
| Joshua Tree - Black Rock | 104 | 40 |
| Saugus Iron Works | 88 | 4 |
| Sequoia and Kings Canyon: | | |
| Ash Mountain | 99 | 44 |
| Lower Kaweah | 91 | 25 |
| Yosemite - Turtleback Dome | 88 | 8 |

**Network Quality Assurance**

Overall data capture for NPS ozone monitoring continues to be high (94%) and exceeds NPS objectives and EPA requirements. The EPA accepts data from the NPS ARD as high quality and uses them to determine park areas that are in violation of the standards and in non-attainment. NPS data are used in peer-reviewed publications and in several government agency reports, and are submitted to the EPA Air Quality System (AQS) database (*http://www.epa.gov/air/data/*) and to AIRNow for presentation daily on the Web (*http://airnow.gov*).

The Gaseous Pollutant Monitoring Program (GPMP) acknowledges and thanks all the park employees who perform the station checks and keep everything operating smoothly. Air quality monitoring would not be possible without your help. Thank you for a job well done.

Dr. John D. Ray

GPMP Program Manager
NPS Air Resources Division
303-969-2820
john_d_ray@nps.gov

**Great Smoky Mountains National Park, North Carolina/Tennessee Purchase Knob Photo by Joe Adlhoch/ Air Resource Specialists, Inc.**

# Introduction

The National Park Service Air Resources Division (NPS ARD) is responsible for providing policy and technical support to national parks on air quality issues. NPS ARD has established monitoring networks for gaseous pollutants, wet and dry deposition, and visibility. This 2007 annual data summary report summarizes data from the ozone monitoring network. Dry deposition data are summarized by the Clean Air Status and Trends Network (CASTNet); wet deposition by the National Atmospheric Deposition Program (NADP); and visibility by the Interagency Monitoring of Visual Environments (IMPROVE) program.

**Air Resources Division**
**Air Quality Monitoring Objectives**

- Provide data to make pollutant risk assessments of adverse effects to natural resources (Air Quality Related Values)
- Provide data related to National Ambient Air Quality Standards (NAAQS) and New Source Review
- Determine trends that assist in compliance predictions, policy objectives, and regional assessments
- Provide specific answers from special studies that assist modeling, regional pollution transport issues, State Implementation Plan (SIP) development, and national control strategies
- Provide timely information to the public and researchers to assess current conditions in parks

The overall purpose of the National Park Service Gaseous Pollutant Monitoring Program (GPMP) is to monitor the status and trends of ambient air quality conditions in national park units. This purpose is outlined by the Clean Air Act of 1977 (and 1990 amendments) and the Organic Act of 1916, which assign the federal land managers the responsibility of protecting the natural resources in national parks. Several monitoring objectives have been derived from this purpose.

The NPS monitoring objectives call for the collection of data to support the National Park Service's involvement in both the development of state air quality control plans, and the evaluation of permit applications for new or expanding air pollution sources wishing to locate near park units. The Clean Air Act gives federal land managers an affirmative responsibility to protect air quality related values in Class I areas and to assess whether new sources will have an adverse impact on park resources and values. Information on air quality in NPS units can also be used to evaluate the performance of atmospheric models that simulate transport and impacts of pollutants.

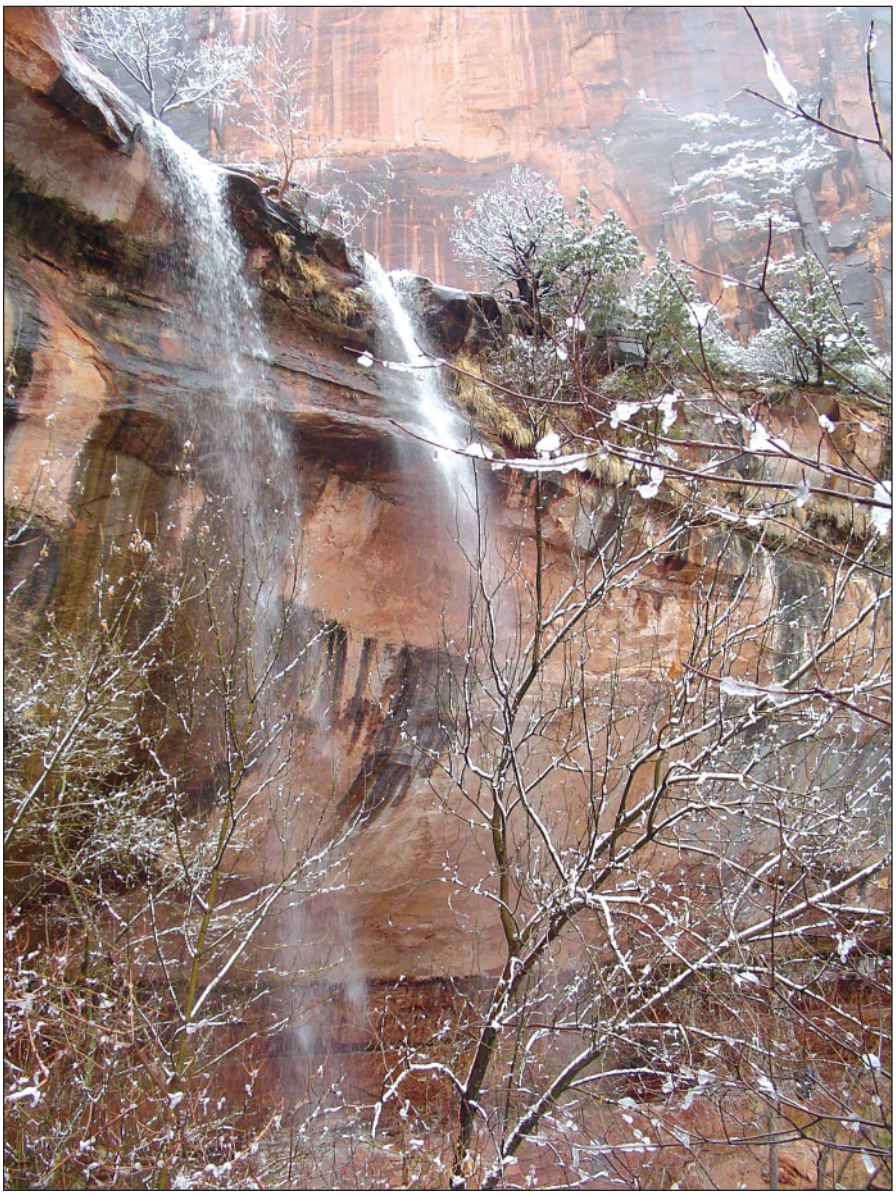
To meet these objectives the NPS ARD has established an air quality monitoring program. This data summary report presents only ozone ($O_3$), sulfur dioxide ($SO_2$), particulate matter (PM), and meteorological data from continuous monitors that report hourly data. Other gas, particulate, and precipitation monitoring are performed under the visibility and deposition programs and are reported separately.

Ozone, meteorological, and some $SO_2$ monitoring methods and quality assurance procedures adopted by the GPMP network were developed in accordance with the EPA regulations of 40 CFR, Part 58, Appendix D. These regulations, although addressing primarily health-effects based monitoring in areas of high population, are generally pertinent to the GPMP. These design criteria allow for the direct comparison of data collected by the NPS with that collected by the EPA, and state and local air pollution control agencies. As a supplement to the basic network, the ARD also conducts short-term air quality monitoring including portable ozone and special studies monitoring in selected parks. In addition,

the ARD cooperates with other national and state programs that monitor ambient gases, meteorology, deposition chemistry, particulate matter, and visibility.

Data collected by this network are incorporated in the EPA Air Quality System (AQS) database, which is a national database of air quality data collected throughout the country. These data are also stored in the NPS ARD's Information Management Center (IMC), and are publicly available through the NPS ARD's Web site at *http://www.nature.nps.gov/air/Monitoring/network.cfm#data.*

**Zion National Park, Utah**
**Waterfalls**
**Photo by Joe Adlhoch/**
**Air Resource Specialists, Inc.**



# Network Description

*The POMS are intended for short-term seasonal use at locations where reference method monitoring has not occurred or is not practical.*

The NPS air quality monitoring strategy has focused primarily on Class I areas defined by the Clean Air Act Amendments of 1977. The GPMP network consists of individual stations located in park units throughout the United States. The NPS also participates with other agencies in cooperative monitoring programs. This section describes the GPMP network and cooperating programs.

**GPMP Network Monitoring**

During 2007, 84 monitoring sites in 61 units of the National Park System conducted some combination of ozone, sulfur dioxide, particulate matter, and meteorological monitoring. Of these, the NPS ARD supported 47 monitoring sites in 39 units. The locations of the sites that operated during the year are presented on the map in Figure 1. The parameters monitored at each park unit are indicated with colored flags. The CASTNet flag identifies sites where the NPS operates Clean Air Status and Trends Network monitoring systems in cooperation with EPA to estimate dry atmospheric deposition. The enhanced gaseous and/or particulates flag indicates that the NPS sponsors additional or high-resolution gaseous or particulate monitoring at the park. Monitoring agencies and park units with more than one monitoring site are indicated. Site specifications, including site names, abbreviations, AQS identification numbers, locations, and monitored parameters are listed in Table 1.

In addition to monitoring for regulatory compliance, the NPS added non-certified portable ozone monitoring systems (POMS) to the GPMP in 2003. These sites employ portable ozone analyzers and meteorological sensors, generally configured for solar and battery power. The POMS monitors have been extensively tested and compared to other NPS monitoring equipment. The data are equivalent to the certified monitors and can be used for survey monitoring to obtain air quality baseline information. Throughout this report, POMS site names in tables and figures have been underlined to distinguish them from monitoring sites meeting all EPA guidelines.

**Cooperating Programs**

Data from cooperating programs are reported by those programs and are not included in this report. The exception to that is ozone, sulfur dioxide, particulate matter, and meteorology collected in NPS units by state agencies which supplement the data collected by the GPMP.

*State Programs*

The NPS cooperates with a number of state agencies. At some sites, state air quality agencies provide measurement and operations support, and data are generally shared directly among cooperating agencies. Relevant $O_3$, $SO_2$, PM, and meteorological data submitted by states to the EPA AQS are retrieved for inclusion in this report.

There are also numerous sites near park units operated by state or other agencies, independent of the NPS. Data from these sites are also retrieved from the EPA AQS for inclusion in this report, but are presented separately from data collected by state sites in cooperation with the NPS. Throughout this report, state-operated monitoring site names in tables and figures are indicated in italics.

*CASTNet*
Most GPMP stations operate cooperatively with the EPA Clean Air Status and Trends Network (CASTNet). Weekly integrated particulate samples are collected on filter packs at CASTNet sites. The samples are analyzed for ambient atmospheric nitrates, sulfates, ammonium, sulfur dioxide, and nitric acid, and the results are used to estimate atmospheric dry deposition. More information is available at the CASTNet Web site at *http://www.epa.gov/castnet.*

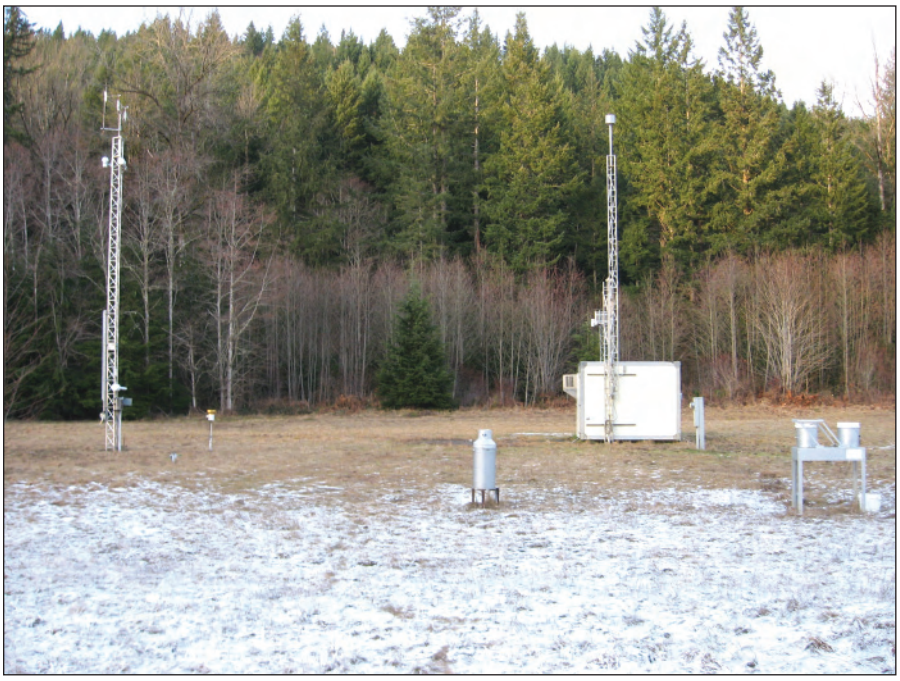
*IMPROVE*
The Interagency Monitoring of Protected Visual Environments (IMPROVE) is a consortium of federal and state agencies which conduct visibility monitoring in Class I areas, including national parks. A number of instruments are used to monitor visibility, including:

- Aerosol samplers, which collect 24-hour integrated particle samples every three days on a series of filter media. Filters are later analyzed for $PM_{2.5}$ and $PM_{10}$ mass, elements, ions, and carbon.
- Transmissometers, which directly measure the atmospheric light extinction over a sight path of several kilometers.
- Nephelometers, which perform point optical measurements of the scattering component of atmospheric light extinction.
- Cameras, which document the appearance of a scene as viewed through the atmosphere, are often collocated with IMPROVE stations. Digital images from many sites are posted to the Internet along with relevant air quality data and other information in near real-time for public viewing.

More information is available at the IMPROVE Web site at *http://vista.cira.colostate.edu/improve.*

*NADP/NTN and NADP/MDN*
The National Atmospheric Deposition Program/National Trends Network (NADP/NTN) includes wet deposition monitoring at over 250 sites nationwide. The NADP network has been collecting data for over 30 years, and is coordinated from the Program Office at the Illinois State Water Survey in Champaign, Illinois. Data for all major ions are available in concentrations (mg/L) and depositions expressed by kilograms/hectare (kg/ha). The National Atmospheric Deposition Program/Mercury Deposition Network (NADP/MDN) includes wet mercury deposition monitoring at over 90 sites nationwide. NADP sites are often collocated with the GPMP air quality monitoring stations. Data from these networks are not presented in this report. More information about both of these programs is available at the NADP Web site at *http://nadp.sws.uiuc.edu/.*

**Mount Rainier National Park, Washington**
**Air Quality Monitoring Station**
**Photo by Mike Slate/**
**Air Resource Specialists, Inc.**



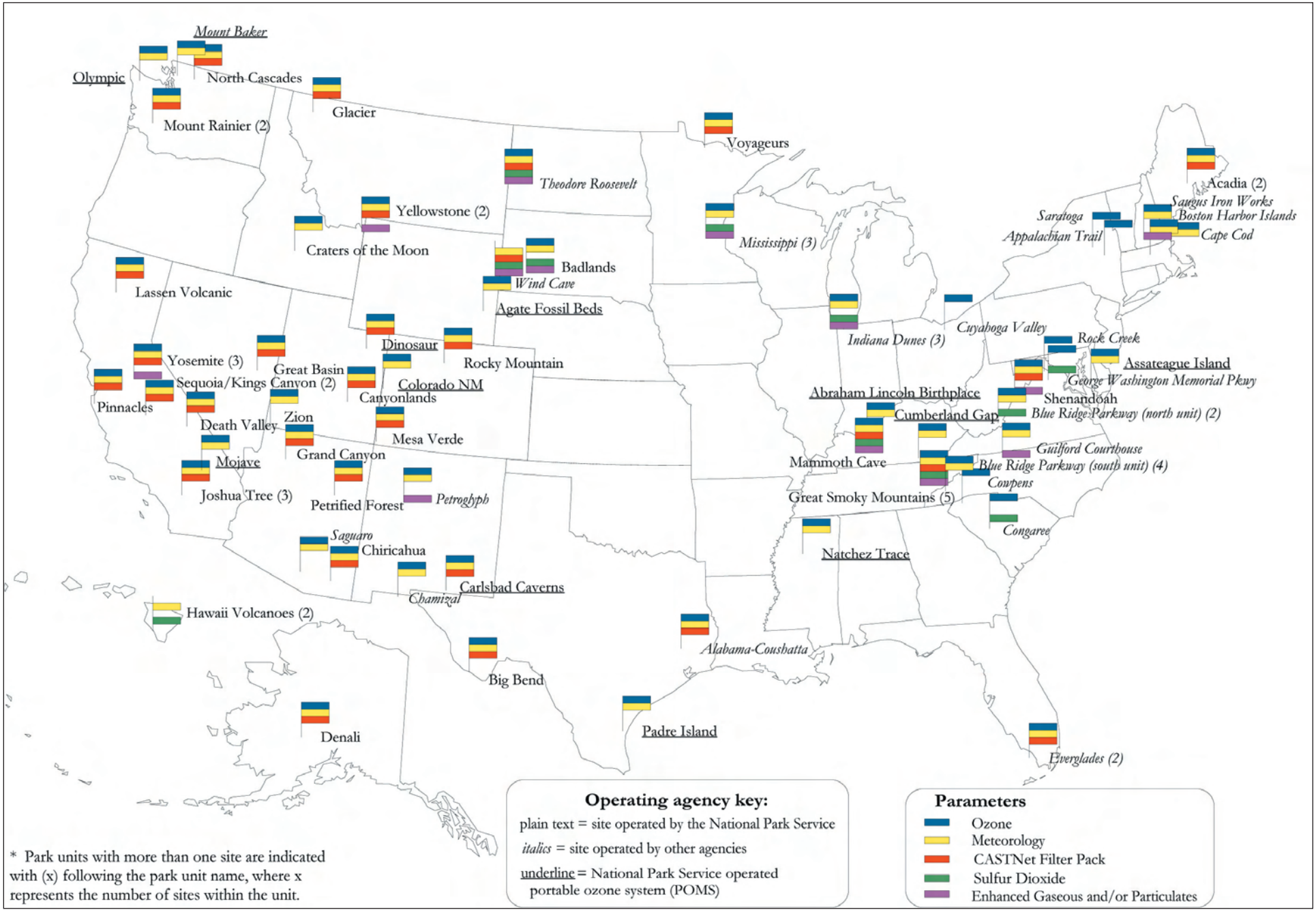



**Figure 1. 2007 Air quality monitoring in or nearby park units.**

**Table 1. 2007 Site specifications.**

| National Park Unit | Site Name | State | NPS Abbr. | CASTNet Abbr. | AQS ID Number | Latitude (degrees west) | Longitude (degrees north) | Elev. (m) | $O_3$ Years[a] | $SO_2$ | WD | WS | TMP | RH | RNF | WET | DTP | SOL | Filter Pack[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sites operated by the National Park Service** | | | | | | | | | | | | | | | | | | | |
| Abraham Lincoln Birthplace | Visitor's Center | KY | ABLI-VC | --- | 21-123-1001 | 37.5314 | 85.7347 | 1212 | 2 | --- | X | X | X | X | X | --- | --- | X | --- |
| Agate Fossil Beds | Residence Area | NE | AGFO-RA | --- | 31-165-1001 | 42.4283 | 103.7294 | 1344 | 1 | --- | X | X | X | X | X | --- | --- | X | --- |
| Assateague Island | Maintenance Area | MD | ASIS-MA | --- | 24-047-1001 | 38.2511 | 75.1594 | 3 | 3 | --- | X | X | X | X | X | --- | --- | X | --- |
| Badlands | Visitor Center | SD | BADL-VC | --- | 46-071-1001 | 43.7436 | 101.9414 | 739 | 11 | X | X | X | X | X | X | --- | --- | X | --- |
| Big Bend | K-Bar Ranch Road | TX | BIBE-KB | BBE401 | 48-043-0101 | 29.3022 | 103.1772 | 1052 | 18 | --- | X | X | X | X | X | X | X | X | X |
| Canyonlands | Island in the Sky | UT | CANY-IS | CAN407 | 49-037-0101 | 38.4586 | 109.8211 | 1809 | 16 | --- | X | X | X | X | X | X | X | X | X |
| Carlsbad Caverns | Maintenance Area | NM | CAVE-MA | --- | 35-015-3001 | 32.1783 | 104.4406 | 1349 | 2 | --- | X | X | X | X | X | --- | --- | X | X |
| Chiricahua | Entrance Station | AZ | CHIR-ES | CHA467 | 04-003-8001 | 32.0092 | 109.3892 | 1570 | 17 | --- | X | X | X | X | X | X | X | X | X |
| Colorado | Maintenance Yard | CO | COLM-MY | --- | 08-077-1001 | 39.1067 | 108.7411 | 1740 | 2 | --- | X | X | X | X | X | --- | --- | X | --- |
| Craters of the Moon | Visitor Center | ID | CRMO-VC | --- | 16-023-0101 | 43.4606 | 113.5622 | 1815 | 16 | --- | X | X | X | X | --- | --- | --- | X | --- |
| Cumberland Gap | Hensley Settlement | KY | CUHA-HS | --- | 21-013-1002 | 36.6719 | 83.5264 | 1013 | 2 | --- | X | X | X | X | X | --- | --- | X | --- |
| Death Valley | Park Village | CA | DEVA-PV | DEV412 | 06-027-0101 | 36.5092 | 116.8481 | 125 | 15 | --- | X | X | X | X | X | X | X | X | X |
| Denali | Headquarters | AK | DENA-HQ | DEN417 | 02-290-0003 | 63.7258 | 148.9633 | 661 | 21 | --- | X | X | X | X | X | X | X | X | X |
| Dinosaur | West Entrance Housing | UT | DINO-WE | --- | 49-047-1002 | 40.4372 | 109.3047 | 1463 | 3 | --- | X | X | X | X | X | --- | --- | X | X |
| Everglades | Beard Center | FL | EVER-BC | EVE419 | 12-086-0030 | 25.3911 | 80.6806 | 2 | --- | --- | X | X | X | X | X | X | X | X | X |
| Glacier | West Glacier Horse Stables | MT | GLAC-WG | GLR468 | 30-029-8001 | 48.5103 | 113.9956 | 976 | 16 | --- | X | X | X | X | X | X | X | X | X |
| Grand Canyon | The Abyss | AZ | GRCA-AS | GRC474 | 04-005-8001 | 36.0597 | 112.1822 | 2073 | 15 | --- | X | X | X | X | X | X | X | X | X |
| Great Basin | Maintenance Yard | NV | GRBA-MY | GRB411 | 32-033-0101 | 39.0053 | 114.2158 | 2060 | 15 | --- | X | X | X | X | X | X | X | X | X |
| Great Smoky Mountains | Clingmans Dome | TN | GRSM-CD | --- | 47-155-0102 | 35.5619 | 83.4981 | 2021 | 15 | --- | X | X | X | X | X | --- | --- | X | --- |
| Great Smoky Mountains | Cove Mountain | TN | GRSM-CM | --- | 47-155-0101 | 35.6967 | 83.6086 | 1243 | 20 | X | X | X | X | X | X | --- | --- | --- | --- |
| Great Smoky Mountains | Look Rock | TN | GRSM-LR | GRS420 | 47-009-0101 | 35.6331 | 83.9422 | 793 | 20 | --- | X | X | X | X | X | X | X | X | X |
| Hawaii Volcanoes | Observatory | HI | HAVO-OB | --- | 15-001-0007 | 19.4203 | 155.2881 | 1123 | --- | X | X | X | X | X | X | --- | --- | --- | --- |
| Hawaii Volcanoes | Visitor Center | HI | HAVO-VC | --- | 15-001-0005 | 19.4308 | 155.2578 | 1215 | --- | X | X | X | X | X | X | --- | --- | X | --- |
| Joshua Tree | Black Rock | CA | JOTR-BR | JOT403 | 06-071-9002 | 34.0714 | 116.3906 | 1244 | 15 | --- | X | X | X | X | X | X | X | X | X |
| Joshua Tree | Cottonwood Canyon | CA | JOTR-CC | --- | 06-065-0008 | 33.7411 | 115.8206 | 984 | 3 | --- | X | X | X | X | X | --- | --- | X | --- |
| Joshua Tree | Pinto Wells | CA | JOTR-PW | --- | 06-065-1004 | 33.9397 | 115.4108 | 326 | 2 | --- | X | X | X | X | X | --- | --- | X | X |
| Lassen Volcanic | Manzanita Lake Fire Station | CA | LAVO-ML | LAV410 | 06-089-3003 | 40.5403 | 121.5764 | 1756 | 21 | --- | X | X | X | X | X | X | X | X | X |
| Mammoth Cave | Houchin Meadow | KY | MACA-HM | MAC426 | 21-061-0501 | 37.1317 | 86.1481 | 243 | 13 | X | X | X | X | X | X | X | X | X | X |
| Mesa Verde | Resource Management Area | CO | MEVE-RM | MEV405 | 08-083-0101 | 37.1983 | 108.4903 | 2165 | 15 | --- | X | X | X | X | X | X | X | X | X |
| Mojave | Kelso Mountains | CA | MOJA-KM | --- | 06-071-1001 | 35.1019 | 115.7767 | 1212 | 1 | --- | X | X | X | X | X | --- | --- | X | --- |
| Mount Rainier | Tahoma Woods | WA | MORA-TW | MOR409 | 53-053-1010 | 46.7583 | 122.1244 | 415 | 17 | --- | X | X | X | X | X | X | X | X | X |

