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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

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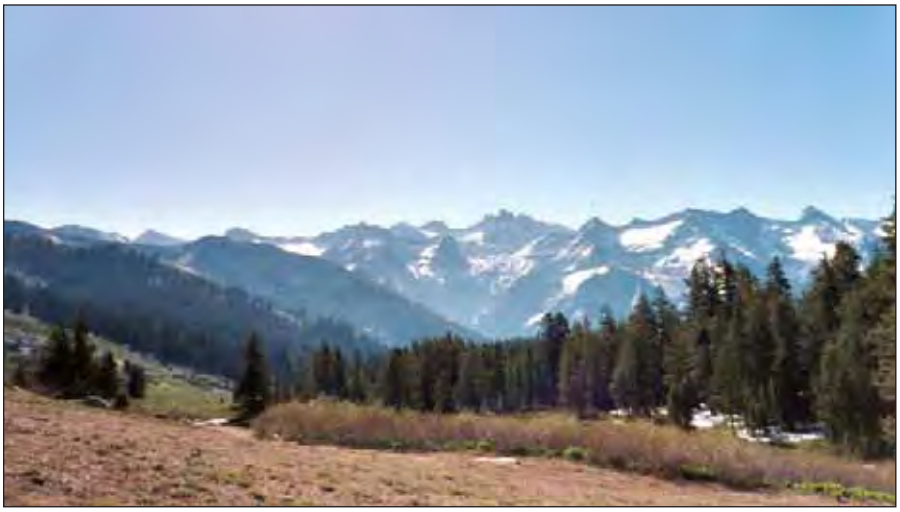
Sequoia-Kings Canyon National Parks, California Alta Meadow Photo by Laura Weber/ Air Resource Specialists, Inc.



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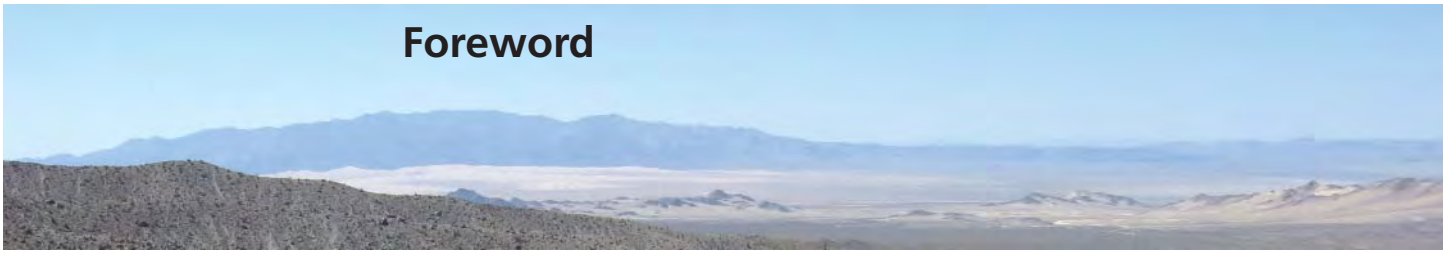
Photo by Jessica Ward/ Air Resource Specialists, Inc.



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.

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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.