**Table 1. 2007 Site specifications (continued).**

| National Park Unit | Site Name | State | NPS Abbr. | CASTNet Abbr. | AQS ID Number | Latitude (degrees west) | Longitude (degrees north) | Elev. (m) | $O_3$ Years[a] | $SO_2$ | WD | WS | TMP | RH | RNF | WET | DTP | SOL | Filter Pack[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sites operated by the National Park Service** | | | | | | | | | | | | | | | | | | | |
| Natchez Trace Parkway | Dancy Ranger Station | MS | NATR-DR | --- | 28-155-1001 | 33.6636 | 89.0622 | 94 | 2 | --- | X | X | X | X | X | --- | --- | X | --- |
| North Cascades | Marblemount Ranger Stn | WA | NOCA-MM | NCS415 | 53-057-0013 | 48.5397 | 121.4472 | 109 | 12 | --- | X | X | X | X | X | X | X | X | X |
| Olympic | Hurricane Ridge Portable | WA | OLYM-HP | --- | 53-009-1004 | 47.9706 | 123.5028 | 1543 | 4 | --- | X | X | X | X | X | --- | --- | X | --- |
| Padre Island | Malaquite Visitor Center | TX | PAIS-MV | --- | 48-273-1001 | 27.4267 | 97.2983 | 6 | 3 | --- | X | X | X | X | X | --- | --- | X | --- |
| Petrified Forest | South Entrance | AZ | PEFO-SE | PET427 | 04-017-0119 | 34.8225 | 109.8919 | 1723 | 6 | --- | X | X | X | X | X | X | X | X | X |
| Pinnacles | SW of East Entrance Station | CA | PINN-ES | PIN414 | 06-069-0003 | 36.485 | 121.1556 | 335 | 21 | --- | X | X | X | X | X | X | X | X | X |
| Rocky Mountain | Long's Peak | CO | ROMO-LP | ROM406 | 08-069-0007 | 40.2778 | 105.5453 | 2743 | 23 | --- | X | X | X | X | X | X | X | X | X |
| Sequoia and Kings Canyon | Ash Mountain | CA | SEKI-AS | SEK430 | 06-107-0009 | 36.4894 | 118.8269 | 457 | 9 | --- | X | X | X | X | X | X | X | X | X |
| Sequoia and Kings Canyon | Lower Kaweah | CA | SEKI-LK | --- | 06-107-0006 | 36.5658 | 118.7772 | 1890 | 24 | --- | X | X | X | X | X | --- | --- | X | --- |
| Shenandoah | Big Meadows | VA | SHEN-BM | SHN418 | 51-113-0003 | 38.5231 | 78.4347 | 1073 | 25 | --- | X | X | X | X | X | X | X | X | X |
| Voyageurs | Sullivan Bay | MN | VOYA-SB | VOY413 | 27-137-0034 | 48.4128 | 92.8292 | 429 | 12 | --- | X | X | X | X | X | X | X | X | X |
| Yellowstone | Old Faithful | WY | YELL-OF | --- | 56-039-1012 | 44.4569 | 110.8314 | 2246 | --- | --- | X | X | X | X | --- | --- | --- | --- | --- |
| Yellowstone | Water Tank | WY | YELL-WT | YEL408 | 56-039-1011 | 44.5597 | 110.4006 | 2400 | 12 | --- | X | X | X | X | X | X | X | X | X |
| Yosemite | School Yard | CA | YOSE-SY | --- | 06-043-1004 | 37.7477 | 119.5917 | 1234 | 2 | --- | X | X | X | X | X | --- | --- | X | --- |
| Yosemite | Turtleback Dome | CA | YOSE-TD | YOS404 | 06-043-0003 | 37.7061 | 119.7061 | 1605 | 15 | --- | X | X | X | X | X | X | X | X | X |
| Zion | Dalton's Wash | UT | ZION-DW | --- | 49-053-0130 | 37.1983 | 113.1506 | 1213 | 4 | --- | X | X | X | X | X | --- | --- | X | --- |
| # active park units: 39 | # active park sites: 47 | | | | | | | | | | | | | | | | | | |
| **Sites operated by cooperating state agencies** | | | | | | | | | | | | | | | | | | | |
| *Acadia* | Cadillac Mountain | ME | ACAD-CM | --- | 23-009-0102 | 44.3472 | 68.2278 | 466 | 13 | --- | X | X | X | X | --- | --- | --- | --- | --- |
| *Acadia* | McFarland Hill | ME | ACAD-MH | ACA416 | 23-009-0103 | 44.3769 | 68.2608 | 158 | 10 | --- | X | X | X | X | X | X | X | X | X |
| *Cape Cod* | Cape Cod | MA | CACO-XX | --- | 25-001-0002 | 41.9758 | 70.0247 | 41 | 21 | --- | X | X | X | X | --- | --- | --- | X | --- |
| *Chamizal* | Chamizal | TX | CHAM-XX | --- | 48-141-0044 | 31.7656 | 106.455 | 1128 | 16 | --- | X | X | X | X | --- | --- | --- | X | --- |
| *Congaree* | Congaree Bluff | SC | COSW-BL | --- | 45-079-0021 | 33.8147 | 80.7811 | 34 | 8 | X | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Cowpens* | State Monitor | SC | COWP-SM | --- | 45-021-0002 | 35.1303 | 81.8164 | 296 | 20 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Great Smoky Mountains* | Cades Cove | TN | GRSM-CC | --- | 47-009-0102 | 35.6042 | 83.7831 | 564 | 15 | --- | X | X | X | X | X | --- | --- | X | --- |
| *Great Smoky Mountains* | Purchase Knob | NC | GRSM-PK | --- | 37-087-0036 | 35.59 | 83.0775 | 1500 | 13 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Mount Rainier* | Jackson Visitor's Center | WA | MORA-JV | --- | 53-053-0012 | 46.7853 | 121.7378 | 1615 | 10 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Saguaro* | Pima County | AZ | SAGU-PC | --- | 04-019-0021 | 32.1744 | 110.7364 | 938 | 16 | --- | X | X | X | X | X | --- | --- | X | --- |
| *Theodore Roosevelt* | Painted Canyon Visitor Cntr | ND | THRO-VC | THR422 | 38-007-0002 | 46.8947 | 103.3778 | 850 | 10 | X | X | X | X | X | X | X | X | X | X |
| *Wind Cave* | Visitor Center | SD | WICA-VC | WNC429 | 46-033-0132 | 43.5578 | 103.4839 | 1292 | 4 | X | X | X | X | X | X | X | X | X | X |
| *Yosemite* | Village | CA | YOSE-VI | --- | 06-043-1001 | 37.7458 | 119.6028 | 1216 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| # active park units: 11 | # active park sites: 13 | | | | | | | | | | | | | | | | | | |

**Table 1. 2007 Site specifications (continued).**

| National Park Unit | Site Name | State | NPS Abbr. | CASTNet Abbr. | AQS ID Number | Latitude (degrees west) | Longitude (degrees north) | Elev. (m) | $O_3$ Years[a] | $SO_2$ | WD | WS | TMP | RH | RNF | WET | DTP | SOL | Filter Pack[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Nearby sites operated by other agencies** | | | | | | | | | | | | | | | | | | | |
| *Alabama-Coushatta* | CASTNet Site | TX | ALCO-CA | ALC188 | --- | 30.4211 | 94.4044 | | 4 | --- | X | X | X | X | X | X | X | X | X |
| *Appalachian Trail* | Mount Greylock Summit | MA | APTR-MG | --- | 25-003-4002 | 42.6367 | 73.1686 | 1140 | 19 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Blue Ridge Parkway* | 7510 Blue Ridge Parkway | NC | BLRI-75 | --- | 37-011-0002 | 35.9717 | 81.9342 | 987 | 9 | --- | --- | --- | X | X | --- | --- | --- | --- | --- |
| *Blue Ridge Parkway* | Barnet Knob Firetower Road | NC | BLRI-BK | --- | 37-099-0005 | 35.5244 | 83.2361 | 1433 | 9 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Blue Ridge Parkway* | Frying Pan Mountain | NC | BLRI-FP | --- | 37-087-0035 | 35.3792 | 82.7925 | 1585 | 14 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Blue Ridge Parkway* | Route 191 | NC | BLRI-RO | --- | 37-021-0030 | 35.5 | 82.6 | 675 | 19 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Blue Ridge Parkway* | Ranger Station | VA | BLRI-RS | --- | 51-163-0003 | 37.6261 | 79.5131 | 280 | 9 | --- | --- | --- | X | X | --- | --- | --- | --- | --- |
| *Blue Ridge Parkway* | Vinton Elementary | VA | BLRI-VE | --- | 51-161-1004 | 37.2856 | 79.8842 | 346 | 27 | X | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Boston Harbor Islands* | Former Nike Missile Site | MA | BOHA-NM | --- | 25-025-0041 | 42.3175 | 70.9689 | 10 | 10 | --- | X | X | X | X | --- | --- | --- | X | --- |
| *Cuyahoga Valley* | 800 Patterson | OH | CUVA-PA | --- | 39-153-0020 | 41.1061 | 81.5039 | 305 | 28 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Everglades* | Cutler Road | FL | EVER-CR | --- | 12-086-0029 | 25.5861 | 80.3269 | 4 | 23 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *George Washington Pkwy* | Alexandria Health | VA | GEWA-AH | --- | 51-510-0009 | 38.8108 | 77.0447 | 23 | 39 | X | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Guilford Courthouse* | Mendenhall Middle School | NC | GUCO-MM | --- | 37-081-0013 | 36.1092 | 79.8011 | 247 | 7 | --- | --- | X | X | X | X | --- | X | X | --- |
| *Indiana Dunes* | Ammunition Bunker | IN | INDU-AB | --- | 18-089-0022 | 41.5733 | 87.3047 | 183 | 15 | X | X | X | X | X | --- | --- | --- | X | --- |
| *Indiana Dunes* | Gas Station | IN | INDU-GS | --- | 18-091-0005 | 41.7169 | 86.9075 | 187 | 32 | X | X | X | X | --- | --- | --- | X | --- | --- |
| *Indiana Dunes* | Water Treatment Plant | IN | INDU-WT | --- | 18-127-0024 | 41.6175 | 87.1992 | 183 | 25 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Mississippi* | Anoka County Airport | MN | MISS-AC | --- | 27-003-1002 | 41.1397 | 93.2075 | 281 | 29 | X | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Mississippi* | Somerset Town Hall | WI | MISS-ST | --- | 55-109-1002 | 45.1244 | 92.6625 | 278 | 41 | --- | X | X | --- | --- | --- | --- | --- | --- | --- |
| *Mississippi* | Washington County | MN | MISS-WC | --- | 27-163-6015 | 45.1189 | 92.855 | 0 | 11 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Mount Baker* | Mount Baker | WA | MTBA-XX | --- | --- | 48.8561 | 121.6817 | 1463 | 1 | --- | X | X | X | X | X | --- | --- | X | --- |
| *Petroglyph* | Westside Taylor Ranch | NM | PETR-WT | --- | 35-001-0027 | 35.1519 | 106.6836 | 5111 | 9 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Rock Creek* | Achbold Parkway | DC | ROCR-AP | --- | 11-001-0025 | 38.9753 | 77.0228 | 91 | 28 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |

**Table 1. 2007 Site specifications (continued).**

| National Park Unit | Site Name | State | NPS Abbr. | CASTNet Abbr. | AQS ID Number | Latitude (degrees west) | Longitude (degrees north) | Elev. (m) | $O_3$ Years[a] | $SO_2$ | WD | WS | TMP | RH | RNF | WET | DTP | SOL | Filter Pack[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Nearby sites operated by other agencies** | | | | | | | | | | | | | | | | | | | |
| *Saratoga* | Stillwater | NY | SARA-ST | --- | 36-091-0004 | 43.0122 | 73.6489 | 120 | 20 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Saugus Iron Works* | Lynn Water Treatment | MA | SAIR-LW | --- | 25-009-2006 | 42.4744 | 70.9725 | 52 | 16 | --- | X | X | X | X | X | --- | --- | X | --- |
| # active park units: 15 | # active park sites: 24 | | | | | | | | | | | | | | | | | | |

[a] The values in this column represent the number of years an ozone analyzer has been operational at the site.

[b] A filter pack is a part of the CASTNet network and is used to measure dry deposition using the "inferential method." This method combines air quality concentration data with meteorological measurements and land use functions to compute deposition velocities. Ambient air is drawn across the filter at either 3.0 or 1.5 liters per minute. The filter is then analyzed in a lab to yield weekly average concentrations of particulate sulfate ($SO_4^{2-}$), particulate nitrate ($NO_3^-$), particulate ammonium ($NH_4^+$), sulfur dioxide ($SO_2$), and nitric acid ($HNO_3$). In some cases, the positive ions $Na^+$, $K^+$, $Ca^{2+}$, and $Mg^{2+}$ are also measured from the filter samples.

Operating agency key: plain text = site operated by the National Park Service
*italics* = site operated by a state agency
<u>underline</u> = site operated by the National Park Service, but consisting of non-EPA certified portable instrumentation

Parameter key: $O_3$ = ozone analyzer; $SO_2$ = sulfur dioxide analyzer; WD = vector wind direction; SWS = scalar wind speed; TMP = ambient temperature; RH = relative humidity; RNF = precipitation; WET = wetness; DTP = delta temperature; SOL = solar radiation

*Note:* Dashed lines indicate parameter not measured at that site.

# Data Summaries

Surface-level ozone, sulfur dioxide, and particulate matter are regulated under the Clean Air Act, the comprehensive federal law that regulates air quality in the United States. Among other things, the Clean Air Act requires the EPA to set standards for "criteria pollutants." These standards, known as the National Ambient Air Quality Standards (NAAQS), define the national targets for acceptable concentrations of each of the criteria pollutants.

In 2007 the primary NAAQS for ozone was 0.08 ppm (85 ppb) equivalent) over an 8-hour period. An exceedance of the standard occurs when an 8-hour average ozone concentration is greater than or equal to 85 ppb. An exceedance of the standard is not the same as a violation. A violation occurs when the 3-year average of the fourth highest daily maximum 8-hour average ozone concentration equals or exceeds 85 ppb. The secondary ozone standard defined by the EPA, which is supposed to protect the environment, is the same as the primary standard. In this report, ozone concentrations are compared to the NAAQS that was in place during the time period reported.

This section presents 2007 data summaries for the NPS GPMP. Ozone summaries for all sites are presented first, followed by data summaries for sulfur dioxide, particulate matter, and meteorological parameters. In these data summary products, site names of EPA-certified sites operated by the NPS are indicated with plain text, site names of EPA-certified sites operated by state or other agencies are written in italics, and site names of portable ozone monitoring systems (POMS) operated by the NPS are underlined.

Throughout this report data summary tables are split according to each of these groups. Generally, four site groupings are provided in each table to compare data among sites that are operated in a similar manner.

| ***Pollutant*** | ***Primary and Secondary NAAQS Standards During 2007*** | ***Averaging Time*** |
|---|---|---|
| *Ozone ($O_3$)* | *0.08 ppm (84 ppb)* | *4th highest 8-hour average over 3 years* |
| *Sulfur Dioxide ($SO_2$)* | *0.03 ppm (primary) (34 ppb)* | *annual arithmetic mean* |
| | *0.14 ppm (primary) (144 ppb)* | *daily arithmetic mean* |
| | *0.5 ppm (secondary) (549 ppb)* | *3-hour average* |
| *Particulate Matter ($PM_{2.5}$)* | *15.0 $\mu g/m^3$* | *annual arithmetic mean* |
| | *35 $\mu g/m^3$* | *98th percentile of the highest daily average over 3 years* |
| *Particulate Matter ($PM_{10}$)* | *150 $\mu g/m^3$* | *daily arithmetic mean* |

*http://www.epa.gov/air/criteria.html*
*Note: To convert from ppm to ppb, multiply by 1000.*

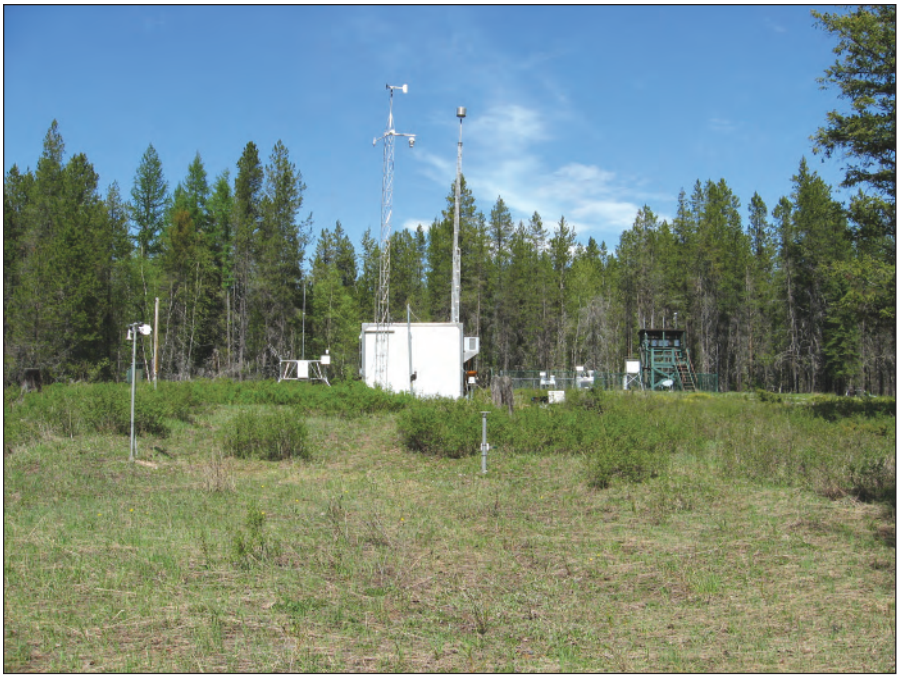
## Ozone Data Summaries

Ground-level ozone, produced by the reaction of nitrogen oxides ($NO_x$) and volatile organic compounds (VOCs) in the presence of sunlight, is one of the most widespread pollutants affecting vegetation and public health in the U.S. Although ozone is principally viewed as an urban problem, ozone and its precursor emissions can travel long distances, resulting in elevated ozone levels in national parks. Combustion processes from power plants, automobiles, and industries are the main anthropogenic emitters of $NO_x$. Vehicles, industries, and natural vegetation emit VOCs.

Exposure to ozone affects human health, causing acute respiratory problems, aggravation of asthma, temporary decreases in lung capacity in some people, inflammation of lung tissue, and impairment of the body's immune system. Ozone also affects vegetation in national parks.

*Research shows that some plants are more sensitive than humans to ozone and that effects on plants occur well below the EPA National Ambient Air Quality Standards (NAAQS).*

To quantify ozone exposure to plants, various indices other than the primary and secondary standards are often used. These indices, described further on page 32, are believed to be biologically relevant because they take into account both peak ozone concentrations and cumulative exposure to ozone.