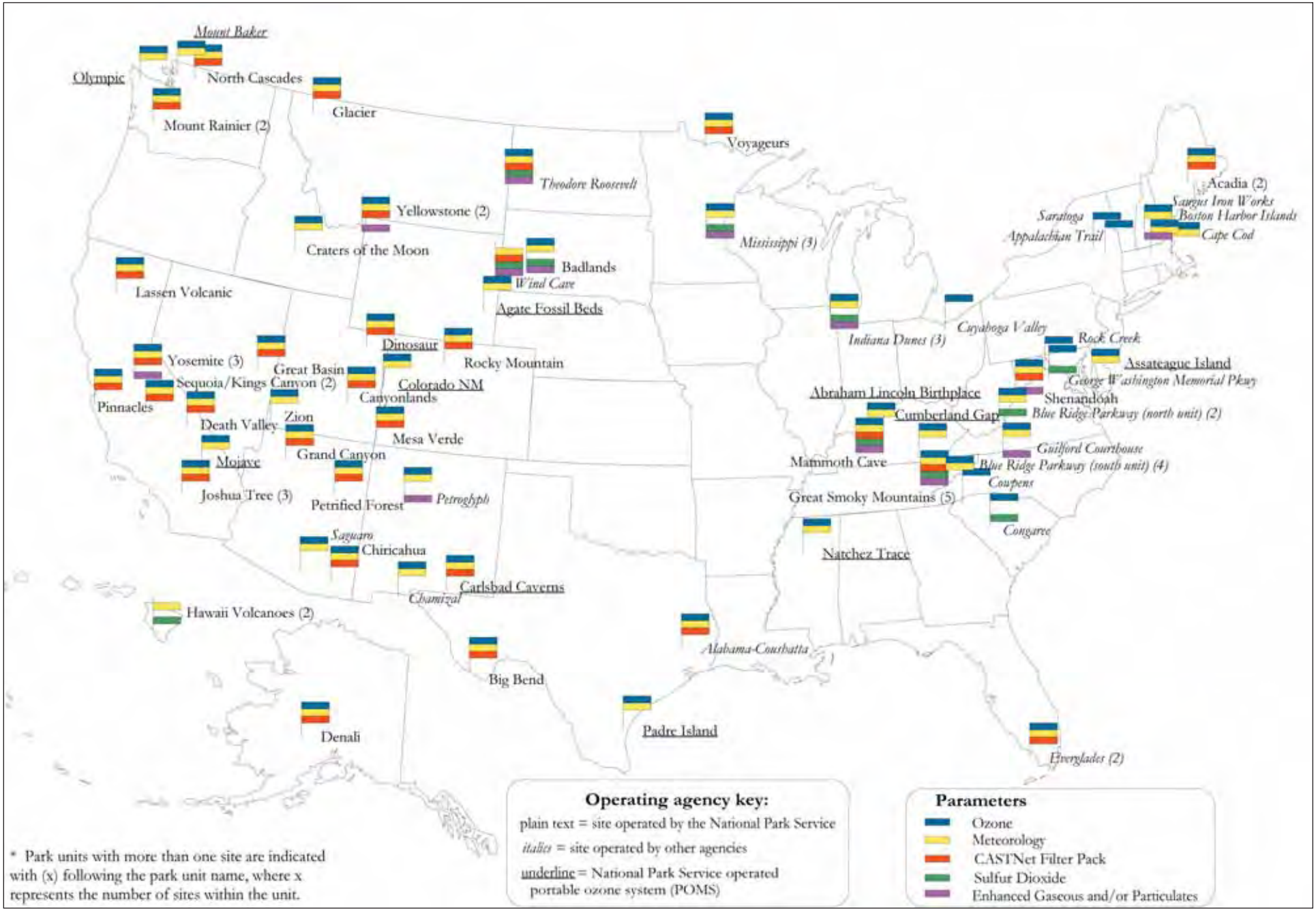


Figure 1. 2007 Air quality monitoring in or nearby park units.

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 µg/m^3*	*annual arithmetic mean*
	35 µg/m^3	*98th percentile of the highest daily average over 3 years*
Particulate Matter (PM_{10})	*150 µg/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.