**Glacier National Park, Montana Air Quality Monitoring Station Photo by Martin Valvur/ Air Resource Specialists, Inc.**

### *Annual Ozone Summaries*

Table 2 summarizes $O_3$ measurements with respect to the daily maximum 8-hour average concentrations at each NPS monitoring site. The five highest daily maximum 8-hour average ozone concentrations are listed, as well as the total number of days with exceedances of the NAAQS 8-hour standard (8-hour average ozone values greater than or equal to 85 ppb). At each site with an EPA-certified monitor, the fourth highest value column and the number of days column are both color-coded to identify sites where the fourth highest daily maximum 8-hour average ozone value exceeded the 8-hour standard during 2007. Note that other sites may have experienced fewer than four exceedances of the 8-hour standard, and are not color coded. Ozone summary statistics from POMS are highlighted bold where exceedances occurred. These sites should be compared to EPA standards for reference purposes only.

In 2007, six park units operated by the NPS and cooperating state agencies exceeded the 8-hour standard, as compared to six sites in 2006 (see Table 2). From 2006 to 2007, six of the NPS and cooperating state-operated park units had an increase in the number of days with an exceedance of the 8-hour standard and seven park units had a decrease.

The map in Figure 2 presents the annual fourth highest 8-hour average ozone concentrations for all network sites listed in Table 2. Ozone values for EPA-certified sites are color-coded to represent values below (green) and above (orange and red) the national standard. Values from portable sites that exceed the standard are in bold but are not colored and are included for reference only.

The map in Figure 3 presents the annual number of days which exceeded the 8-hour standard for all network sites listed in Table 2. The data points are color-coded to distinguish between sites that did not exceed NAAQS (green) and those that did (orange and red). Data from portable sites (no color) are included for reference.

The map in Figure 4 presents the annual second highest 1-hour average ozone concentrations for all network sites. Ozone values for EPA-certified sites are color-coded to represent four distinct levels. Ozone values from portable sites (no color) are included for reference only.

**Table 2. 2007 Summary of 8-hour average ozone concentrations (ppb).**

| National Park Unit | Site Name | Valid Number of Days | 1st Highest | 2nd Highest | 3rd Highest | 4th Highest[a] | 5th Highest | # Days with 8-Hour Average $O_3$ Values ≥85 ppb[a] |
|---|---|---|---|---|---|---|---|---|
| **Sites operated by the National Park Service** | | | | | | | | |
| Badlands | Visitor Center | 363 | 68 | 65 | 65 | 64 | 64 | 0 |
| Big Bend | K-Bar Ranch Road | 355 | 72 | 72 | 71 | 68 | 67 | 0 |
| Canyonlands | Island in the Sky | 339 | 74 | 74 | 73 | 72 | 71 | 0 |
| Chiricahua | Entrance Station | 352 | 73 | 70 | 68 | 67 | 67 | 0 |
| Craters of the Moon | Visitor Center | 220 | 71 | 68 | 67 | 67 | 65 | 0 |
| Death Valley | Park Village | 351 | 94 | 91 | 91 | 85 | 85 | 6 |
| Denali | Headquarters | 348 | 55 | 55 | 53 | 53 | 53 | 0 |
| Glacier | West Glacier Horse Stables | 339 | 59 | 54 | 54 | 54 | 54 | 0 |
| Grand Canyon | The Abyss | 352 | 72 | 70 | 70 | 69 | 69 | 0 |
| Great Basin | Maintenance Yard | 348 | 82 | 80 | 78 | 75 | 75 | 0 |
| Great Smoky Mountains | Clingmans Dome | 174 | 92 | 90 | 88 | 87 | 87 | 9 |
| Great Smoky Mountains | Cove Mountain | 360 | 89 | 89 | 88 | 88 | 86 | 5 |
| Great Smoky Mountains | Look Rock | 363 | 96 | 95 | 92 | 88 | 87 | 11 |
| Joshua Tree | Black Rock | 341 | 106 | 105 | 104 | 104 | 103 | 40 |
| Joshua Tree | Cottonwood Canyon | 281 | 82 | 78 | 76 | 76 | 75 | 0 |
| Lassen Volcanic | Manzanita Lake Fire Station | 362 | 78 | 77 | 76 | 76 | 73 | 0 |
| Mammoth Cave | Houchin Meadow | 359 | 84 | 84 | 83 | 82 | 82 | 0 |
| Mesa Verde | Resource Management Area | 356 | 72 | 71 | 71 | 70 | 69 | 0 |
| Mount Rainier | Tahoma Woods | 342 | 65 | 62 | 61 | 58 | 54 | 0 |
| North Cascades | Marblemount Ranger Stn | 354 | 57 | 51 | 50 | 48 | 48 | 0 |
| Petrified Forest | South Entrance | 278 | 74 | 71 | 69 | 69 | 68 | 0 |
| Pinnacles | SW of East Entrance Station | 361 | 83 | 77 | 76 | 75 | 74 | 0 |
| Rocky Mountain | Long's Peak | 335 | 79 | 79 | 78 | 78 | 77 | 0 |
| Sequoia and Kings Canyon | Ash Mountain | 238 | 102 | 102 | 102 | 99 | 98 | 44 |
| Sequoia and Kings Canyon | Lower Kaweah | 360 | 94 | 93 | 92 | 91 | 91 | 25 |
| Shenandoah | Big Meadows | 339 | 75 | 75 | 74 | 73 | 73 | 0 |
| Voyageurs | Sullivan Bay | 327 | 75 | 68 | 67 | 63 | 63 | 0 |
| Yellowstone | Water Tank | 347 | 69 | 67 | 66 | 65 | 64 | 0 |
| Yosemite | Turtleback Dome | 334 | 97 | 92 | 92 | 88 | 88 | 8 |
| Zion | Dalton's Wash | 305 | 77 | 77 | 71 | 71 | 70 | 0 |
| **Sites operated by cooperating state agencies** | | | | | | | | |
| *Acadia* | Cadillac Mountain | 186 | 98 | 94 | 89 | 86 | 85 | 5 |
| *Acadia* | McFarland Hill | 300 | 92 | 85 | 83 | 83 | 82 | 2 |
| *Cape Cod* | Cape Cod | 170 | 93 | 85 | 82 | 82 | 80 | 2 |
| *Chamizal* | Chamizal | 359 | 78 | 77 | 77 | 75 | 73 | 0 |
| *Congaree* | Congaree Bluff | 333 | 76 | 72 | 71 | 70 | 69 | 0 |
| *Cowpens* | State Monitor | 358 | 74 | 68 | 67 | 67 | 67 | 0 |
| *Great Smoky Mountains* | Cades Cove | 243 | 86 | 79 | 77 | 74 | 74 | 1 |
| *Great Smoky Mountains* | Purchase Knob | 208 | 78 | 78 | 78 | 78 | 77 | 0 |
| *Mount Rainier* | Jackson's Visitor's Center | 326 | 72 | 68 | 68 | 64 | 62 | 0 |
| *Saguaro* | Pima County | 357 | 75 | 73 | 73 | 73 | 73 | 0 |
| *Theodore Roosevelt* | Painted Canyon Visitor Cntr | 352 | 69 | 64 | 64 | 64 | 64 | 0 |
| *Wind Cave* | Visitor Center | 363 | 75 | 71 | 69 | 69 | 68 | 0 |

**Table 2. 2007 Summary of 8-hour average ozone concentrations (ppb) (continued).**

| National Park Unit | Site Name | Valid Number of Days | 1st Highest | 2nd Highest | 3rd Highest | 4th Highest[a] | 5th Highest | # Days with 8-Hour Average $O_3$ Values ≥85 ppb[a] |
|---|---|---|---|---|---|---|---|---|
| **Nearby sites operated by other agencies** | | | | | | | | |
| *Alabama-Coushatta* | CASTNet Site | 240 | 73 | 73 | 70 | 69 | 66 | 0 |
| *Appalachian Trail* | Mount Greylock Summit | 143 | 93 | 86 | 83 | 80 | 79 | 2 |
| *Blue Ridge Parkway* | 7510 Blue Ridge Parkway | 181 | 76 | 73 | 68 | 66 | 66 | 0 |
| *Blue Ridge Parkway* | Barnet Knob Firetower Road | 200 | 84 | 83 | 80 | 80 | 77 | 0 |
| *Blue Ridge Parkway* | Frying Pan Mountain | 193 | 90 | 84 | 78 | 77 | 77 | 1 |
| *Blue Ridge Parkway* | Route 191 | 213 | 77 | 77 | 73 | 73 | 72 | 0 |
| *Blue Ridge Parkway* | Ranger Station | 205 | 73 | 70 | 66 | 65 | 65 | 0 |
| *Blue Ridge Parkway* | Vinton Elementary | 182 | 86 | 79 | 77 | 76 | 76 | 1 |
| *Boston Harbor Islands* | Former Nike Missile Site | 53 | 82 | 80 | 76 | 72 | 69 | 0 |
| *Cuyahoga Valley* | 800 Patterson | 213 | 97 | 92 | 90 | 90 | 89 | 9 |
| *Everglades* | Cutler Road | 357 | 75 | 75 | 74 | 71 | 69 | 0 |
| *George Washington Pkwy* | Alexandria Health | 211 | 90 | 85 | 85 | 84 | 83 | 3 |
| *Guilford Courthouse* | Mendenhall Middle School | 198 | 103 | 89 | 87 | 86 | 84 | 4 |
| *Indiana Dunes* | Ammunition Bunker | 143 | 89 | 89 | 85 | 85 | 80 | 4 |
| *Indiana Dunes* | Gas Station | 162 | 81 | 78 | 77 | 73 | 67 | 0 |
| *Indiana Dunes* | Water Treatment Plant | 176 | 91 | 89 | 89 | 84 | 81 | 3 |
| *Mississippi* | Anoka County Airport | 358 | 86 | 80 | 75 | 74 | 74 | 1 |
| *Mississippi* | Somerset Town Hall | 358 | 79 | 78 | 78 | 75 | 73 | 0 |
| *Mississippi* | Washington County | 176 | 79 | 79 | 79 | 77 | 71 | 0 |
| *Mount Baker* | Mount Baker | 103 | 56 | 52 | 50 | 49 | 49 | 0 |
| *Petroglyph* | Westside Taylor Ranch | 363 | 75 | 73 | 72 | 71 | 71 | 0 |
| *Rock Creek* | Achbold Parkway | 350 | 87 | 87 | 85 | 84 | 83 | 3 |
| *Saratoga* | Stillwater | 349 | 88 | 87 | 83 | 82 | 82 | 2 |
| *Saugus Iron Works* | Lynn Water Treatment | 299 | 103 | 102 | 93 | 88 | 83 | 4 |
| **Portable ozone monitoring systems** | | | | | | | | |
| Abraham Lincoln Birthplace | Visitor Center | 168 | 85 | 83 | 75 | 72 | 72 | 1 |
| Agate Fossil Beds | Residence Area | 65 | 69 | 68 | 66 | 66 | 65 | 0 |
| Assateague Island | Maintenance Area | 130 | 96 | 86 | 76 | 74 | 73 | 2 |
| Carlsbad Caverns | Maintenance Area | 137 | 67 | 66 | 66 | 66 | 65 | 0 |
| Colorado | Maintenance Yard | 150 | 67 | 67 | 67 | 67 | 67 | 0 |
| Cumberland Gap | Hensley Settlement | 149 | 88 | 88 | 87 | **85** | 82 | 4 |
| Dinosaur | West Entrance Housing | 163 | 68 | 64 | 63 | 63 | 63 | 0 |
| Joshua Tree | Pinto Wells | 138 | 83 | 83 | 82 | 81 | 78 | 0 |
| Mojave | Kelso Mountains | 118 | 101 | 91 | 89 | **88** | 87 | 6 |
| Natchez Trace Parkway | Dancy Ranger Station | 184 | 73 | 73 | 70 | 70 | 69 | 0 |
| Olympic | Hurricane Ridge Portable | 40 | 56 | 53 | 51 | 51 | 45 | 0 |
| Padre Island | Malaquite Visitor Center | 161 | 80 | 78 | 75 | 75 | 72 | 0 |
| Yosemite | School Yard | 195 | 72 | 67 | 66 | 66 | 66 | 0 |

[a] The primary and secondary National Ambient Air Quality Standard for ozone is 0.08 ppm over an 8-hour period. (An exceedance of the standard occurs when an 8-hour average ozone concentration is greater than or equal to 85 ppb. A violation of the standard occurs when the 3-year average of the fourth highest daily maximum 8-hour average ozone concentration equals or exceeds 85 ppb.) Exceedances of the standard are highlighted here in orange or red.

*Note:* The color coding break points follow the color categories used on the EPA's AIRNow Web Site (*http://www.airnow.gov*). Dashed lines represent no data available at that site.

Operating agency key: plain text = site operated by the National Park Service; *italics* = site operated by a state agency; underline = site operated by the National Park Service, but consisting of non-EPA certified portable instrumentation

Color shading key: 4th highest 8-hour average: = 85 - 105 ppb ozone concentration; > 105 ppb ozone concentration. # days with 8-hour average ≥85 ppb: = 4 - 10 days; > 10 days

Note: On March 12, 2008, the EPA revised the ozone standard from 0.08 ppm to 75 ppb. 8-hour average ozone concentrations > 75 ppb will exceed the new ozone standard.

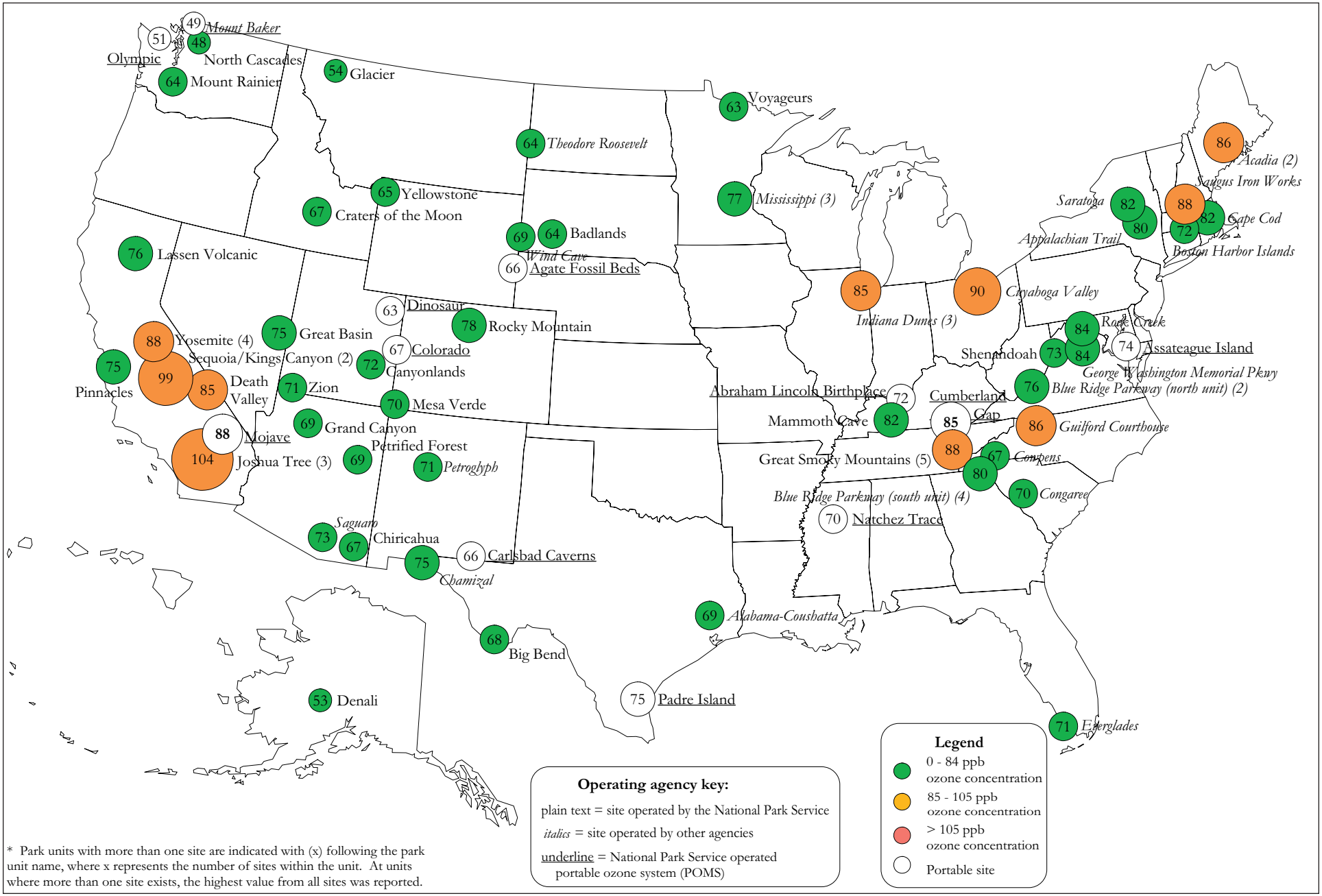



**Figure 2. 2007 Annual fourth highest daily maximum 8-hour average ozone concentrations (in ppb).**

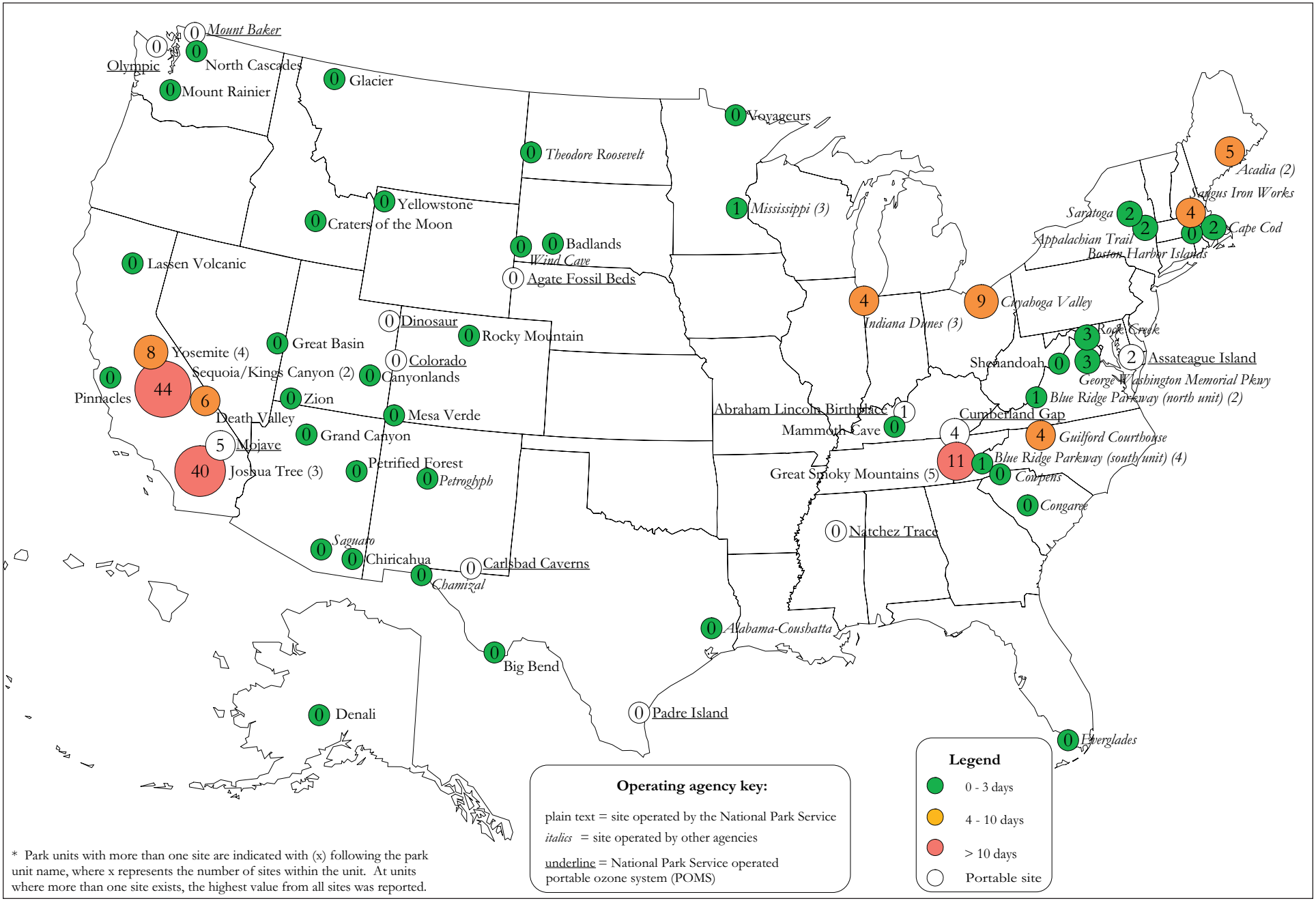



**Figure 3. 2007 Annual number of days with daily maximum 8-hour average ozone values ≥85 ppb.**

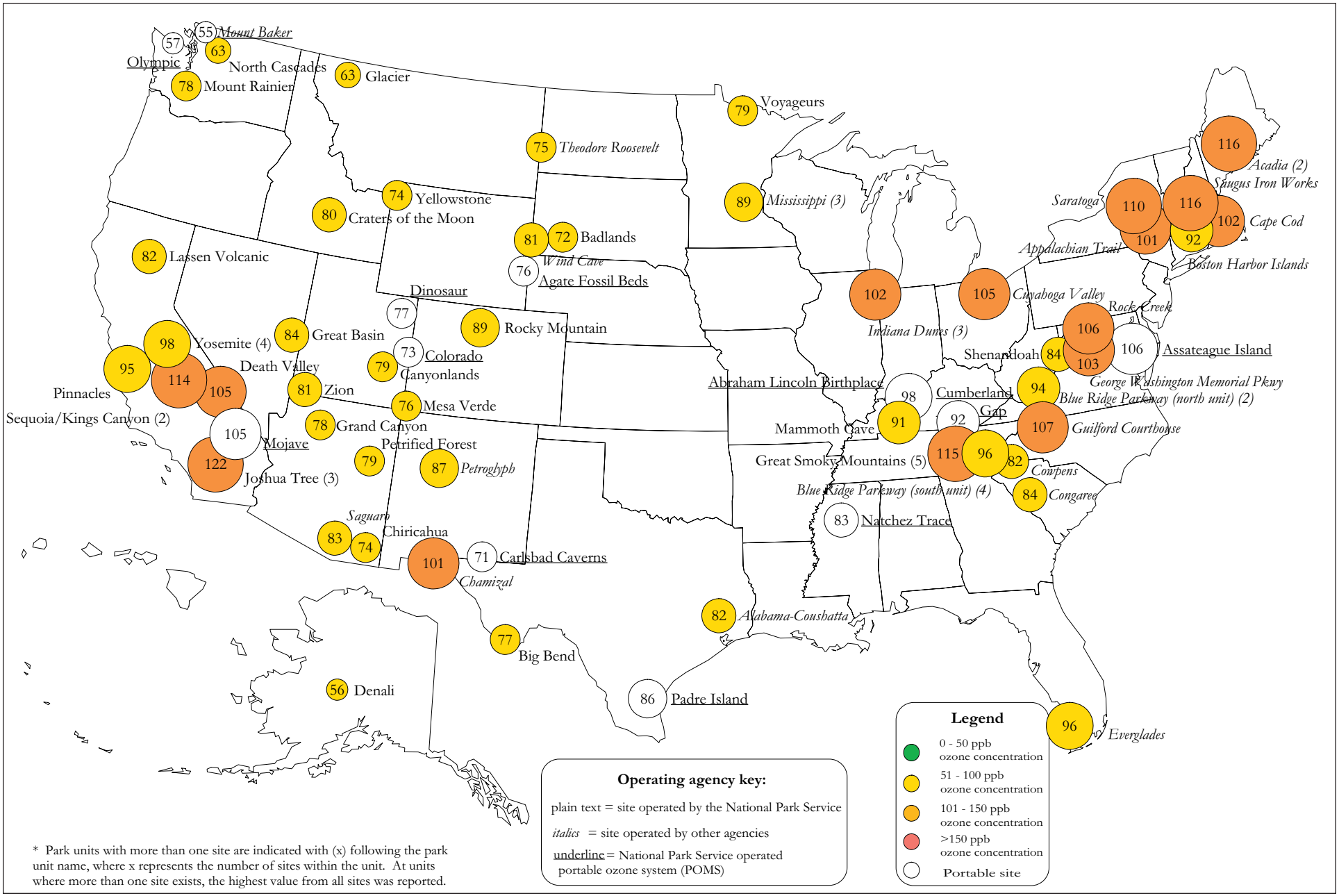



**Figure 4. 2007 Annual second highest 1-hour average ozone concentrations (in ppb).**

**Black Canyon of the Gunnison National Park, Colorado Photo by Jessica Ward/ Air Resource Specialists, Inc.**

*Ozone Violation Summaries*

Table 3 presents ozone violation summaries for NPS-operated and cooperating sites for all 3-year periods over the last 10 years, with violations indicated in orange and red. For sites operating independently of the NPS, only the 2003-2005, 2004-2006, and 2005-2007 violation summaries are presented.