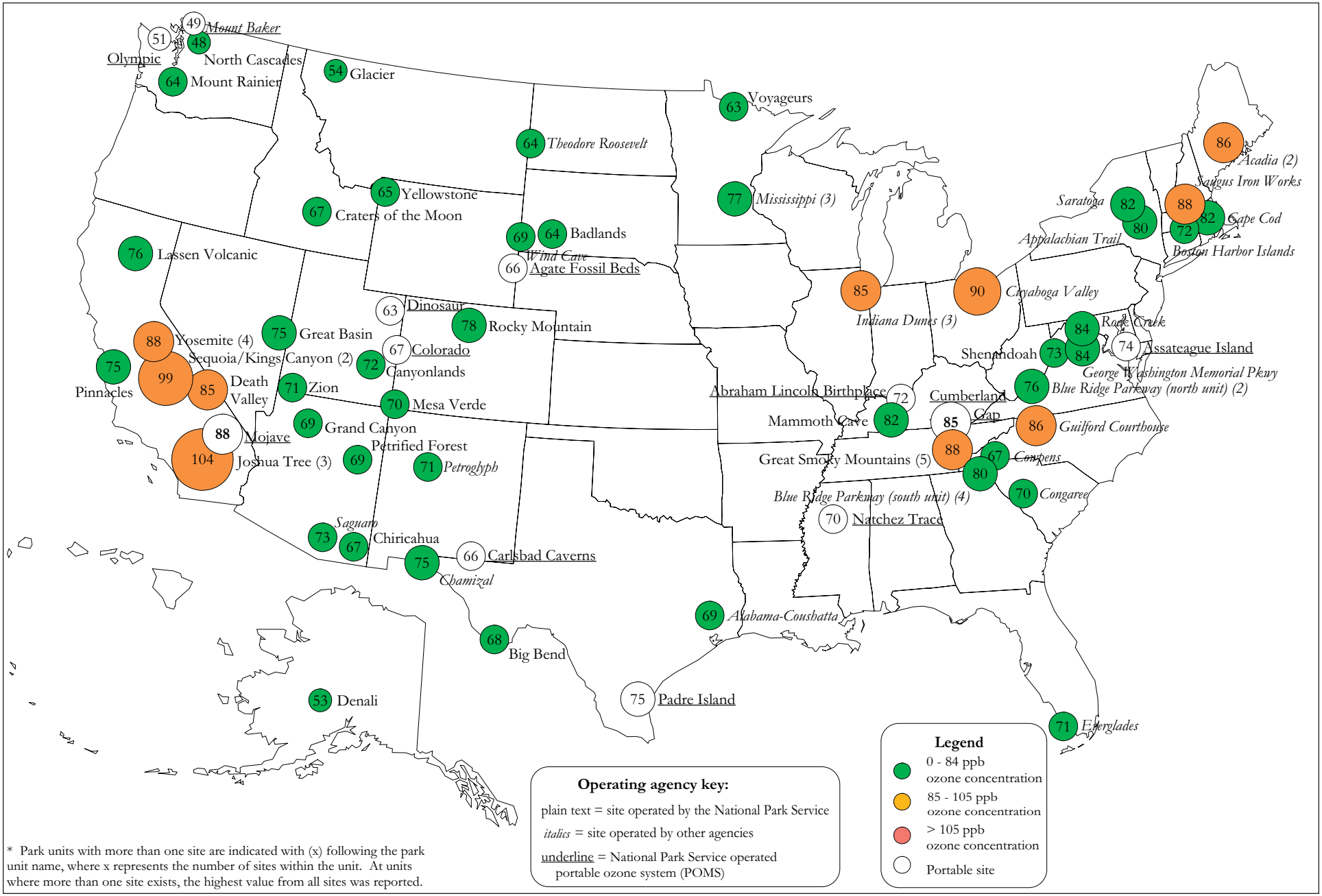


Figure 2. 2007 Annual fourth highest daily maximum 8-hour average ozone concentrations (in ppb).