During the summarized period, a violation of the standard occurs when the 3-year average of the fourth highest daily maximum 8-hour average ozone concentration equals or exceeds 85 ppb. Table values in parentheses indicate that the EPA data completeness requirement for the 3-year period was not met. However, annual fourth highest daily maximum 8-hour ozone concentrations greater than or equal to 85 ppb for calendar years not meeting the EPA data completeness requirement are included in the NAAQS violation computation.

In 2007, five of the NPS and cooperating state-operated sites within four national park units were in violation of the NAAQS 8-hour standard, up from four sites within three units in 2006 (see Table 3). One site operated independently of the NPS recorded a violation in 2007.

**Table 3. 2007 Ozone violation summary - primary standard[a].**

| National Park Unit | Site Name | 2005 - 2007 | 2004 - 2006 | 2003 - 2005 | 2002 - 2004 | 2001 - 2003 | 2000 - 2002 | 1999 - 2001 | 1998 - 2000 |
|---|---|---|---|---|---|---|---|---|---|
| **Sites operated by the National Park Service** | | | | | | | | | |
| Badlands | Visitor Center | 68 | 67 | (66) | (64) | (67) | --- | --- | --- |
| Big Bend | K-Bar Ranch Road | 66 | 63 | 63 | 62 | 62 | (62) | (63) | 66 |
| Canyonlands | Island in the Sky | 69 | 69 | 71 | 72 | 70 | (71) | (71) | 73 |
| Chiricahua | Entrance Station | 71 | 72 | 71 | 70 | 69 | 69 | 70 | 70 |
| Craters of the Moon | Visitor Center | (67) | --- | --- | 67 | (65) | (63) | (63) | 66 |
| Death Valley | Park Village | 84 | 82 | 81 | 80 | 81 | 81 | 79 | 80 |
| Denali | Headquarters | 52 | 51 | 52 | 53 | 54 | 49 | 49 | 48 |
| Glacier | West Glacier Horse Stables | 55 | 54 | 56 | 55 | 53 | 49 | 48 | 51 |
| Grand Canyon | The Abyss | 72 | 73 | 74 | 74 | 74 | 73 | 72 | 73 |
| Great Basin | Maintenance Yard | 73 | 72 | 72 | 72 | 70 | 72 | 72 | 73 |
| Great Smoky Mountains | Clingmans Dome | (83) | (80) | (79) | (87) | (92) | (98) | (98) | (102) |
| Great Smoky Mountains | Cove Mountain | 82 | 77 | 78 | 86 | 92 | 96 | 96 | 101 |
| Great Smoky Mountains | Look Rock | 86 | 84 | 86 | 91 | 92 | 94 | 96 | 104 |
| Joshua Tree | Black Rock | 103 | 103 | 105 | 106 | 99 | 94 | 92 | 102 |
| Joshua Tree | Cottonwood Canyon | (66) | (62) | (45) | --- | --- | --- | --- | --- |
| Lassen Volcanic | Manzanita Lake Fire Station | 72 | 69 | 68 | 71 | 72 | 74 | 77 | 78 |
| Mammoth Cave | Houchin Meadow | 76 | 72 | 73 | 77 | 80 | 84 | 88 | 94 |
| Mesa Verde | Resource Management Area | 73 | 73 | 70 | 68 | 67 | 69 | 69 | 70 |
| Mount Rainier | Tahoma Woods | (56) | (58) | (61) | 63 | 61 | 56 | 60 | 57 |
| North Cascades | Marblemount Ranger Stn | (47) | (48) | (51) | 51 | 50 | 46 | 48 | 46 |
| Petrified Forest | South Entrance | (70) | (70) | (71) | (66) | (64) | (55) | --- | --- |
| Pinnacles | SW of East Entrance Station | 74 | 75 | 75 | 80 | 81 | 81 | (79) | (82) |
| Rocky Mountain | Long's Peak | 75 | 74 | 77 | 82 | 81 | 78 | 74 | 77 |
| Sequoia and Kings Canyon | Ash Mountain | (103) | (103) | (105) | (105) | (107) | (105) | (104) | (105) |
| Sequoia and Kings Canyon | Lower Kaweah | 95 | 96 | 97 | 101 | 101 | 98 | (94) | (93) |
| Shenandoah | Big Meadows | 77 | 77 | (80) | 82 | 87 | 85 | 87 | 93 |
| Voyageurs | Sullivan Bay | (65) | 64 | 66 | 64 | 65 | (64) | 67 | 68 |
| Yellowstone | Water Tank | 64 | 63 | 61 | 63 | 65 | 65 | 67 | 67 |
| Yosemite | Turtleback Dome | 86 | 86 | 88 | 90 | 90 | 89 | 86 | 88 |
| Zion | Dalton's Wash | 79 | 80 | (82) | (74) | --- | --- | --- | --- |
| **# park units with violations:** | | **4** | **3** | **4** | **4** | **5** | **5** | **6** | **6** |
| **# sites with violations:** | | **5** | **4** | **5** | **7** | **8** | **8** | **9** | **9** |
| **Sites operated by cooperating state agencies** | | | | | | | | | |
| *Acadia* | Cadillac Mountain | 82 | 80 | 82 | 88 | 94 | 93 | 89 | 87 |
| *Acadia* | McFarland Hill | 74 | 71 | 74 | 80 | 87 | 84 | 85 | 83 |
| *Cape Cod* | Cape Cod | 84 | 84 | 86 | 88 | 95 | 93 | 96 | 89 |
| *Chamizal* | Chamizal | 74 | 73 | 72 | 78 | 79 | 81 | 75 | (79) |
| *Congaree* | Congaree Bluff | 71 | 71 | 71 | 74 | 77 | 77 | (74) | (73) |
| *Cowpens* | State Monitor | 73 | 74 | 75 | 80 | 84 | 87 | 87 | 92 |
| *Great Smoky Mountains* | Cades Cove | 70 | 67 | (67) | 73 | 76 | 79 | 81 | (85) |
| *Great Smoky Mountains* | Purchase Knob | 77 | 75 | 78 | 82 | 86 | 88 | 87 | 90 |
| *Mount Rainier* | Jackson Visitor's Center | 61 | (60) | (59) | --- | --- | --- | --- | --- |
| *Saguaro* | Pima County | 76 | 76 | (76) | (75) | (73) | 72 | 69 | (71) |
| *Theodore Roosevelt* | Painted Canyon Visitor Cntr | 63 | 60 | 59 | 60 | 61 | 59 | 58 | (57) |
| *Wind Cave* | Visitor Center | 70 | (71) | (70) | --- | --- | --- | --- | --- |
| **# park units with violations:** | | **0** | **0** | **1** | **2** | **3** | **4** | **4** | **4** |
| **# sites with violations:** | | **0** | **0** | **1** | **2** | **4** | **4** | **5** | **5** |

**Table 3. 2007 Ozone violation summary - primary standard[a] (continued).**

| National Park Unit | Site Name | 2005 - 2007 | 2004 - 2006 | 2003 - 2005 | 2002 - 2004 | 2001 - 2003 | 2000 - 2002 | 1999 - 2001 | 1998 - 2000 |
|---|---|---|---|---|---|---|---|---|---|
| **Nearby sites operated by other agencies** | | | | | | | | | |
| *Alabama-Coushatta* | CASTNet Site | (70) | (71) | (72) | --- | --- | --- | --- | --- |
| *Appalachian Trail* | Mount Greylock Summit | (81) | (78) | (80) | --- | --- | --- | --- | --- |
| *Blue Ridge Parkway* | 7510 Blue Ridge Parkway | 69 | 69 | 71 | --- | --- | --- | --- | --- |
| *Blue Ridge Parkway* | Barnet Knob Firetower Road | (76) | (73) | (72) | --- | --- | --- | --- | --- |
| *Blue Ridge Parkway* | Frying Pan Mountain | 79 | 78 | 78 | --- | --- | --- | --- | --- |
| *Blue Ridge Parkway* | Route 191 | 74 | 74 | 74 | --- | --- | --- | --- | --- |
| *Blue Ridge Parkway* | Ranger Station | 69 | 69 | 71 | --- | --- | --- | --- | --- |
| *Blue Ridge Parkway* | Vinton Elementary | 76 | 74 | 74 | --- | --- | --- | --- | --- |
| *Boston Harbor Islands* | Former Nike Missile Site | (79) | 81 | 81 | --- | --- | --- | --- | --- |
| *Cuyahoga Valley* | 800 Patterson | 85 | 81 | 85 | --- | --- | --- | --- | --- |
| *Everglades* | Cutler Road | 69 | 68 | 66 | --- | --- | --- | --- | --- |
| *George Washington Pkwy* | Alexandria Health | 83 | 81 | 81 | --- | --- | --- | --- | --- |
| *Guilford Courthouse* | Mendenhall Middle School | (82) | (81) | (82) | --- | --- | --- | --- | --- |
| *Indiana Dunes* | Ammunition Bunker | 82 | 75 | 76 | --- | --- | --- | --- | --- |
| *Indiana Dunes* | Gas Station | 77 | 76 | 78 | --- | --- | --- | --- | --- |
| *Indiana Dunes* | Water Treatment Plant | 81 | 76 | 78 | --- | --- | --- | --- | --- |
| *Mississippi* | Anoka County Airport | 69 | 66 | 68 | --- | --- | --- | --- | --- |
| *Mississippi* | Somerset Town Hall | 71 | 67 | (69) | --- | --- | --- | --- | --- |
| *Mississippi* | Washington County | (72) | (67) | (68) | --- | --- | --- | --- | --- |
| *Petroglyph* | Westside Taylor Ranch | 72 | 71 | 72 | --- | --- | --- | --- | --- |
| *Rock Creek* | Achbold Parkway | 81 | 80 | 78 | --- | --- | --- | --- | --- |
| *Saratoga* | Stillwater | 79 | 77 | 82 | --- | --- | --- | --- | --- |
| *Saugus Iron Works* | Lynn Water Treatment | 84 | 83 | 83 | --- | --- | --- | --- | --- |
| **# park units with violations:** | | **1** | **0** | **1** | **0** | **0** | **0** | **0** | **0** |
| **# sites with violations:** | | **1** | **0** | **1** | **0** | **0** | **0** | **0** | **0** |

[a] The primary and secondary National Ambient Air Quality Standard for ozone is 0.08 ppm over an 8-hour period. (An exceedance of the standard occurs when an 8-hour average ozone concentration is greater than or equal to 85 ppb. A violation of the standard occurs when the 3-year average of the fourth highest daily maximum 8-hour average ozone concentration equals or exceeds 85 ppb.) Exceedances of the standard are highlighted here in orange or red.

*Note:* The color coding break points follow the color categories used on the EPA's AIRNow Web Site (*http://www.airnow.gov*).

Operating agency key: plain text = site operated by the National Park Service
*italics* = site operated by a state agency
underline = site operated by the National Park Service, but consisting of non-EPA certified portable instrumentation

Color shading key: 4th highest 8-hour average
= 85 - 105 ppb ozone concentration
> 105 ppb ozone concentration

*Note:* A number in parenthesis ( ) indicates that data completeness was not met. The primary standard requires 90 percent data completeness, on average, during the 3-year period, with no single year within the period having less than 75 percent data completeness. This data completeness requirement would have to be satisfied in order to determine that the standard has been met at a monitoring site. However, calendar years with less than 75 percent data completeness are included in the computation if the annual fourth-highest daily maximum 8-hour concentration is greater than the level of the standard. A site could be found not to have met the standard with less than complete data.

Dashed lines represent no data available at that site.

Note: On March 12, 2008, the EPA revised the ozone standard from 0.08 ppm to 75 ppb. In future years, 3-year average of the fourth highest daily maximum 8-hour average ozone concentrations greater than 75 ppb will violate the new ozone standard.

**Implications of the New National Ambient Air Quality Standard**

*New Ozone Standard*

On March 12, 2008, the EPA issued new, more stringent NAAQS for ozone by lowering the ozone standard from 84 parts per billion (ppb) (0.08 ppm) to 75 ppb (0.075 ppm) for both the primary and secondary standard[1]. The new standard is a significant enhancement to protection of both human health and for vegetation and other natural resources. The primary standard is designed to better protect human health, and the secondary standard is intended to provide protection against "welfare" effects, including harm to native vegetation in protected areas[1,2,3]. By law, the EPA is required to base the NAAQS on science while providing an adequate margin for human safety. Economic issues related to the implementation of standards are not considered when determining NAAQS.

*Current Status*

Many NPS units exceed the existing ozone NAAQS, prompting concerns for human health and vegetation. Affected parks issue health advisories to visitors and employees on high ozone days because ozone harms lung tissue and can cause respiratory problems. The new lower ozone standard will result in NAAQS exceedances at more parks. Also, there will be a greater number of days considered unhealthy in parks, and thus more health advisory alerts.

Based on recent data, ozone concentrations in 11 parks operated by the NPS and state agencies violate the new standard. Data from the NPS portable stations and state monitoring near parks suggest another 73 sites have ozone concentrations that exceed the new standard. Rural counties without ozone monitoring may also exceed the standard. NPS interpolation mapping of ozone estimates that more than 150 park units may have concentrations that exceed the standard. How the EPA will structure rural monitoring and the specific requirements used to determine areas in violation are unknown at this point.

Ozone also affects vegetation. Visible plant injury and reduced growth from ozone have been documented in parks. Ozone can cause stress on entire ecosystems by reducing the ability of sensitive plant species and genotypes to adapt to or withstand environmental stresses, including freezing temperatures, pest infestations, or root disease. In addition, because it interferes with photosynthesis, ozone decreases the potential for carbon sequestration by plants. When revising the ozone standard the EPA did not adopt a separate secondary standard to protect "public welfare"[2,3].

*Parks That May Violate the NAAQS Based on Measurements*

In all past designations of non-attainment, EPA has required a minimum of 3 years' of ozone data collected according to EPA monitoring regulations using certified equivalent-method analyzers. Usually attainment status is determined at the county or metropolitan level based on monitors in those areas. Many natural areas and national parks are in rural areas and counties that do not have monitoring. Furthermore, when a park is in more than one county usually only the county with the direct monitoring data gets the designation status. Examples of this are Joshua Tree NP and Shenandoah NP where NPS monitoring showed a violation of the old NAAQS, but only the county in which the monitor was located received a non-attainment designation.

Table 4 lists the 11 parks that violate the new standard (greater than 75 ppb) based on direct monitoring in the parks. See Figure 5 for locations. Ozone concentrations from Rocky Mountain NP are right at the standard (75 ppb).

**Table 4. Parks that violate the new ozone NAAQS for 3-year average annual 4th highest 8-hour ozone (ppb).**

| Park Name | Park Code | 2005-2007 | 2004-2006 |
|---|---|---|---|
| Joshua Tree | JOTR | 103 | 103 |
| Sequoia & Kings Canyon | SEKI | 103 | 103 |
| Great Smoky Mountains | GRSM | 86 | 84 |
| Yosemite | YOSE | 86 | 86 |
| Cape Cod | CACO | 84 | 84 |
| Death Valley | DEVA | 84 | 82 |
| Acadia | ACAD | 82 | 80 |
| Zion | ZION | 79 | 80 |
| Shenandoah | SHEN | 77 | 77 |
| Mammoth Cave | MACA | 76 | 72 |
| Saguaro | SAGU | 76 | 76 |

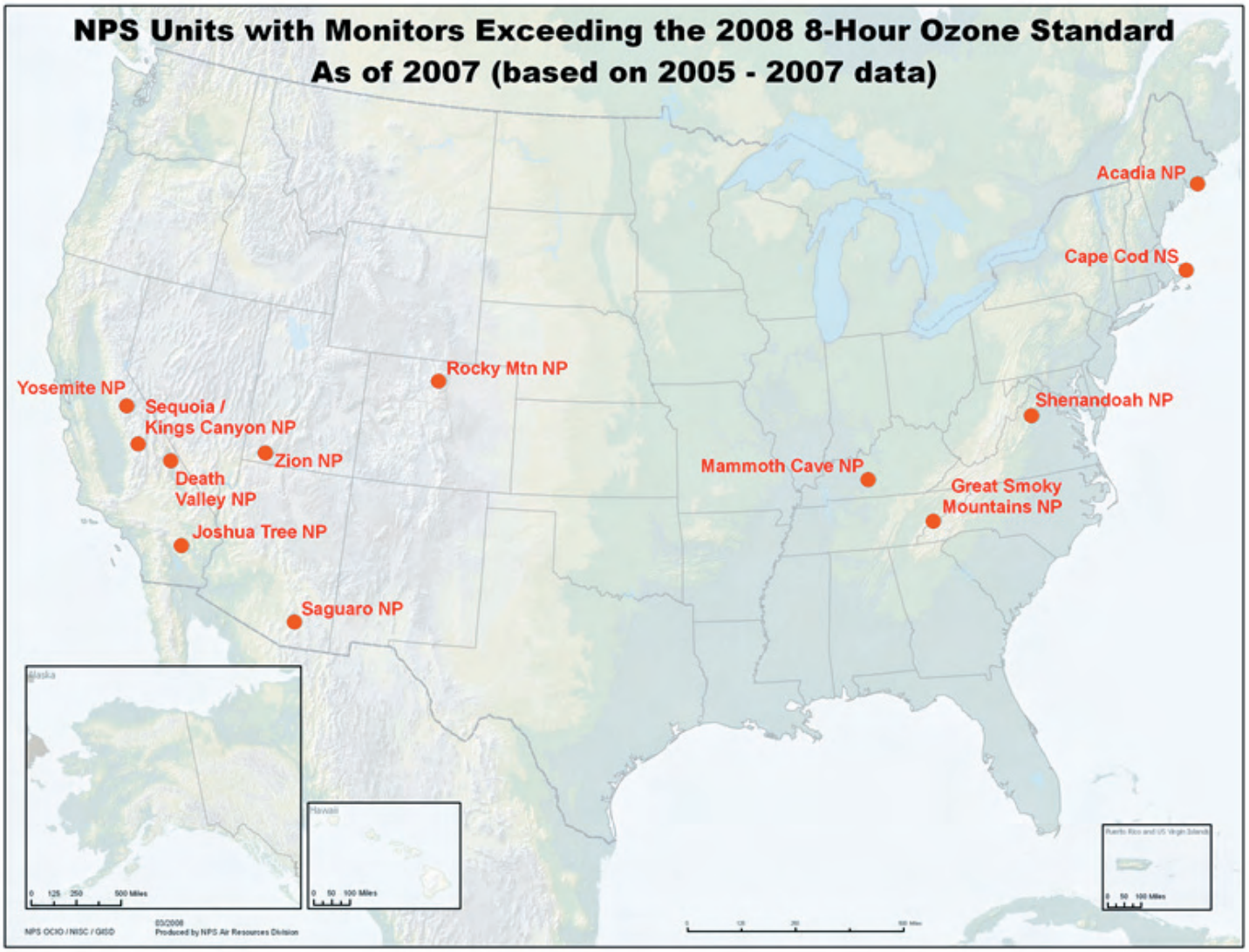



**Figure 5. Park units that will violate the new ozone NAAQS based on NPS monitoring network data.**

The parks in Table 5 have monitors that show ozone concentrations close to the new standard. Rocky Mountain NP and Chamizal are very close to the standard based on monitoring data.

**Table 5. Parks with monitoring data that are close to the new NAAQS of 75 ppb.**

| | | 4th Highest 8-Hour Ozone | |
|---|---|---|---|
| Park Name | Park Code | 2005-2007 3-year avg | 2004-2006 3-year avg |
| Chamizal | CHAM | 74 | 73 |
| Cowpens | COWP | 73 | 74 |
| Rocky Mountain | ROMO | 75 | 74 |
| Great Basin | GRBA | 73 | 72 |
| Grand Canyon | GRCA | 72 | 73 |

POMS data indicate an additional eight parks with measured data that are very likely to violate the 75 ppb standard. POMS stations are temporary monitors that move after a few seasons and are intended only to provide a baseline measurement. The POMS stations in Table 6 have at least one year with a 4th highest 8-hour ozone average greater than 75 ppb. It is unlikely the EPA will designate an area as non-attainment based on these measurements since these monitors are not reference or equivalency methods. However, the data support arguments for reference or equivalency method monitoring in these areas.

**Table 6. Portable ozone data (POMS) indicate several parks with high ozone (bold values exceed the standard).**

| POMS Network | | Annual 4th Highest 8-Hour Ozone Concentration (ppb) | | | | | |
|---|---|---|---|---|---|---|---|
| Park Name | Park Code | 3-year avg | 2007 | 2006 | 2005 | 2004 | 2003 |
| Black Canyon of the Gunnison | BLCA | 71 | --- | --- | 68 | **80** | 67 |
| Padre Island | PAIS | 75 | 75 | **80** | 71 | --- | --- |
| Assateague Island | ASIS | **78** | 74 | **84** | 72 | --- | --- |
| Lake Mead | LAME | **82** | --- | **81** | **84** | **80** | **77** |
| Joshua Tree (eastern POMS site) | JOTR | --- | **81** | **83** | --- | --- | --- |
| Abraham Lincoln Birthplace | ABLI | --- | 72 | **77** | --- | --- | --- |
| Cumberland Gap | CUGA | --- | **85** | 71 | --- | --- | --- |
| Gulf Islands | GUIS | --- | --- | --- | 74 | **78** | --- |
| Mojave | MOJA | -- | **88** | --- | --- | --- | --- |

Nearby monitors (within 5 miles of a park unit) have been found for a number of parks (Table 7). The 30 parks listed in Table 7 are projected to violate the new standard based on 2005-2007 data. If the park and the monitor are in the same county, then the violation may lead to designation of the county as non-attainment which would include the park.

In total, 92 parks with direct data measurements are likely to violate the new NAAQS. This number is based on current and recent past data, not on future predictions from modeling or projected emission changes. Figures 5 and 6 display park units that exceed and may potentially violate the new ozone standard.

| Source | Park Counts | Period |
|---|---|---|
| NPS monitored parks | 11 | 2005-2007 |
| POMS monitor data | 8 | 1-3 seasons |
| Nearby monitors (SLAMS) | 73 | 2005-2007 |
| | 92 parks potentially violate the new standard | |

**Table 7. NPS units within 5 miles of an ozone monitor and 2005-2007 average.**

| Park Name | Park Code | State | 4th Highest 8-Hour Ozone (2005-2007) | Park Name | Park Code | State | 4th Highest 8-Hour Ozone (2005-2007) |
|---|---|---|---|---|---|---|---|
| Martin Luther King, Jr. NHS | MALU | GA | 89 | Fredericksburg NC | FRED | VA | 80 |
| Fire Island NS | FIIS | NY | 88 | Jean Lafitte NPres | JELA | LA | 80 |
| Chattahoochee River NRA | CHAT | GA | 87 | Adams NHS | ADAM | MA | 80 |
| Kennesaw Mountain NBP | KEMO | GA | 87 | Chickamauga and Chattanooga NMP | CHCH | TN | 80 |
| Gateway NRA | GATE | NY | 86 | Boston Harbor Islands NRA | BOHA | MA | 80 |
| Statue of Liberty NM | STLI | NJ | 86 | Boston African American NHS | BOAF | MA | 80 |
| General Grant NM | GEGR | NY | 86 | Boston NHP | BOST | MA | 80 |
| Hamilton Grange NMem | HAGR | NY | 86 | Frederick Law Olmsted NHS | FRLA | MA | 80 |
| Saint Paul's Church NHS | SAPA | NY | 85 | John Fitzgerald Kennedy NHS | JOFI | MA | 80 |
| Hampton NHS | HAMP | MD | 85 | Longfellow NHS | LONG | MA | 80 |
| National Capital Parks - East | NACE | DC | 85 | Gulf Islands NS | GUIS | MS | 80 |
| National Capital Parks NRA | NACA | MD | 85 | James A. Garfield NHS | JAGA | OH | 80 |
| Ben Franklin NMem | BEFR | PA | 85 | Maggie L. Walker NHS | MALW | VA | 80 |
| Edgar Allan Poe NHS | EDAL | PA | 85 | Richmond NBP | RICH | VA | 79 |
| Gloria Dei (Old Swedes) Church NHS | GLDE | PA | 85 | Dayton Aviation Heritage NHP | DAAV | OH | 79 |
| Independence NHP | INDE | PA | 85 | Timpanogos Cave NM | TICA | UT | 79 |
| Thaddeus Kosciuszko NMem | THKO | PA | 85 | Fredericksburg & Spotsylvania NMP | FRSP | VA | 79 |
| John F. Kennedy Cntr for Performing Arts | JOFK | DC | 84 | Lake Mead NRA | LAME | NV | 79 |
| Lafayette Square P | WHHO | DC | 84 | First Ladies NHS | FILA | OH | 79 |
| National Mall & Memorial Parks | NACC | DC | 84 | Cuyahoga Valley NP | CUVA | OH | 79 |
| Rock Creek P | ROCR | DC | 84 | Saugus Iron Works NHS | SAIR | MA | 79 |
| Theodore Roosevelt NMem | THIS | VA | 84 | Lowell NHP | LOWE | MA | 78 |
| Arlington House Robert E. Lee | ARHO | VA | 84 | Little Rock Central High School NHS | CHSC | AR | 78 |
| Lyndon Baines Johnson NMem | LYBA | VA | 84 | Natchez NHP | NATC | MS | 78 |
| Clara Barton NHS | CLBA | MD | 84 | Guilford Courthouse NMP | GUCO | NC | 78 |
| George Washington Mem PKWY | GWMP | MD | 84 | Indiana Dunes NL | INDU | IN | 78 |
| Ulysses S. Grant NHS | ULSG | MO | 84 | Petersburg NB | PETE | VA | 78 |
| Jefferson National Expansion Mem NHS | JEFF | MO | 83 | Antietam NB | ANTI | MD | 78 |
| Wolf Trap Farm Park | WOTR | VA | 83 | Santa Monica Mountains NRA | SAMO | CA | 77 |
| Ocmulgee NM | OCMU | GA | 82 | Cumberland Gap NHP | CUGA | KY | 76 |
| New Bedford Whaling NHP | NEBE | MA | 82 | Tonto NM | TONT | AZ | 76 |
| Roger Williams NMem | ROWI | RI | 82 | Tupelo NB | TUPE | MS | 76 |
| William Howard Taft NHS | WIHO | OH | 82 | Allegheny Portage Railroad NHS | ALPO | PA | 76 |
| Prince William Forest Park | PRWI | VA | 81 | Big Thicket NPres | BITH | TX | 76 |
| Sleeping Bear Dunes NL | SLBE | MI | 81 | Blue Ridge Parkway | BLRI | VA | 76 |
| Monocacy NB | MONO | MD | 81 | Illinois & Michigan Canal NHC | ILMI | IL | 75 |
| Manassas NBP | MANA | VA | 81 | | | | |

Notes:
- NPS units within 5 miles of ozone monitors used to compute 2005-2007 4th Highest 8-hour average
- Monitors used include ozone monitors and CASTNet monitors
- Ozone values are taken at park centroid - for parks with multiple units centroid of the largest unit was used

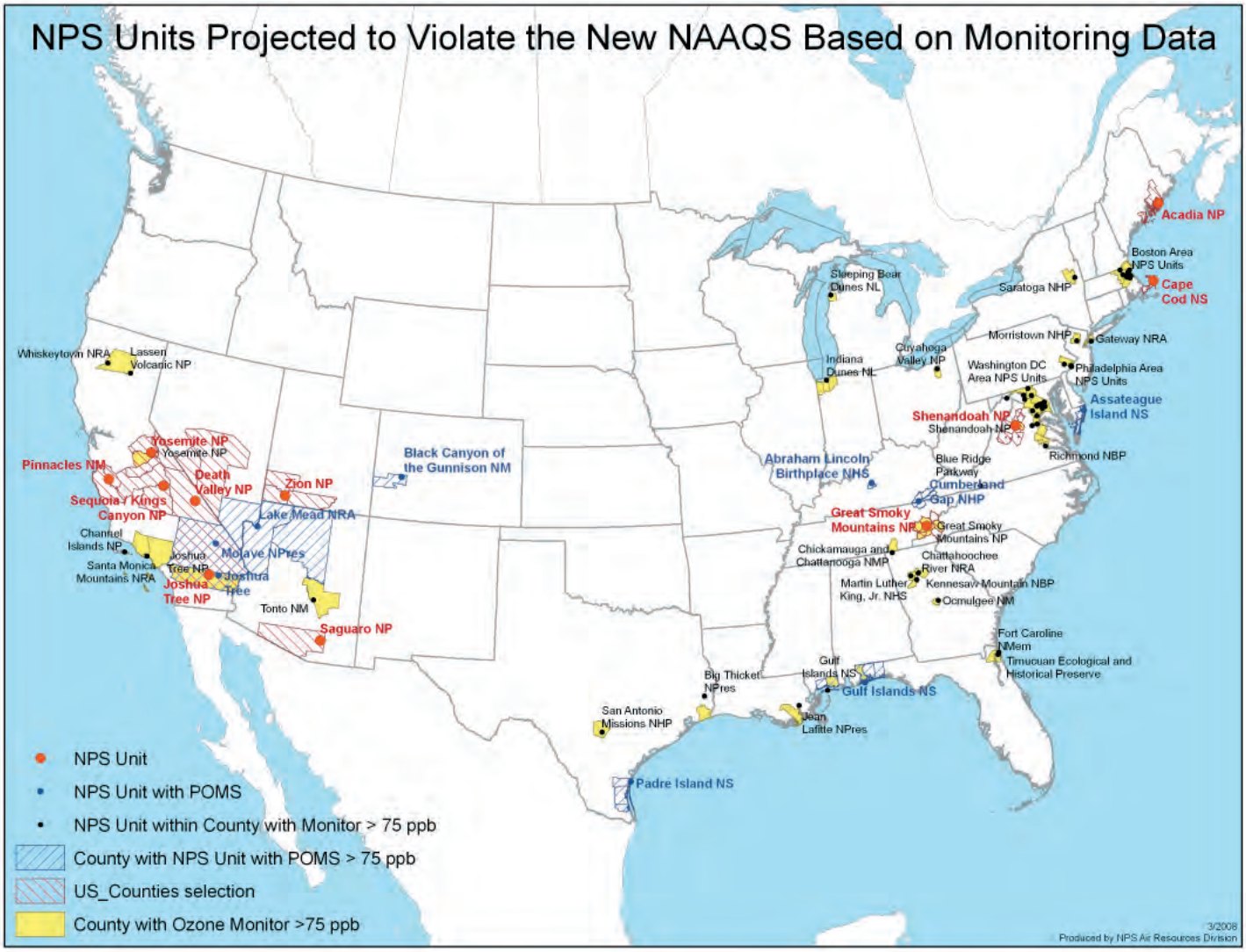
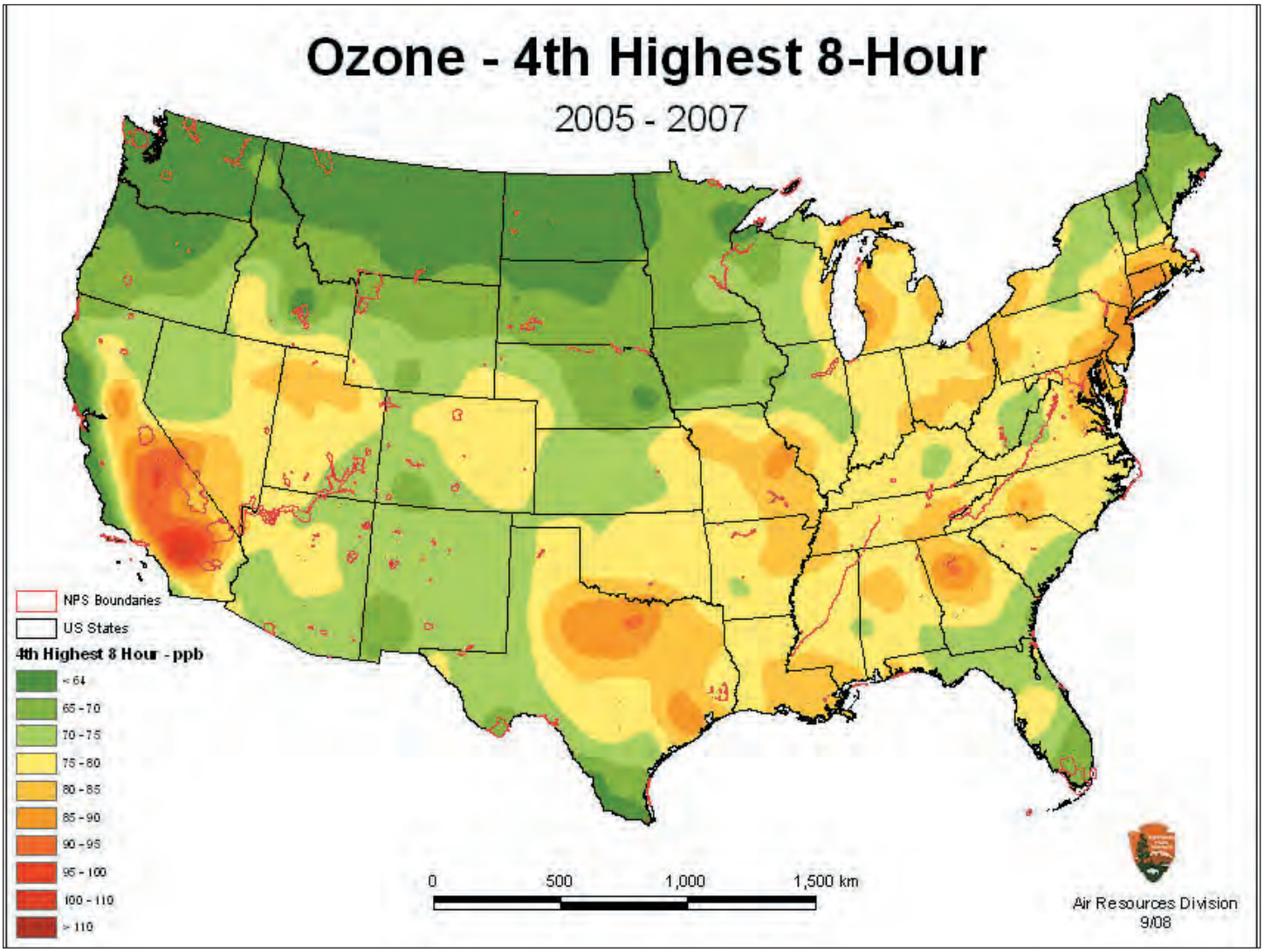



**Figure 6. Counties and park units with monitoring data that support a possible violation of the new ozone NAAQS of 75 ppb. Only counties with NPS monitors or park units are shown. See Figure 9 for the urban counties EPA expects will violate the new standard.**

*Estimates From GIS Interpolation*
The NPS Air Atlas project[4] (*http://www.nature.nps.gov/air/maps/AirAtlas/index.cfm*) has taken data reported to the EPA AQS database plus Clean Air Status and Trends Network (CASTNet) data and interpolated the ozone values over the continental U.S. Although interpolated ozone values do not translate to a violation of the standard, this analysis does suggest a broader range of high ozone concentrations than direct monitoring alone indicates. In Figure 7, the yellow through the reds have 4th highest 8-hour ozone values of 75 ppb or greater for a three-year average. These are the areas most likely to violate the new standard. On this map, the boundary of the 75 ppb and greater areas is only approximate.

Park units with interpolation zones that project possible violations of the ozone NAAQS are shown more clearly in Figure 8. Blue square symbols are park units within the violation zone and open squares are outside. Some parks are borderline or show locally monitored concentrations that conflict with interpolations, such as Rocky Mountain NP, Pinnacles NM, and Acadia NP. Actual monitoring data will have to be used to resolve these conflicts.

**Figure 7. Interpolations of monitoring data from the Air Atlas program. Yellow to red areas are projected to violate the new standard.**



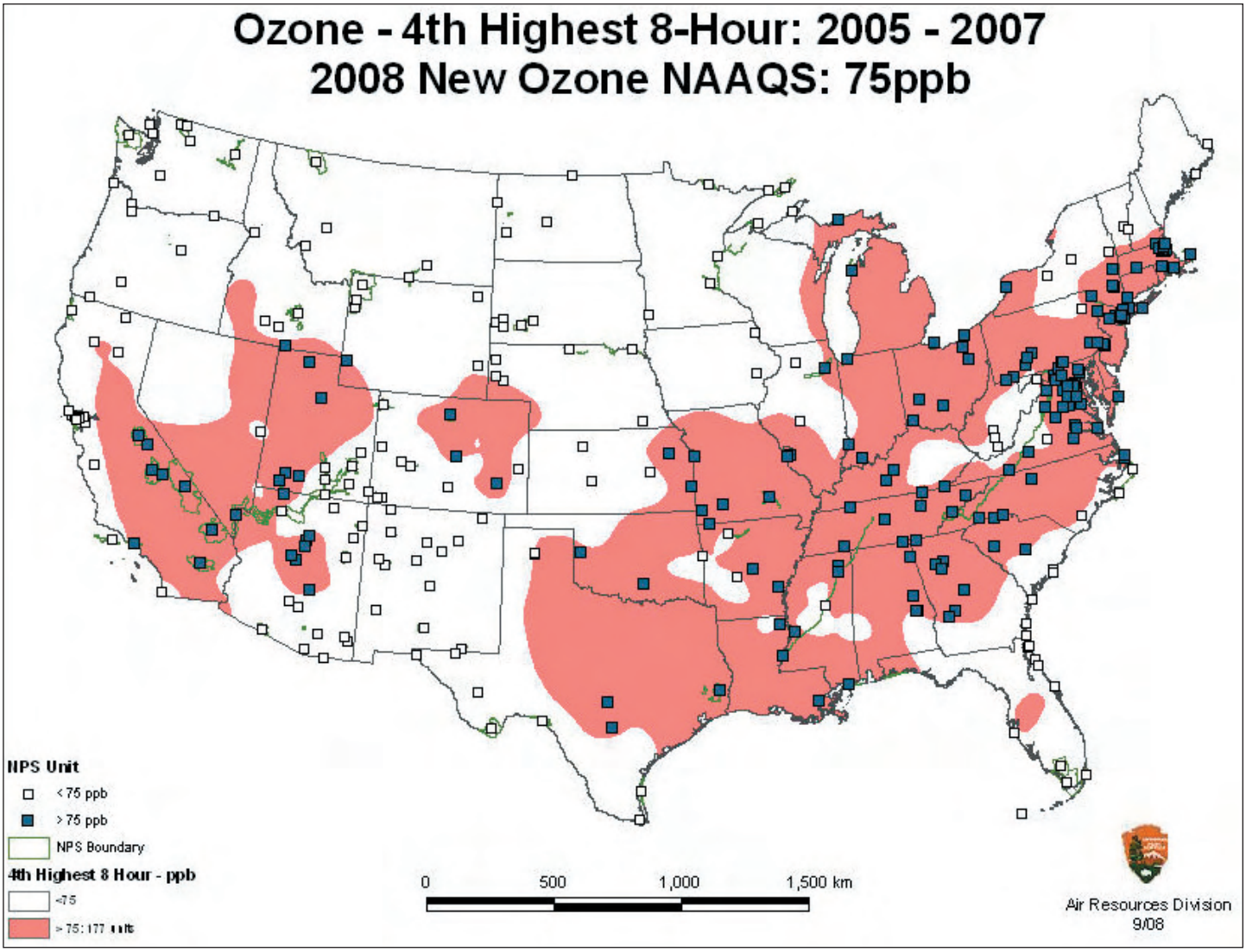



**Figure 8. Violation areas are extracted from the Figure 6 map and the parks in the violation areas are shown.**

In its announcement of the new standard, the EPA provided a map and list of counties it expects to violate the new standard. Combining this information with the parks that are projected to violate the NAAQS based on monitoring and the parks in the >75 ppb $O_3$ interpolation areas (Figure 8) another map can be generated based on counties (Figure 9). More than 150 park units fall within counties that by measurement or interpolation might violate the new standard.

Since counties are designated non-attainment based on monitors within their boundaries, Figure 9 is an estimate of which counties and parks will be represented by monitors and which ones will not. If the counties become designated as non-attainment the parks would benefit from clearer air associated with the control measures that might be implemented.

**Counties Potentially in Violation**

- **325** counties that could violate the standard according to interpolation intersect with a county containing an NPS unit.
- **141** NPS units in counties that could violate the standard according to interpolation of which counties have an ozone monitor (some counties have multiple park units).
- **1457** counties that could violate the standard according to interpolation of which counties do NOT have an ozone monitor.

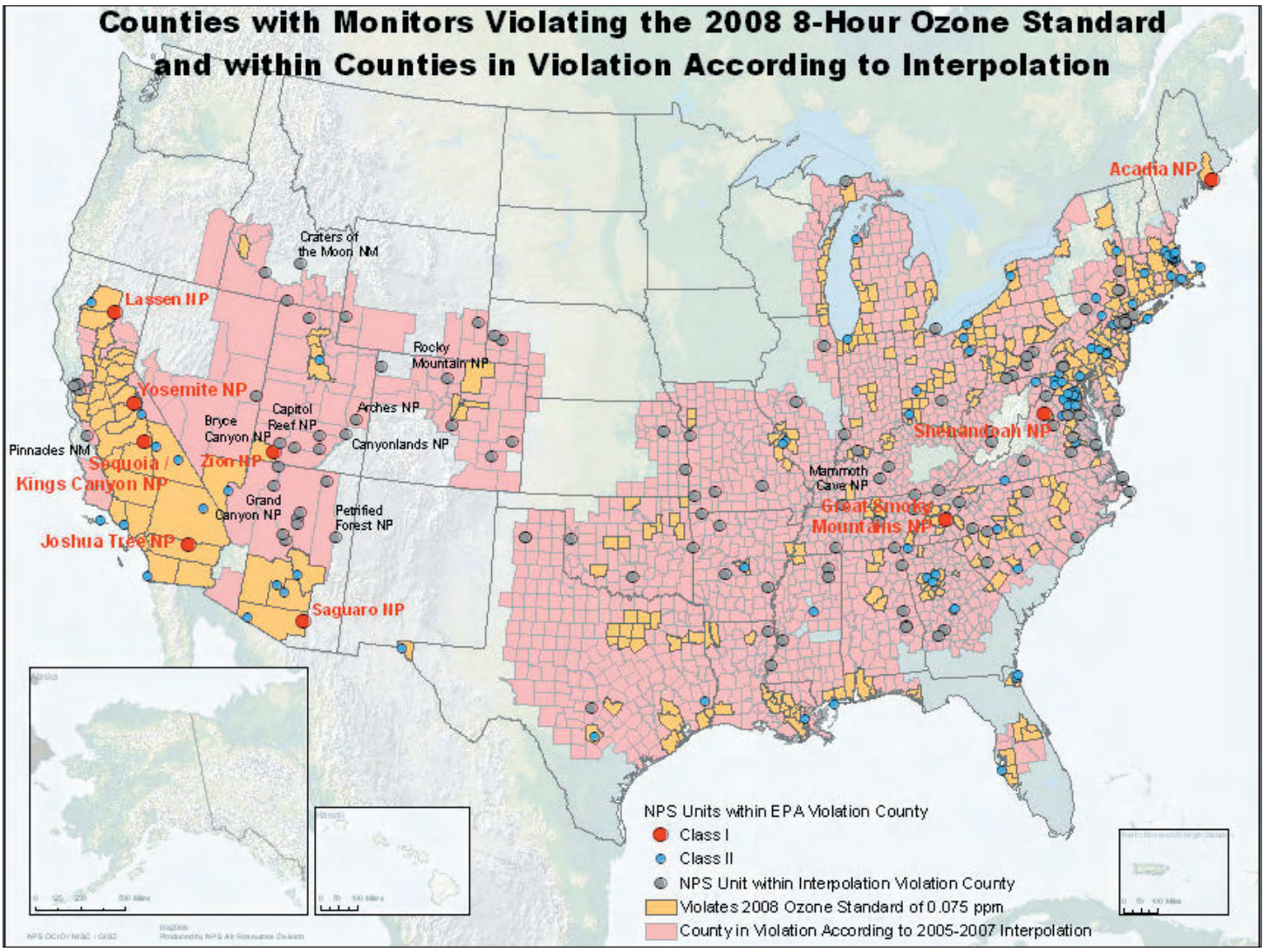



**Figure 9. This map combines the counties EPA projects to violate the new standard (orange) and the counties projected from Air Atlas (rose color) as potentially in violation. The red, blue, and gray dots are park locations. Many rural counties have the potential to violate the standard.**

EPA has proposed that each state should have at least two rural monitors, but a rule has not yet been promulgated. If EPA requires only two rural monitors in each state then very large areas that may exceed the 75 ppb standard will not be effectively covered. Current EPA plans (not formally announced or final) are to use the rural CASTNet monitors as the foundation for rural monitoring. Most of the CASTNet stations in the Western states are NPS monitors. At least 22 states have fewer than two CASTNet rural monitors. The EPA network (*http://www.epa.gov/ttn/amtic/ncore/networks.html*) with trace-leveling monitoring (NCORE) may fill in rural monitoring in some states. Many states also run rural monitors to get upwind or background concentrations to assist in pollutant modeling. Despite the planned rural monitoring coverage there will still be a large number of rural counties (and parks) with no monitoring data (Figure 10).

*Frequency of Exceedances*

The standard doesn't specifically address the number of days that exceed the standard and are therefore considered unhealthy air quality days. In many places the number of days that exceed the standard are many more than four per year. The frequency of exceedances per year, for locations where there is monitoring information, is given in Table 8 as an average number per year for the period 2005-2007. Five parks are highlighted that either already issue health warnings or might consider it because of the high number of exceedance days. In many cases, visibility and $PM_{2.5}$ air quality is also quite poor during high ozone days. The combination of pollutants is more serious than when pollutants are considered separately and should be included in air quality advisories.

**Figure 10. The counties highlighted in green have both park unit(s) and a monitor in the county (black dots) and are in areas that are potentially in violation according to interpolation.**

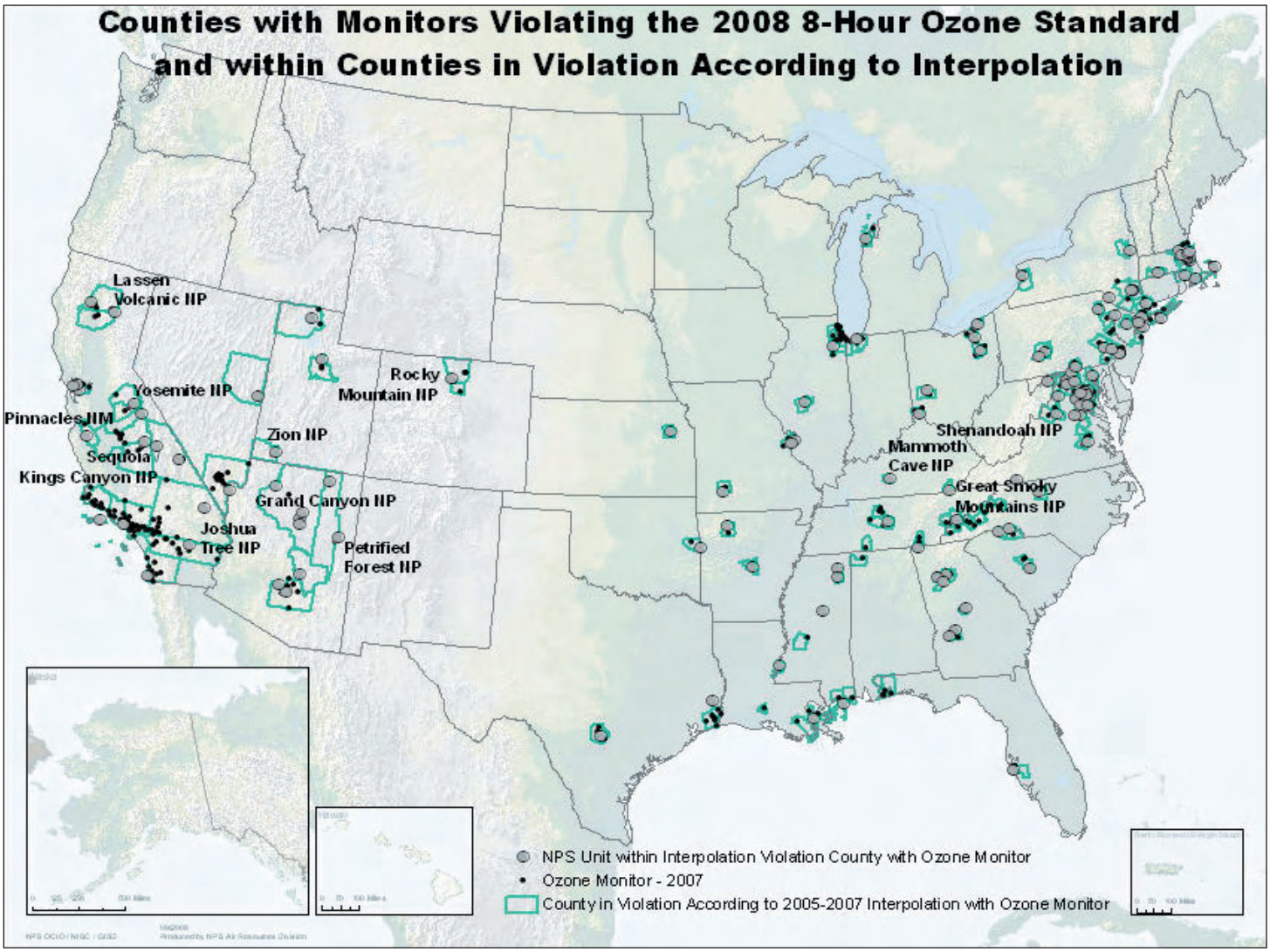


**Table 8. Frequency of exceedances (mean number of days) where the daily maximum 8-hour average was greater than 75 ppb based on 2005-2007 data. This mean is based on a simple count of the days. No annual completeness criteria (such as a minimum number of valid daily 8-hour maximums) were applied.**

| Park Name | Site Code | Park Code | Average Exceeds/ Year | Number of Years | Park Name | Site Code | Park Code | Average Exceeds/ Year | Number of Years |
|---|---|---|---|---|---|---|---|---|---|
| Abraham Lincoln Birthplace | ABLI-VC | ALBI | 2 | 1 | Indiana Dunes | INDU-GS | INDU | 5 | 3 |
| Acadia | ACAD-CM | ACAD | 8 | 3 | Indiana Dunes | INDU-WT | INDU | 8 | 3 |
| Acadia | ACAD-MH | ACAD | 3 | 3 | Isle Royale AQS Comparison Site #1 | ISRO-X1 | ISRO | 0 | 3 |
| Agate Fossil Beds | AGFO-RA | AGFO | 0 | 1 | Isle Royale AQS Comparison Site #2 | ISRO-X2 | ISRO | 8 | 3 |
| Appalachian Trail | APTR-MG | APTR | 8 | 3 | Joshua Tree | JOTR-BR | JOTR | 68 | 3 |
| Assateague Island | ASIS-MA | ASIS | 3 | 1 | Joshua Tree | JOTR-CC | JOTR | 5 | **3** |
| Badlands | BADL-VC | BADL | 0 | 3 | Joshua Tree | JOTR-PW | JOTR | 6 | 1 |
| Big Bend | BIBE-KB | BIBE | 0 | 3 | Lake Mead AQS Comp. Site #1 | LAME-X1 | LAME | 6 | 3 |
| Big South AQS Comparison Site | BISO-XX | BISO | 2 | 3 | Lake Mead AQS Comp. Site #2 | LAME-X2 | LAME | 1 | 3 |
| Blue Ridge Parkway | BLRI-75 | BLRI | 1 | 3 | Lassen Volcanic | LAVO-ML | LAVO | 2 | 3 |
| Blue Ridge Parkway | BLRI-BK | BLRI | 5 | 3 | Mammoth Cave | MACA-HM | MACA | 6 | **3** |
| Blue Ridge Parkway | BLRI-BR | BLRI | 6 | 2 | Mesa Verde | MEVE-RM | MEVE | 2 | 3 |
| Blue Ridge Parkway | BLRI-FP | BLRI | 8 | 3 | Mississippi | MISS-AC | MISS | 1 | 3 |
| Blue Ridge Parkway | BLRI-RO | BLRI | 3 | 3 | Mississippi | MISS-ST | MISS | 2 | 3 |
| Blue Ridge Parkway | BLRI-RS | BLRI | 0 | 3 | Mississippi | MISS-WC | MISS | 2 | 3 |
| Blue Ridge Parkway | BLRI-VE | BLRI | 5 | 3 | Mojave | MOJA-KM | MOJA | 26 | 1 |
| Boston Harbor Islands | BOHA-NM | BOHA | 6 | 3 | Mount Rainier | MORA-JV | MORA | 0 | 3 |
| Canyonlands | CANY-IS | CANY | 0 | 3 | Mount Rainier | MORA-TW | MORA | 0 | 3 |
| Cape Cod | CACO-XX | CACO | 13 | 3 | Natchez Trace | NATR-DR | NATR | 0 | 1 |
| Carlsbad Caverns | CAVE-MA | CAVE | 0 | 1 | North Cascades | NOCA-MM | NOCA | 0 | **3** |
| Chamizal | CHAM-XX | CHAM | 4 | 3 | Olympic | OLYM-BL | OLYM | 0 | 1 |
| Chiricahua | CHIR-ES | CHIR | 0 | 3 | Olympic | OLYM-HP | OLYM | 0 | 1 |
| Colorado | COLM-MY | COLM | 0 | 1 | Padre Island | PAIS-MV | PAIS | 2 | 1 |
| Congaree | COSW-BL | COSW | 2 | 3 | Petrified Forest | PEFO-SE | PEFO | 1 | **3** |
| Cowpens | COWP-SM | COWP | 4 | 3 | Petroglyph | PETR-WT | PETR | 1 | 3 |
| Craters of the Moon | CRMO-VC | CRMO | 0 | 3 | Pinnacles | PINN-ES | PINN | 4 | 3 |
| Cumberland Gap | CUGA-HS | CUGA | 16 | 1 | Rock Creek | ROCR-AP | ROCR | 10 | 3 |
| Cuyahoga Valley | CUVA-PA | CUVA | 16 | 3 | Rocky Mountain | ROMO-LP | ROMO | 4 | 3 |
| Death Valley | DEVA-PV | DEVA | 17 | 3 | Saguaro | SAGU-PU | SAGU | 4 | 3 |
| Denali | DENA-HQ | DENA | 0 | 3 | Saratoga | SARA-ST | SARA | 7 | **3** |
| Dinosaur | DINO-WE | DINO | 0 | 1 | Saugus Iron Works | SAIR-LW | SAIR | 10 | 3 |
| Everglades | EVER-CR | EVER | 1 | 3 | Sequoia and Kings Canyon | SEKI-AS | SEKI | 82 | 3 |
| George Washington | GEWA-AH | GEWA | 12 | 3 | Sequoia and Kings Canyon | SEKI-LK | SEKI | 63 | 3 |
| Glacier | GLAC-WG | GLAC | 0 | 3 | Shenandoah | SHEN-BM | SHEN | 5 | 3 |
| Grand Canyon | GRCA-AS | GRCA | 2 | 3 | Theodore Roosevelt | THRO-VC | THRO | 0 | 3 |
| Great Basin | GRBA-MY | GRBA | 2 | 3 | Voyageurs | VOYA-SB | VOYA | 1 | 3 |
| Great Smoky Mountains | GRSM-CC | GRSM | 1 | 3 | Wind Cave | WICA-VC | WICA | 1 | 3 |
| Great Smoky Mountains | GRSM-CD | GRSM | 21 | 3 | Yellowstone | YELL-WT | YELL | 0 | 3 |
| Great Smoky Mountains | GRSM-CM | GRSM | 18 | 3 | Yosemite | YOSE-M2 | YOSE | 0 | 1 |
| Great Smoky Mountains | GRSM-LR | GRSM | 26 | 3 | Yosemite | YOSE-MO | YOSE | 1 | 1 |
| Great Smoky Mountains | GRSM-PK | GRSM | 8 | 3 | Yosemite | YOSE-MR | YOSE | 0 | 1 |
| Guilford Courthouse | GUCO-MM | GUCO | 14 | 3 | Yosemite | YOSE-SY | YOSE | 0 | 1 |
| Gulf Is. Port. AQS Comparison Site | GUIS-XX | GUIS | 12 | 3 | Yosemite | YOSE-TD | YOSE | 23 | 3 |
| Indiana Dunes | INDU-AB | INDU | 7 | 3 | Zion | ZION-DW | ZION | 4 | 3 |

Severity of the NAAQS violation can be judged by both high concentrations of the 4th highest 8-hour values and by the number of exceedances per year. Parks can assess the severity based on frequency of exceedances during the summer season. Table 9 is a proposed scale that defines and categorizes violation severities.

**Table 9. Ozone violation severity can also be judged by the frequency of events.**

| Number of exceedances per year | Severity |
|---|---|
| 4 | Borderline, likely to violate standard |
| 20 | Serious, average of once per week |
| 50 | 30% of days unhealthy |
| > 75 | > 50% of days unhealthy |

***Timelines for Implementation of the New Standard***

The following is the EPA schedule for implementation of the new standard if the final rule is not challenged and delayed by court action[1].

*The Clean Air Act requires EPA to designate areas as attainment (meeting the standards), nonattainment (not meeting the standards), or unclassifiable (insufficient data to classify) after the Agency sets a new standard, or revises an existing standard. The following schedule will apply to the revised ozone standards:*

- *States must make recommendations to EPA no later than March 2009 for areas to be designated attainment, nonattainment or unclassifiable.*
- *EPA will issue final designations of attainment, nonattainment and unclassifiable areas no later than March 2010, unless there is insufficient information to make these designation decisions. In that case, EPA will issue designations no later than March 2011.*
- *States must submit State Implementation Plans outlining how they will reduce pollution to meet the standards by a date that EPA will establish in a separate rule. That date will be no later than three years after EPA's final designations. If EPA issues designations in 2010, then these plans would be due no later than 2013.*
- *States are required to meet the standards by deadlines that may vary based on the severity of the problem in the area.*

The years 2006 – 2008 will be the 3-year basis for designating non-attainment based on the new ozone standard. The current non-attainment areas will remain in effect and must progress towards attainment until new designations in 2010 and new plans in 2013. EPA modeling has projected that ozone concentrations will continue to decrease during that time. If that happens, then the number of locations that might violate the new standard, based on 2004-2006 and 2007 data, may be an overestimate.

***Conclusions***

The new ozone standard of 75 ppb is more protective and will result in significantly more rural park units being included in the regulatory process for air quality improvement. Best information at this time indicates 92 parks have measured ozone concentrations that could put them in violation of the 75 ppb ozone NAAQS. There will be many more cultural and battlefield park units in urban areas classified as non-attainment. Some of these, like Rock Creek in Washington DC, do have significant natural resources. Potentially, more than 150 parks highlighted in this analysis could violate the ozone standard.

Many of the park units that would violate the new NAAQS are rural or in low population areas. Based on this, two challenges present themselves:

1. Notify visitors and staff of the ozone health risks.
2. Assure that all park units that violate the ozone standard actually get designated as non-attainment so that State Implementation Plans are revised to specifically address control measures to improve the ozone in these parks.

Although current EPA rules specify that monitoring data must be used to designate a county non-attainment, for rural counties in the future, some combination of monitoring and modeling is more likely to be used, but is currently not specified by the EPA. The secondary ozone standard has not been used much in the past since the primary and secondary standards have been the same values. At the new standard of 75 ppb many more rural and natural areas without significant emission sources will have to be considered for non-attainment designation and some form of control strategies be implemented.

**Resource Injury Indices**

To quantify ozone exposure to plants, various indices other than the NAAQS primary and secondary standards are often used. These indices, defined below, take into account both peak ozone concentrations and cumulative exposure to ozone.

- W126 – A cumulative index that is calculated as the maximum 3-month sum of the 0800-2000 hourly average ozone concentrations during the EPA-designated ozone season, where a weighting function is used to give increasing significance (weights between 0 and 1) to concentrations of ozone greater than 0.04 ppm (40 ppb), and no weight to concentrations below 0.04 ppm (40 ppb). Units of this index are ppm-hr. EPA considered using the W126 metric for the secondary standard in its recent review of the ozone NAAQS. In its technical review, EPA recognized that the W126 was a more biologically relevant measure of ozone exposure to plants. NPS supported a secondary standard of 7-9 ppm-hr.
- SUM06 – A cumulative index that is calculated as the maximum 3-month sum of the 0800-2000 hourly average ozone concentrations during the ozone season that are equal to or greater than 0.06 ppm (60 ppb). The units of this index are ppm-hr. Several thresholds have been developed for SUM06 (Heck and Cowling, 1997[5]).

Table 10 displays the W126 and SUM06 thresholds for ozone effects to vegetation.

Table 11 presents the ozone exposure indices summary statistics for 2007. Summaries for POMS are included for reference only. Since portable sites are deployed for seasonal use, there may be significant biases in W126 and SUM06 exposure indices calculated from their data. These statistics were not calculated for sites that were operational for less than three months during the year. In 2007 these sites were Agate Fossil Beds and Olympic.

Figure 11 presents the 3-month maximum W126 exposure index. Figure 12 presents the annual 3-month maximum SUM06 exposure index for all network sites listed in Table 11. Index values are color-coded to represent three distinct levels of cumulative exposure. Data from portable sites (no color) are included for reference only.

Ozone effects depend not only on ozone exposure, but on other factors that may ameliorate or magnify the extent of ozone injury, including soil moisture, presence of other air pollutants, insects or diseases, and other environmental stresses. A high W126 exposure in a drought year, for example, may not result in vegetation injury because stomatal closure to prevent moisture loss will also prevent ozone uptake.

In 2006, assessments were completed to evaluate the potential for ozone injury to vegetation at many national park service units. The assessments are available at *http://www.nature.nps.gov/air/pubs/ecoeffects.cfm*. Information on ozone-sensitive plant species is available at *http://www.nature.nps.gov/air/pubs/pdf/baltfinalreport1.pdf*.

**Table 10. W126 and SUM06 thresholds for ozone effects to vegetation (based on 3-month, 12-hour exposure)[5]**

| | W126 | SUM06 |
|---|---|---|
| **Growth Reduction** | | |
| Tree seedlings - natural forest stands | 7-13 ppm-hrs | 10-15 ppm-hrs |
| Tree seedlings/saplings - plantations | 9-14 ppm-hrs | 12-16 ppm-hrs |
| **Visible Foliar Injury** | | |
| Plants in natural ecosystems | 5-9 ppm-hrs | 8-12 ppm-hrs |

**Table 11. 2007 Summary of indices for resource injury (W126 and SUM06).**

| National Park Unit | Site Name | $O_3$% Valid | W126[a] (ppm-hr) | SUM06[b] (ppm-hr) |
|---|---|---|---|---|
| **Sites operated by the National Park Service** | | | | |
| Badlands | Visitor Center | 99.8 | 5.9 | 4.5 |
| Big Bend | K-Bar Ranch Road | 98.8 | 17.5 | 17.3 |
| Canyonlands | Island in the Sky | 97.2 | 27.9 | 33.0 |
| Chiricahua | Entrance Station | 97.1 | 18.4 | 20.8 |
| Craters of the Moon | Visitor Center | 60.4 | 14.7 | 10.7 |
| Death Valley | Park Village | 97.3 | 51.4 | 80.0 |
| Denali | Headquarters | 97.3 | 4.0 | 0.0 |
| Glacier | West Glacier Horse Stables | 96.2 | 0.9 | 0.0 |
| Grand Canyon | The Abyss | 97.6 | 32.7 | 48.4 |
| Great Basin | Maintenance Yard | 96.6 | 27.8 | 34.3 |
| Great Smoky Mountains | Clingmans Dome | 95.6 | 53.4 | 79.9 |
| Great Smoky Mountains | Cove Mountain | 99.6 | 45.6 | 65.9 |
| Great Smoky Mountains | Look Rock | 99.7 | 42.9 | 61.9 |
| Joshua Tree | Black Rock | 95.5 | 88.2 | 119.0 |
| Joshua Tree | Cottonwood Canyon | 77.0 | 30.0 | 41.1 |
| Lassen Volcanic | Manzanita Lake Fire Station | 99.7 | 18.9 | 23.5 |
| Mammoth Cave | Houchin Meadow | 99.3 | 25.1 | 35.0 |
| Mesa Verde | Resource Management Area | 98.5 | 25.9 | 32.0 |
| Mount Rainier | Tahoma Woods | 97.0 | 1.9 | 1.6 |
| North Cascades | Marblemount Ranger Station | 98.7 | 1.2 | 0.2 |
| Petrified Forest | South Entrance | 86.6 | 19.9 | 25.3 |
| Pinnacles | SW of East Entrance Station | 99.7 | 15.5 | 20.6 |
| Rocky Mountain | Long's Peak | 96.7 | 25.7 | 31.4 |
| Sequoia and Kings Canyon | Ash Mountain | 69.0 | 75.5 | 111.2 |
| Sequoia and Kings Canyon | Lower Kaweah | 99.6 | 75.6 | 102.2 |
| Shenandoah | Big Meadows | 96.2 | 25.1 | 39.2 |
| Voyageurs | Sullivan Bay | 94.9 | 7.8 | 5.3 |
| Yellowstone | Water Tank | 96.7 | 13.7 | 11.9 |
| Yosemite | Turtleback Dome | 96.6 | 44.4 | 67.0 |
| Zion | Dalton's Wash | 92.0 | 24.5 | 34.9 |
| **Sites operated by cooperating state agencies** | | | | |
| *Acadia* | Cadillac Mountain | 99.3 | 14.5 | 16.2 |
| *Acadia* | McFarland Hill | 99.5 | 10.9 | 10.9 |
| *Cape Cod* | Cape Cod | 94.1 | 17.4 | 20.6 |
| *Chamizal* | Chamizal | 99.0 | 14.2 | 17.2 |
| *Congaree* | Congaree Bluff | 93.0 | 10.1 | 13.3 |
| *Cowpens* | State Monitor | 98.9 | 8.7 | 9.1 |
| *Great Smoky Mountains* | Cades Cove | 99.2 | 15.5 | 22.2 |
| *Great Smoky Mountains* | Purchase Knob | 94.4 | 26.9 | 36.6 |
| *Mount Rainier* | Jackson Visitor's Center | 86.9 | 4.6 | 3.9 |
| *Saguaro* | Pima County | 98.4 | 19.9 | 24.5 |
| *Theodore Roosevelt* | Painted Canyon Visitor Center | 96.8 | 5.9 | 3.4 |
| *Wind Cave* | Visitor Center | 99.8 | 9.7 | 8.8 |

**Table 11. 2007 Summary of indices for resource injury (W126 and SUM06) (continued).**

| National Park Unit | Site Name | $O_3$% Valid | W126[a] (ppm-hr) | SUM06[b] (ppm-hr) |
|---|---|---|---|---|
| **Nearby sites operated by other agencies** | | | | |
| *Alabama-Coushatta* | CASTNet site | 65.9 | 3.8 | 2.9 |
| *Appalachian Trail* | Mount Greylock Summit | 96.6 | 24.0 | 31.3 |
| *Blue Ridge Parkway* | 7510 Blue Ridge Parkway | 89.8 | 10.5 | 13.8 |
| *Blue Ridge Parkway* | Barnet Knob Firetower Road | 92.2 | 21.2 | 34.4 |
| *Blue Ridge Parkway* | Frying Pan Mountain | 92.3 | 32.2 | 52.4 |
| *Blue Ridge Parkway* | Route 191 | 99.7 | 14.7 | 18.8 |
| *Blue Ridge Parkway* | Ranger Station | 97.5 | 8.1 | 8.9 |
| *Blue Ridge Parkway* | Vinton Elementary | 99.7 | 15.8 | 19.4 |
| *Boston Harbor Islands* | Former Nike Missile Site | 29.2 | 3.2 | 2.1 |
| *Cuyahoga Valley* | 800 Patterson | 99.8 | 23.9 | 31.5 |
| *Everglades* | Cutler Road | 98.8 | 12.2 | 11.1 |
| *George Washington Pkwy* | Alexandria Health | 100.0 | 19.0 | 24.0 |
| *Guilford Courthouse* | Mendenhall Middle School | 92.8 | 25.9 | 37.1 |
| *Indiana Dunes* | Ammunition Bunker | 91.2 | 13.4 | 17.2 |
| *Indiana Dunes* | Gas Station | 90.5 | 6.2 | 6.2 |
| *Indiana Dunes* | Water Treatment Plant | 97.1 | 14.9 | 19.9 |
| *Mississippi* | Anoka County Airport | 99.2 | 9.6 | 10.9 |
| *Mississippi* | Somerset Town Hall | 99.1 | 9.8 | 10.0 |
| *Mississippi* | Washington County | 98.0 | 10.0 | 10.8 |
| *Mount Baker* | Mount Baker | 94.4 | 0.9 | 0.0 |
| *Petroglyph* | Westside Taylor Ranch | 99.7 | 18.5 | 25.4 |
| *Rock Creek* | Achbold Parkway | 97.8 | 17.2 | 22.4 |
| *Saratoga* | Stillwater | 98.6 | 13.1 | 15.0 |
| *Saugus Iron Works* | Lynn Water Treatment | 97.5 | 12.0 | 13.7 |
| **Portable ozone monitoring systems** | | | | |
| Abraham Lincoln Birthplace | Visitor Center | 98.4 | 12.1 | 14.8 |
| Assateague Island | Maintenance Area | 90.5 | 15.5 | 20.0 |
| Carlsbad Caverns | Maintenance Area | 82.7 | 11.0 | 9.0 |
| Colorado | Maintenance Yard | 91.8 | 9.1 | 9.2 |
| Cumberland Gap | Hensley Settlement | 99.3 | 37.8 | 52.1 |
| Dinosaur | West Entrance Housing | 99.9 | 12.2 | 7.4 |
| Joshua Tree | Pinto Wells | 94.6 | 33.6 | 51.1 |
| Mojave | Kelso Mountains | 82.2 | 50.4 | 75.6 |
| Natchez Trace Parkway | Dancy Ranger Station | 100.0 | 8.6 | 10.0 |
| Padre Island | Malaquite Visitor Center | 88.6 | 13.4 | 19.6 |
| Yosemite | School Yard | 98.2 | 7.3 | 6.1 |

[a] W126 exposure index represents 0800-2000 hourly ozone concentrations where each concentration is weighted by a function that gives greater emphasis to the higher hourly concentrations while still including the lower ones. The value reported here represents a three-month maximum value during the ozone season. Units are ppm-hr. For more information on the W126 exposure index go to *http://www.nature.nps.gov/air/maps/AirAtlas/docs/air_quality_glossary.pdf*.

[b] SUM06 exposure index represents the 0800-2000 hourly ozone concentrations equaling or exceeding 0.06 ppm. The value reported here represents a three-month maximum value during the ozone season. Units are ppm-hr.

Operating agency key: plain text = site operated by the National Park Service; italics = site operated by a state agency; underline = site operated by the National Park Service, but consisting of non-EPA certified portable instrumentation

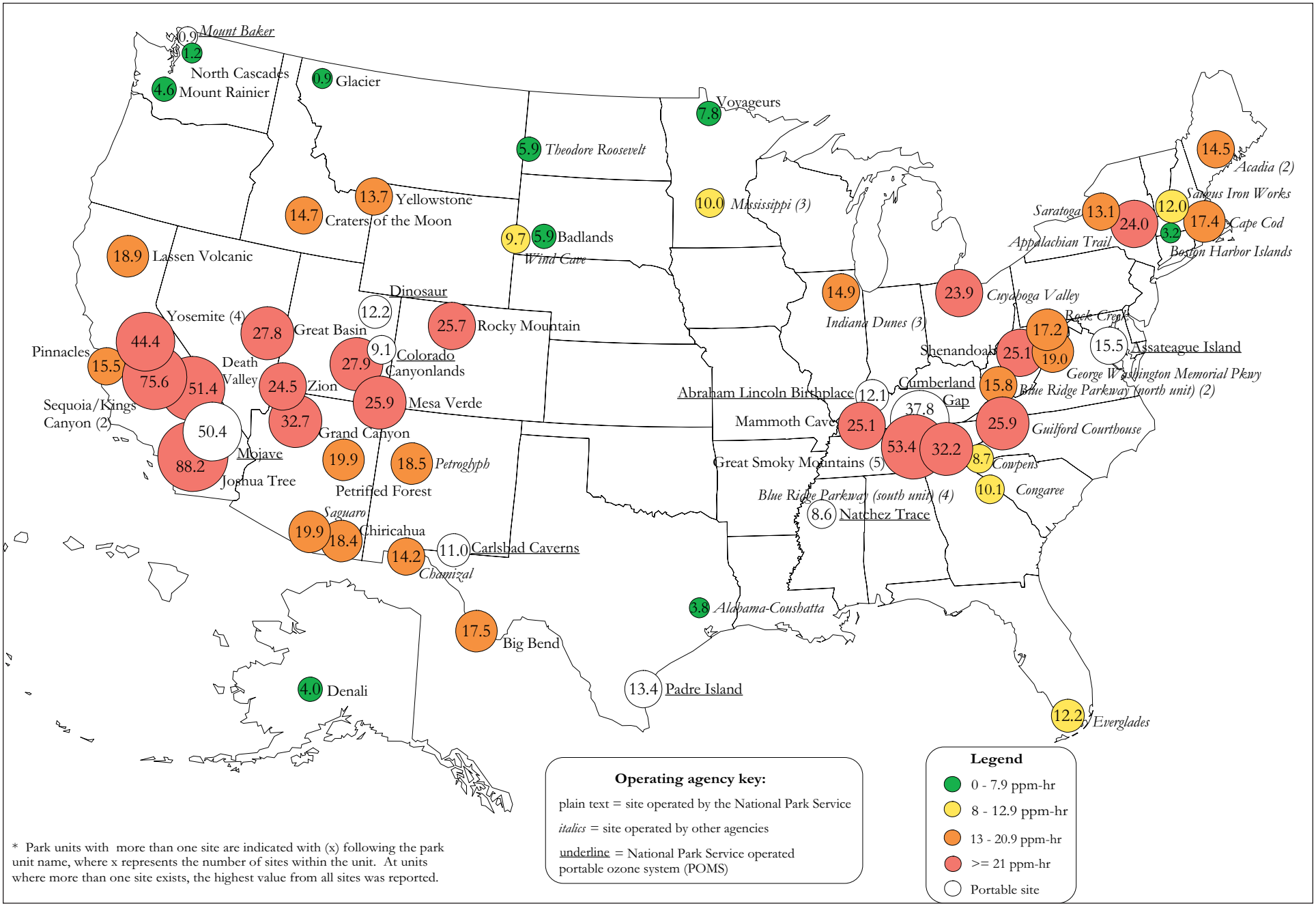



**Figure 11. 2007 3-month maximum W126 exposure index during the ozone season (0800-2000 hourly concentrations).**

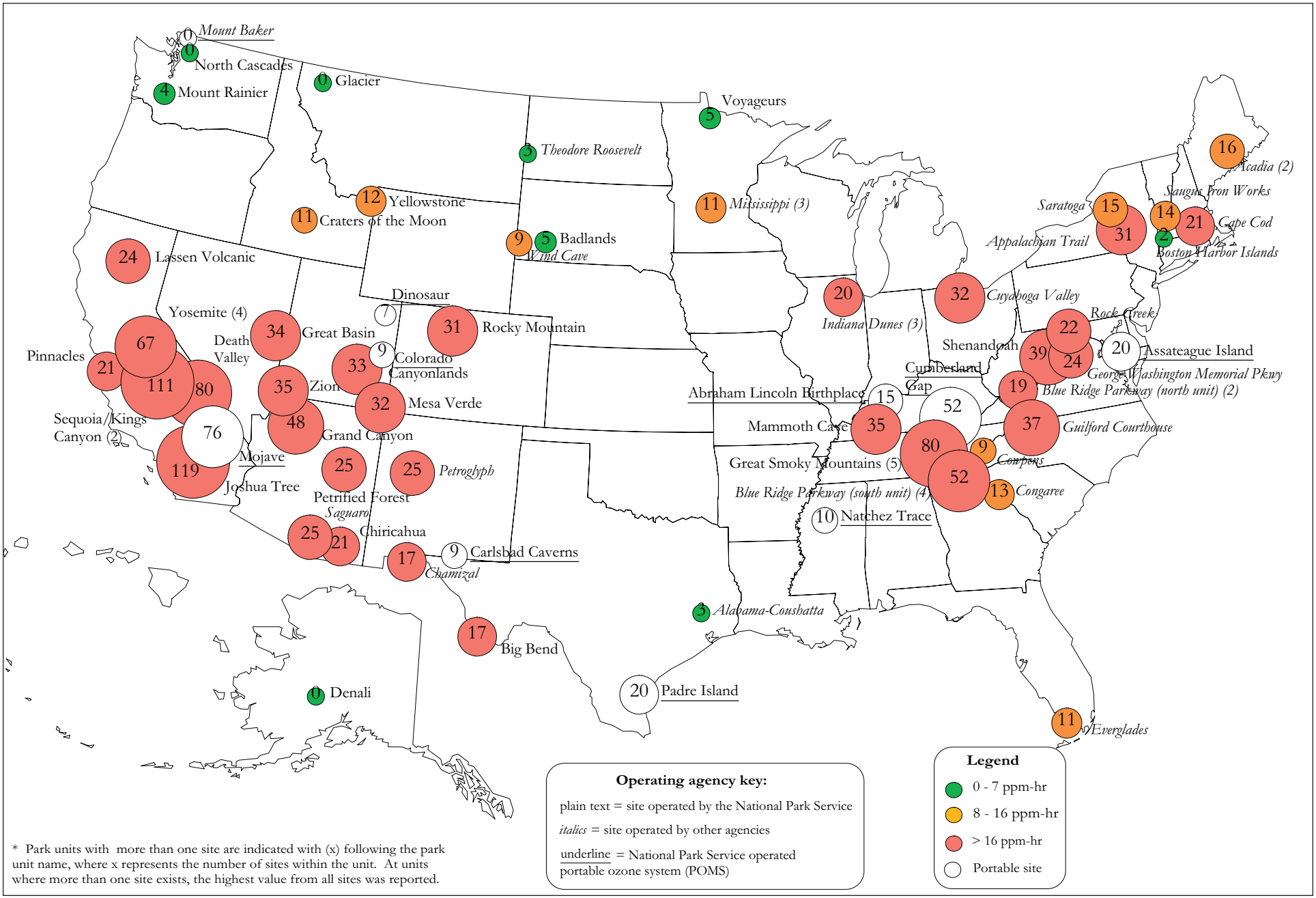



**Figure 12. 2007 3-month maximum SUM06 exposure index during the ozone season (0800-2000 hourly concentrations).**

**Sulfur Dioxide Data Summaries**

Sulfur dioxide ($SO_2$) is a criteria pollutant that over time undergoes chemical transformations in the atmosphere to form sulfur compounds, such as sulfuric acid and particulate sulfate, that can lead to environmental and health effects. Both sulfur dioxide and fine particulate sulfate can cause respiratory problems. Sulfur dioxide and acidic sulfate deposited on the earth's surface can affect aquatic and terrestrial ecosystems. Sulfur compounds are a major constituent of acid rain and sulfate is one of the particulate species responsible for visibility degradation and regional haze.

The primary NAAQS for sulfur dioxide are an annual arithmetic mean of 0.03 ppm and a 24-hour mean of 0.14 ppm, not to be exceeded more than once per year. The secondary NAAQS is a 3-hour mean of 0.50 ppm, not to be exceeded more than once per year. Table 12 summarizes sulfur dioxide measurements for comparison to these standards and lists the number of exceedances for each. Maximum hourly concentrations for each site are also presented in the table for reference. The $SO_2$ at Hawaii Volcanoes National Park violates the $SO_2$ NAAQS and is unhealthy. In 2007, it exceeded the 24-hour standard of 0.14 ppm nine times.

At Hawaii Volcanoes National Park, sulfur dioxide data are collected using a lower range and an upper range. The lower range does not capture values higher than 1 ppm (1,000 ppb), but is considered to be an EPA equivalency method. The upper range captures values above 1 ppm accurately, but is not an EPA equivalent range. The Hawaii Volcanoes National Park data presented in this report were collected using the upper range to give a more accurate representation of sulfur dioxide values.

Hawaii Volcanoes has an $SO_2$ alert system to use current data to warn visitors and staff of developing unhealthy air quality conditions. A color code severity level is used to determine in-park actions using 15-minute average data. See the alert system Web site and associated links for more detail, at *http://www.nature.nps.gov/air/WebCams/parks/havoso2alert/havoalert.cfm.*

**Halema`uma`u plume, Hawaii, just minutes after it turns from bright white to reddish-brown from ash and particulate matter Photo by J. Kauahikaua**

**Table 12. 2007 Summary of sulfur dioxide data.**

| National Park Unit | Site Name | Annual Arithmetic Mean (ppb)[a] | Highest Daily 24-Hour Average Concentration[b] (ppb) | | | | | Highest Daily Maximum 3-Hour Average Concentration[c] (ppb) | | | | | Highest Daily Maximum 1-Hour Average Concentration (ppb) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1st Highest | 2nd Highest | 3rd Highest | 4th Highest | No. of Days with 24-Hour Average ≥ 145 ppb | 1st Highest | 2nd Highest | 3rd Highest | 4th Highest | No. of Days with 3-Hour Maximum ≥ 550 ppb | 1st Highest | 2nd Highest | 3rd Highest | 4th Highest |
| **Sites operated by the National Park Service** | | | | | | | | | | | | | | | | |
| Great Smoky Mountains | Cove Mountain | 1 | 6 | 6 | 6 | 6 | 0 | 21 | 19 | 13 | 13 | 0 | 28 | 25 | 24 | 22 |
| Hawaii Volcanoes * | Observatory | 18 | 222 | 221 | 217 | 217 | 9 | 879 | 830 | 698 | 585 | 5 | 1529 | 1335 | 1183 | 1118 |
| Hawaii Volcanoes * | Visitor Center | 14 | 187 | 168 | 163 | 163 | 6 | 1019 | 604 | 487 | 434 | 2 | 2115 | 1038 | 996 | 886 |
| **Sites operated by cooperating state agencies** | | | | | | | | | | | | | | | | |
| *Badlands* | Visitor Center | 1 | 2 | 2 | 2 | 2 | 0 | 5 | 4 | 3 | 3 | 0 | 5 | 4 | 3 | 3 |
| *Congaree* | Congaree Bluff | 1 | 10 | 8 | 7 | 7 | 0 | 41 | 38 | 32 | 30 | 0 | 80 | 62 | 50 | 46 |
| *Theodore Roosevelt* | Painted Canyon Visitor Ctr | 0 | 3 | 2 | 2 | 1 | 0 | 9 | 6 | 5 | 5 | 0 | 13 | 9 | 8 | 7 |
| *Wind Cave* | Visitor Center | 0 | 2 | 1 | 1 | 1 | 0 | 4 | 3 | 3 | 3 | 0 | 4 | 4 | 4 | 4 |
| **Nearby sites operated by other agencies** | | | | | | | | | | | | | | | | |
| *Blue Ridge Parkway* | Vinton Elementary | 3 | 9 | 9 | 8 | 8 | 0 | 25 | 21 | 20 | 20 | 0 | 29 | 22 | 22 | 20 |
| *George Washington Pkwy* | Alexandria Health | 3 | 12 | 12 | 11 | 10 | 0 | 48 | 33 | 33 | 32 | 0 | 53 | 43 | 42 | 39 |
| *Indiana Dunes* | Ammunition Bunker | 3 | 22 | 21 | 20 | 19 | 0 | 71 | 56 | 54 | 53 | 0 | 121 | 120 | 75 | 66 |
| *Indiana Dunes* | Gas Station | 2 | 15 | 10 | 9 | 9 | 0 | 27 | 23 | 22 | 20 | 0 | 36 | 34 | 31 | 26 |
| *Mississippi* | Anoka County Airport | 1 | 10 | 7 | 6 | 6 | 0 | 22 | 21 | 21 | 19 | 0 | 40 | 24 | 23 | 23 |

[a] The primary annual National Ambient Air Quality Standard for sulfur dioxide is an annual arithmetic mean of 0.03 ppm. (A value greater than 0.03 ppm, 34 ppb, or 80 μg/m$^3$ exceeds the standard.) (40 CFR 50.4.)

[b] The primary daily National Ambient Air Quality Standard for sulfur dioxide is 0.14 ppm over a 24-hour period not to be exceeded more than once per year. (A value greater than 0.14 ppm, 144 ppb, or 365 μg/m$^3$ exceeds that standard.) (40 CFR 50.4.)

[c] The secondary National Ambient Air Quality Standard for sulfur dioxide is 0.5 ppm over a 3-hour period not to be exceeded more than once per year. (A value greater than 0.5 ppm, 549 ppb, or 1300 μg/m$^3$ exceeds the standard.) (40 CFR 50.5.)

* This site collected sulfur dioxide data using an instrument or a range that is not an EPA reference method.

Operating agency key: plain text = site operated by the National Park Service
*italics* = site operated by a state agency

Color shading key: >34 ppb annual arithmetic mean, >144 ppb 24-hour average, or >549 ppb 3-hour average

**Particulate Matter Data Summaries**

Particulate matter (PM), is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. Particles smaller than about 10 micrometers in diameter ($PM_{10}$) can enter the human respiratory system and cause health problems. Particles smaller than about 2.5 micrometers in diameter ($PM_{2.5}$) are most significantly tied to health concerns and, additionally, predominantly responsible for visibility degradation and regional haze. Particulate matter with nitrogen or sulfur species can lead to acid deposition or acid rain. Sources of particulate matter include: industrial activities, vehicle exhaust, fires, vegetation, construction activities, wind-blown dust, and gaseous emissions which undergo chemical processes in the atmosphere to condense into particulate or liquid form.

The primary NAAQS for $PM_{2.5}$ are an annual arithmetic mean of 15 $\mu g/m^3$ and a daily arithmetic mean of 35 $\mu g/m^3$. The daily arithmetic mean standard for $PM_{2.5}$ changed from 65 $\mu g/m^3$ to 35 $\mu g/m^3$ in September 2006, and took effect on December 18, 2006. An exceedance of the standard occurs when either an annual arithmetic mean is greater than 15.0 $\mu g/m^3$ or a daily arithmetic mean is greater than 35 $\mu g/m^3$. An exceedance of the standard is not the same as a violation. A violation occurs when either the 3-year average of the annual mean is greater than 15.0 $\mu g/m^3$ or the 3-year average of the 98$^{th}$ percentile daily mean concentrations is greater than 35 $\mu g/m^3$.

The primary NAAQS for $PM_{10}$ is a daily arithmetic mean of 150 $\mu g/m^3$. An exceedance of the standard occurs when a daily arithmetic mean is greater than 150 $\mu g/m^3$. Again, an exceedance of the standard is not the same as a violation. A violation occurs when a 24-hour average concentration greater than 150 $\mu g/m^3$ occurs more than once per year on average over three years.

*$PM_{2.5}$ Data Summaries*

Table 13 summarizes $PM_{2.5}$ measurements with respect to both the daily 24-hour average maximum concentrations and the annual arithmetic mean. None of the $PM_{2.5}$ monitors at these sites are EPA-reference methods but rather are continuous analyzer methods EPA is considering for equivalency. The four highest and 98$^{th}$ percentile 24-hour average concentrations are listed, as well as the total number of days with 24-hour average $PM_{2.5}$ concentrations greater than 35$\mu g/m^3$. No violation summaries for $PM_{2.5}$ data are presented.

**Table 13. 2007 Summary of $PM_{2.5}$ data from reference and equivalency methods.**

| National Park Unit | Site Name | Sampler Type* | % Valid[a] | Annual Arithmetic Mean[b] (µg/m³) | Highest Daily 24-Hour Average Concentrations[c] (µg/m³) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1st Highest | 2nd Highest | 3rd Highest | 4th Highest | 98th Percentile Value | No. of Days with 24-Hour Average >35 µg/m³ |
| **Sites operated by the National Park Service** | | | | | | | | | | |
| Badlands | Visitor Center | BAM | 99.2 | 4.0 | 27 | 25 | 18 | 18 | 12 | 0 |
| Great Smoky Mountains | Look Rock | TEOM | 99.1 | 15.8 | 97 | 86 | 49 | 44 | 40 | 12 |
| Shenandoah | Big Meadows | TEOM | 95.1 | 8.0 | 36 | 30 | 28 | 28 | 25 | 1 |
| Yellowstone | Old Faithful | BAM | 90.5 | 4.8 | 31 | 23 | 19 | 17 | 14 | 0 |
| **Sites operated by cooperating state agencies** | | | | | | | | | | |
| *Acadia* | McFarland Hill | TEOM | 91.2 | 3.8 | 37 | 29 | 25 | 25 | 22 | 1 |
| *Theodore Roosevelt* | Painted Canyon Visitor Ctr | TEOM | 96.5 | 6.0 | 24 | 21 | 19 | 18 | 15 | 0 |
| *Wind Cave* | Visitor Center | BAM | 94.5 | 3.8 | 28 | 27 | 25 | 18 | 13 | 0 |
| *Yosemite* | Village | BAM | 94.7 | 13.8 | 134 | 47 | 45 | 38 | 32 | 4 |
| **Nearby sites operated by other agencies** | | | | | | | | | | |
| *Guilford Courthouse* | Mendenhall Middle School | TEOM | 92.3 | 14.3 | 49 | 37 | 36 | 36 | 35 | 4 |
| *Indiana Dunes* | Ammunition Bunker | TEOM | 98.9 | 13.0 | 36 | 35 | 35 | 35 | 32 | 1 |
| *Indiana Dunes* | Water Treatment Plant | BAM | 98.9 | 14.0 | 51 | 38 | 33 | 31 | 38 | 2 |
| *Mississippi* | Anoka County Airport | BAM | 99.1 | 10.3 | 51 | 47 | 45 | 45 | 28 | 4 |
| *Petroglyph* | Westside Taylor Ranch | BAM | 73.6 | 6.0 | 37 | 25 | 22 | 20 | 19 | 1 |
| *Saugus Iron Works* | Lynn Water Treatment | BAM | 99.3 | 10.5 | 56 | 38 | 37 | 35 | 29 | 3 |

[a] At sites operated by an agency other than the National Park Service, the primary responsibility for the operation and data reporting of particulate matter belongs to the operating agency.

[b] The primary annual National Ambient Air Quality Standard for $PM_{2.5}$ is an annual arithmetic mean of 15.0 µg/m³. (An exceedance of the standard occurs when an annual arithmetic mean of $PM_{2.5}$ concentrations is greater than 15.0 µg/m³. A violation of the standard occurs when the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations is greater than 15.0 µg/m³ (40 CFR 50.7.)

[c] The primary daily National Ambient Air Quality Standard for $PM_{2.5}$ is a 24-hour average concentration of 35 µg/m³. (An exceedance of the standard occurs when a 24-hour average $PM_{2.5}$ concentration is greater than 35 µg/m³. A violation of the standard occurs when the 3-year average of the annual 98th percentile of 24-hour $PM_{2.5}$ concentrations is greater than 35 µg/m³.) (40 CFR 50.7.)

* TEOM = tapered element oscillating microbalance
BAM = beta attenuation monitor

### *$PM_{10}$ Data Summaries*

Table 14 summarizes $PM_{10}$ measurements with respect to both the daily 24-hour average maximum concentrations. The four highest 24-hour average concentrations are listed, as well as the total number of days with exceedances of the NAAQS 24-hour standard. The number of days column is color-coded to identify sites where an exceedance of the 24-hour standard occurred.

Table 15 presents the same summaries for sites that collected $PM_{10}$ using non-equivalency methods.

Table 16 presents a $PM_{10}$ violation summary based on the 24-hour average standard for one-year periods over the last three years, with violations indicated in red. Table values in parentheses indicate that the EPA data completeness requirement was not met. However, calendar quarters not meeting the EPA data completeness requirements are included in the NAAQS violation computation if the resulting 24-hour average exceeds the standard.

**Bryce Canyon National Park, Utah**
**Photo by Laura Weber/ Air Resource Specialists, Inc.**

**Table 14. 2007 Summary of $PM_{10}$ data from reference and equivalency methods.**

| National Park Unit | Site Name | Sampler Type* | % Valid[a] | Highest Daily 24-Hour Average Concentrations[b] ($\mu g/m^3$) 1st Highest | 2nd Highest | 3rd Highest | 4th Highest | No. of Days with 24-Hour Average >150 $\mu g/m^3$ |
|---|---|---|---|---|---|---|---|---|
| **Sites operated by cooperating state agencies** | | | | | | | | |
| *Badlands* | Visitor Center | BAM | 95.9 | 50 | 40 | 40 | 40 | 0 |
| *Wind Cave* | Visitor Center | BAM | 97.4 | 40 | 40 | 40 | 40 | 0 |

[a] At sites operated by an agency other than the National Park Service, the primary responsibility for the operation and data reporting of particulate matter belongs to the operating agency.

[b] The primary daily National Ambient Air Quality Standard for $PM_{10}$ is a 24-hour average concentration of 150 $\mu g/m^3$. (An exceedance of the standard occurs when a 24-hour average $PM_{10}$ concentration is greater than 150 $\mu g/m^3$. A violation of the standard occurs when a 24-hour average concentration greater than 150 $\mu g/m^3$ occurs more than once in a calendar year.) (40 CFR 50.6.)

* TEOM = tapered element oscillating microbalance
BAM = beta attenuation monitor

Color shading key: >50 $\mu g/m^3$ annual arithmetic mean, >150 $\mu g/m^3$ 24-hour average

*italics* = site operated by a state agency

**Table 15. 2007 Summary of $PM_{10}$ data from non-equivalency methods.**

| National Park Unit | Site Name | Sampler Type | % Valid[a] | Highest Daily 24-Hour Average Concentrations[b] ($\mu g/m^3$) 1st Highest | 2nd Highest | 3rd Highest | 4th Highest | No. of Days with 24-Hour Average >150 $\mu g/m^3$ |
|---|---|---|---|---|---|---|---|---|
| **Sites operated by the National Park Service** | | | | | | | | |
| Joshua Tree | Cottonwood Canyon | E-sampler | 69.0 | 30 | 20 | 10 | 10 | 0 |

[a] At sites operated by an agency other than the National Park Service, the primary responsibility for the operation and data reporting of particulate matter belongs to the operating agency.

[b] The primary daily National Ambient Air Quality Standard for $PM_{10}$ is a 24-hour average concentration of 150 $\mu g/m^3$. (An exceedance of the standard occurs when a 24-hour average $PM_{10}$ concentration is greater than 150 $\mu g/m^3$. A violation of the standard occurs when a 24-hour average concentration greater than 150 $\mu g/m^3$ occurs more than once in a calendar year.) (40 CFR 50.6.)

Color shading key: >50 $\mu g/m^3$ annual arithmetic mean, >150 $\mu g/m^3$ 24-hour average

**Table 16. $PM_{10}$ summary - maximum daily 24-hour average concentration in 2007 ($\mu g/m^3$)[a].**

| National Park Unit | Site Name | Sampler Type* | 2006 | 2005 | 2004 |
|---|---|---|---|---|---|
| **Sites operated by cooperating state agencies** | | | | | |
| *Badlands* | Visitor Center | BAM | 50 | 30 | 40 |
| *Wind Cave* | Visitor Center | BAM | 40 | 30 | 30 |

[a] The primary daily National Ambient Air Quality Standard for $PM_{10}$ is a 24-hour average concentration of 150 $\mu g/m^3$. (An exceedance of the standard occurs when a 24-hour average $PM_{10}$ concentration is greater than 150 $\mu g/m^3$. A violation of the standard occurs when a 24-hour average concentration greater than 150 $\mu g/m^3$ occurs more than once in a calendar year.) (40 CFR 50.6.)

* TEOM = tapered element oscillating microbalance
BAM = beta attenuation monitor

Color shading key: > 1 24-hour average concentration >150 $\mu g/m^3$

*italics* = site operated by a state agency

**Meteorological Data Summaries**
Meteorological data collected along with air quality parameters are used to better understand the local conditions and transport of air pollutants. In addition, meteorological data are essential for air quality deposition modeling efforts. Refer to Table 1 for a list of meteorological parameters collected at each site.

Table 17 presents a summary of selected meteorological data for all sites. The parameters included are wind speed, ambient temperature, relative humidity, and precipitation.

**Wind Cave National Park, South Dakota Meteorological Instrumentation Photo by Martin Valvur/ Air Resource Specialists, Inc.**

**Table 17. 2007 Summary of selected meteorological data.**

| National Park Unit | Site Name | Wind Speed (Scalar[a]) (m/s) Average | Ambient Temperature (degrees C) Average | Ambient Temperature (degrees C) Maximum | Ambient Temperature (degrees C) Minimum | Relative Humidity (%) Average | Relative Humidity (%) Maximum | Relative Humidity (%) Minimum | Precipitation (mm) Annual Accumulation |
|---|---|---|---|---|---|---|---|---|---|
| **Sites operated by the National Park Service** | | | | | | | | | |
| Badlands | Visitor Center | 4.0 | 10.9 | 41.7 | -28.4 | 57 | 100 | 6 | 54.0 |
| Big Bend | K-Bar Ranch Road | 3.5 | 19.5 | 38.4 | -4.7 | 48 | 99 | 3 | 252.0 |
| Canyonlands | Island in the Sky | 2.8 | 11.7 | 34.9 | -14.3 | 38 | 100 | 0 | 217.7 |
| Chiricahua | Entrance Station | 2.9 | 15.6 | 36.4 | -8.5 | 44 | 100 | 6 | 451.4 |
| Craters of the Moon | Visitor Center | 3.4 | 7.3 | 35.2 | -22.2 | 52 | 100 | 7 | --- |
| Death Valley | Park Village | 3.9 | 26.3 | 49.8 | 1.1 | 16 | 95 | 1 | 42.8 |
| Denali | Headquarters | 1.3 | -1.1 | 24.7 | -32.6 | 68 | 99 | 17 | 206.7 |
| Everglades | Beard Center | 2.3 | 23.3 | 34.2 | 0.5 | 84 | 100 | 29 | 1513.1 |
| Glacier | West Glacier Horse Stables | 0.9 | 6.4 | 35.8 | -28.6 | 70 | 99 | 10 | 603.6 |
| Grand Canyon | The Abyss | 2.8 | 11.7 | 33.0 | -15.5 | 38 | 100 | 2 | 289.2 |
| Great Basin | Maintenance Yard | 2.8 | 9.8 | 33.5 | -22.4 | 39 | 98 | 2 | 214.7 |
| Great Smoky Mountains | Clingmans Dome | 3.5 | 13.1 | 22.9 | -1.4 | 81 | 100 | 1 | 685.7 |
| Great Smoky Mountains | Cove Mountain | 4.5 | 11.8 | 29.8 | -18.0 | 68 | 100 | 5 | 608.1 |
| Great Smoky Mountains | Look Rock | 2.5 | 14.1 | 32.4 | -14.8 | 65 | 100 | 10 | 911.6 |
| Hawaii Volcanoes | Observatory | 5.2 | 16.0 | 27.1 | 9.6 | 87 | 100 | 7 | 2051.2 |
| Hawaii Volcanoes | Visitor Center | 3.8 | 14.9 | 23.7 | 8.0 | 91 | 100 | 11 | 2829.1 |
| Joshua Tree | Black Rock | 4.0 | 16.7 | 39.4 | -8.5 | 29 | 96 | 2 | 47.5 |
| Joshua Tree | Cottonwood Canyon | 3.7 | 19.7 | 40.0 | -4.3 | 27 | 100 | 3 | 100.1 |
| Lassen Volcanic | Manzanita Lake Fire Station | 2.0 | 7.2 | 30.5 | -14.4 | 59 | 100 | 6 | 640.7 |
| Mammoth Cave | Houchin Meadow | 1.7 | 15.3 | 39.7 | -13.2 | 66 | 100 | 19 | 1159.8 |
| Mesa Verde | Resource Management Area | 3.0 | 10.7 | 32.3 | -15.2 | 43 | 97 | 5 | 361.7 |
| Mount Rainier | Tahoma Woods | 1.0 | 8.5 | 32.9 | -10.1 | 86 | 100 | 16 | 1297.7 |
| North Cascades | Marblemount Ranger Station | 1.2 | 9.1 | 36.2 | -9.4 | 81 | 97 | 11 | 1965.4 |
| Petrified Forest | South Entrance | 4.0 | 13.1 | 36.3 | -13.4 | 43 | 100 | 3 | 256.8 |
| Pinnacles | SW of East Entrance Station | 2.3 | 14.1 | 41.1 | -9.6 | 58 | 97 | 5 | 145.4 |
| Rocky Mountain | Long's Peak | 2.7 | 4.5 | 25.1 | -24.5 | 51 | 97 | 4 | 272.2 |
| Sequoia and Kings Canyon | Ash Mountain | 2.6 | 16.9 | 41.3 | -3.4 | 50 | 100 | 8 | 423.5 |
| Sequoia and Kings Canyon | Lower Kaweah | 1.7 | 9.4 | 30.5 | -14.0 | 57 | 100 | 4 | 383.0 |
| Shenandoah | Big Meadows | 2.6 | 1.9 | 21.2 | -21.4 | 71 | 99 | 11 | 930.5 |
| Voyageurs | Sullivan Bay | 2.7 | 4.5 | 34.9 | -33.7 | 70 | 100 | 17 | 628.7 |
| Yellowstone | Old Faithful | 1.7 | 3.2 | 31.0 | -38.5 | 66 | 100 | 9 | --- |
| Yellowstone | Water Tank | 1.7 | 2.1 | 28.2 | -32.3 | 64 | 98 | 9 | 439.6 |
| Yosemite | Turtleback Dome | 4.0 | 11.5 | 33.1 | -10.9 | 47 | 99 | 5 | 294.3 |
| Zion | Dalton's Wash | 2.9 | 17.2 | 41.7 | -11.9 | 31 | 100 | 3 | 179.4 |
| **Sites operated by cooperating state agencies** | | | | | | | | | |
| *Acadia* | Cadillac Mountain | 5.9 | 13.5 | 29.8 | -1.9 | 78 | 100 | 17 | --- |
| *Acadia* | McFarland Hill | 3.0 | 7.3 | 33.9 | -22.2 | 71 | 100 | 13 | 1202.2 |
| *Cape Cod* | Cape Cod | 2.5 | 9.8 | 32.9 | -14.2 | 69 | 92 | 14 | --- |
| *Chamizal* | Chamizal | 3.3 | 19.2 | 39.8 | -3.6 | 37 | 97 | 5 | --- |
| *Great Smoky Mountains* | Cades Cove | 1.3 | 14.2 | 34.9 | -12.9 | 72 | 100 | 13 | 866.8 |
| *Saguaro* | Pima County | --- | 21.7 | 42.1 | -4.0 | 34 | 98 | 5 | --- |
| *Theodore Roosevelt* | Painted Canyon Visitor Center | 5.3 | 6.3 | 39.7 | -26.4 | 63 | 100 | 11 | 239.0 |
| *Wind Cave* | Visitor Center | 3.2 | 8.4 | 35.9 | -24.7 | 51 | 100 | 8 | 316.4 |

**Table 17. 2007 Summary of selected meteorological data (continued).**

| National Park Unit | Site Name | Wind Speed (Scalar[a]) (m/s) | Ambient Temperature (degrees C) | | | Relative Humidity (%) | | | Precipitation (mm) |
|---|---|---|---|---|---|---|---|---|---|
| | | Average | Average | Maximum | Minimum | Average | Maximum | Minimum | Annual Accumulation |
| **Nearby sites operated by other agencies** | | | | | | | | | |
| *Alabama-Coushatta* | CASTNet Site | 1.9 | 19.6 | 36.8 | -4.9 | 78 | 99 | 16 | 1290.3 |
| *Blue Ridge Parkway* | 7510 Blue Ridge Parkway | --- | 10.8 | 32.7 | -15.3 | 76 | 100 | 12 | --- |
| *Blue Ridge Parkway* | Ranger Station | --- | 12.6 | 37.3 | -15.7 | 67 | 99 | 7 | --- |
| *Boston Harbor Islands* | Former Nike Missile Site | 2.9 | 10.5 | 35.9 | -15.1 | 72 | 100 | 16 | --- |
| *Guilford Courthouse* | Mendenhall Middle School | 0.9 | 17.4 | 37.7 | -7.2 | 61 | 91 | 2 | 689.5 |
| *Indiana Dunes* | Ammunition Bunker | 3.5 | 10.9 | 34.6 | -22.6 | 70 | 97 | 16 | --- |
| *Indiana Dunes* | Gas Station | 3.5 | 11.0 | 33.5 | -20.0 | --- | --- | --- | --- |
| *Mississippi* | Somerset Town Hall | 2.6 | --- | --- | --- | --- | --- | --- | --- |
| *Mount Baker* | Mount Baker | 1.9 | 9.9 | 26.7 | -1.6 | 79 | 100 | 21 | 509.3 |
| *Saugus Iron Works* | Lynn Water Treatment | 2.6 | 9.8 | 35.9 | -17.1 | 60 | 90 | 3 | 35.5 |
| **Portable ozone monitoring systems** | | | | | | | | | |
| Abraham Lincoln Birthplace | Visitor Center | 0.5 | 22.7 | 39.4 | 1.9 | 69 | 99 | 21 | 428.8 |
| Agate Fossil Beds | Residence Area | 3.3 | 20.0 | 38.7 | -3.9 | 57 | 100 | 9 | 34.2 |
| Assateague Island | Maintenance Area | 1.5 | 22.3 | 37.5 | 7.2 | 75 | 100 | 25 | 186.3 |
| Carlsbad Caverns | Maintenance Area | 4.0 | 22.9 | 38.1 | 9.2 | 54 | 98 | 8 | 411.7 |
| Colorado | Maintenance Yard | 1.8 | 22.1 | 37.1 | 1.3 | 31 | 100 | 3 | 103.1 |
| Cumberland Gap | Hensley Settlement | 2.0 | 19.8 | 30.2 | 4.2 | 70 | 100 | 16 | 132.5 |
| Dinosaur | West Entrance Housing | 1.4 | 21.7 | 38.9 | 1.6 | 37 | 97 | 5 | 85.2 |
| Joshua Tree | Pinto Wells | 3.3 | 31.9 | 47.4 | 14.1 | 20 | 94 | 2 | 13.7 |
| Mojave | Kelso Mountains | 3.4 | 26.5 | 40.0 | 8.5 | 22 | 100 | 4 | 75.5 |
| Natchez Trace Parkway | Dancy Ranger Station | 0.3 | 23.1 | 40.1 | -1.7 | 75 | 98 | 20 | 283.2 |
| Olympic | Hurricane Ridge Portable | 0.7 | 10.0 | 26.4 | -0.5 | 77 | 100 | 7 | 106.1 |
| Padre Island | Malaquite Visitor Center | 5.7 | 26.4 | 32.5 | 5.7 | 82 | 100 | 39 | 520.1 |
| Yosemite | School Yard | 0.8 | 16.4 | 37.8 | -3.6 | 51 | 96 | 8 | 140.1 |

[a] Saguaro reports wind speed as vector wind speed rather than scalar wind speed.

*Note:* Dashed lines represent no data available for that particular parameter at that site.

Operating agency key: plain text = site operated by the National Park Service
*italics* = site operated by a state agency
underline = site operated by the National Park Service, but consisting of non-EPA certified portable instrumentation

*References*


1 EPA Final Rule on Revision to the National Ambient Air Quality Standard for ozone, March 12, 2008. *http://www.epa.gov/groundlevelozone/actions.html#mar07s*

2 Proposed Rule; National Ambient Air Quality Standards for Ozone, 40 CFR Part 50, July 11, 2007. *http://www.epa.gov/groundlevelozone/pdfs/20070711_proposal_fr.pdf*

3 Review of the National Ambient Air Quality Standards for Ozone: Policy Assessment of Scientific and Technical Information OAQPS Staff Paper, EPA-452/R-07-007 July 2007. *http://epa.gov/ttn/naaqs/standards/ozone/data/2007_07_ozone_staff_paper.pdf*

4 NPS Air Atlas of Air Quality, Air Resources Division. *http://www.nature.nps.gov/air/maps/AirAtlas/index.cfm*

5 Heck, W.W. and E.B. Cowling. 1997. The Need for a Long-Term Cumulative Secondary Ozone Standard – An Ecological Perspective. *Environmental Management*. January.

Data quality tables associated with the data presented in this report can be found at *http://ard-request.air-resource.com.* Click "Get Reports."

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NPS D-2017, October 2008

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**Natural Resource Program Center**
**Air Resources Division**
P.O. Box 25287
Denver, CO 80225

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