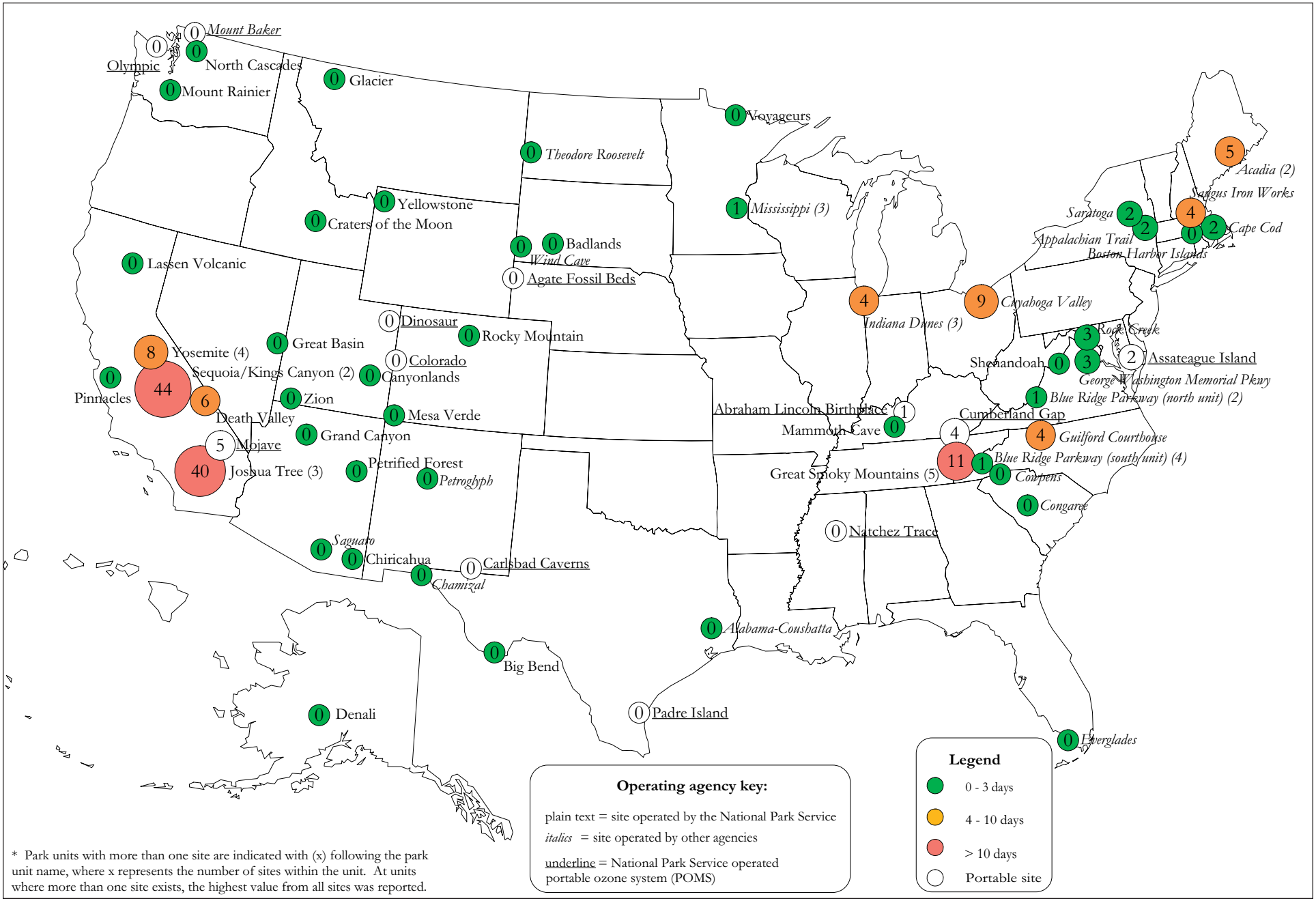


Figure 3. 2007 Annual number of days with daily maximum 8-hour average ozone values ≥85 ppb.

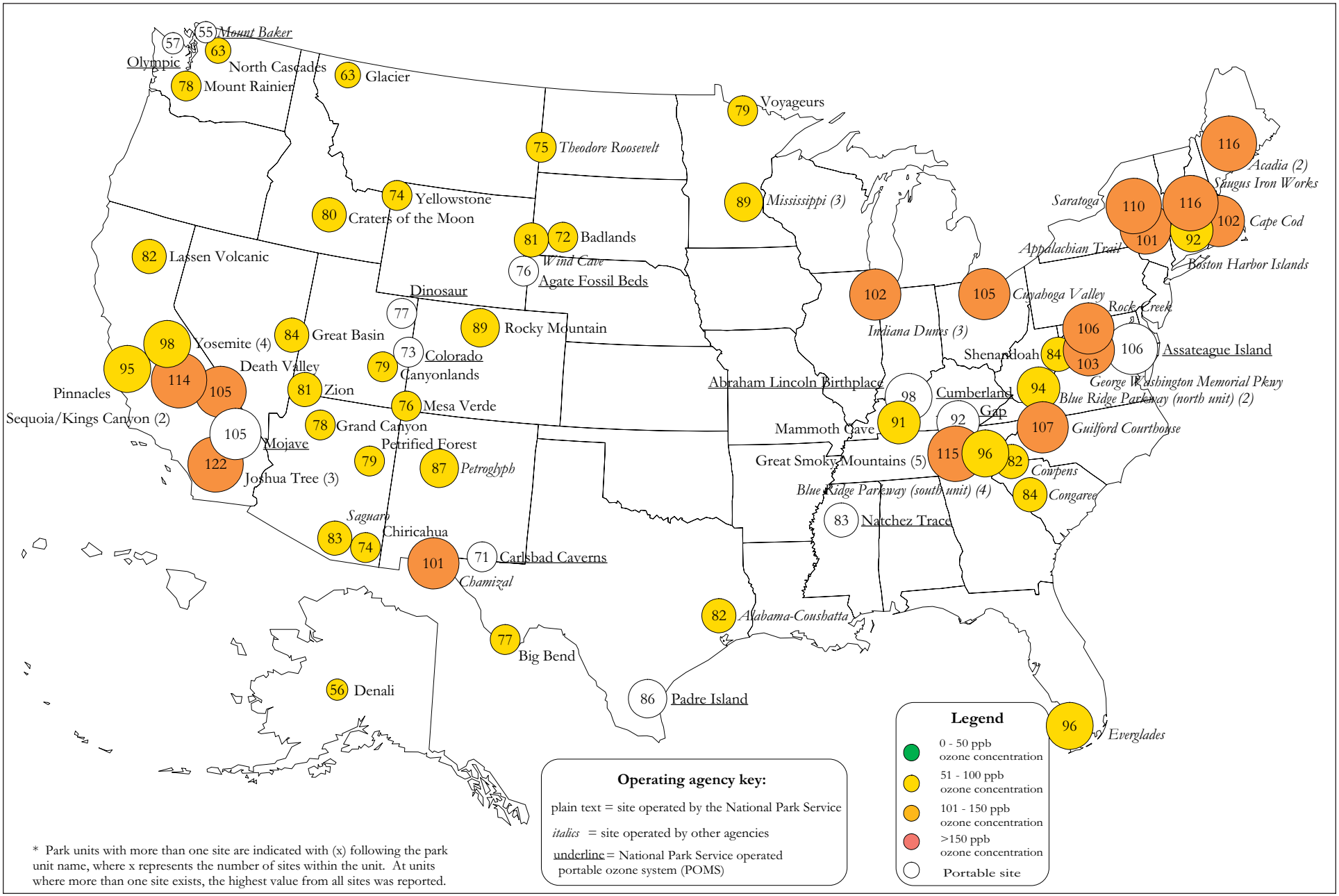


Figure 4. 2007 Annual second highest 1-hour average ozone concentrations (in ppb).

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

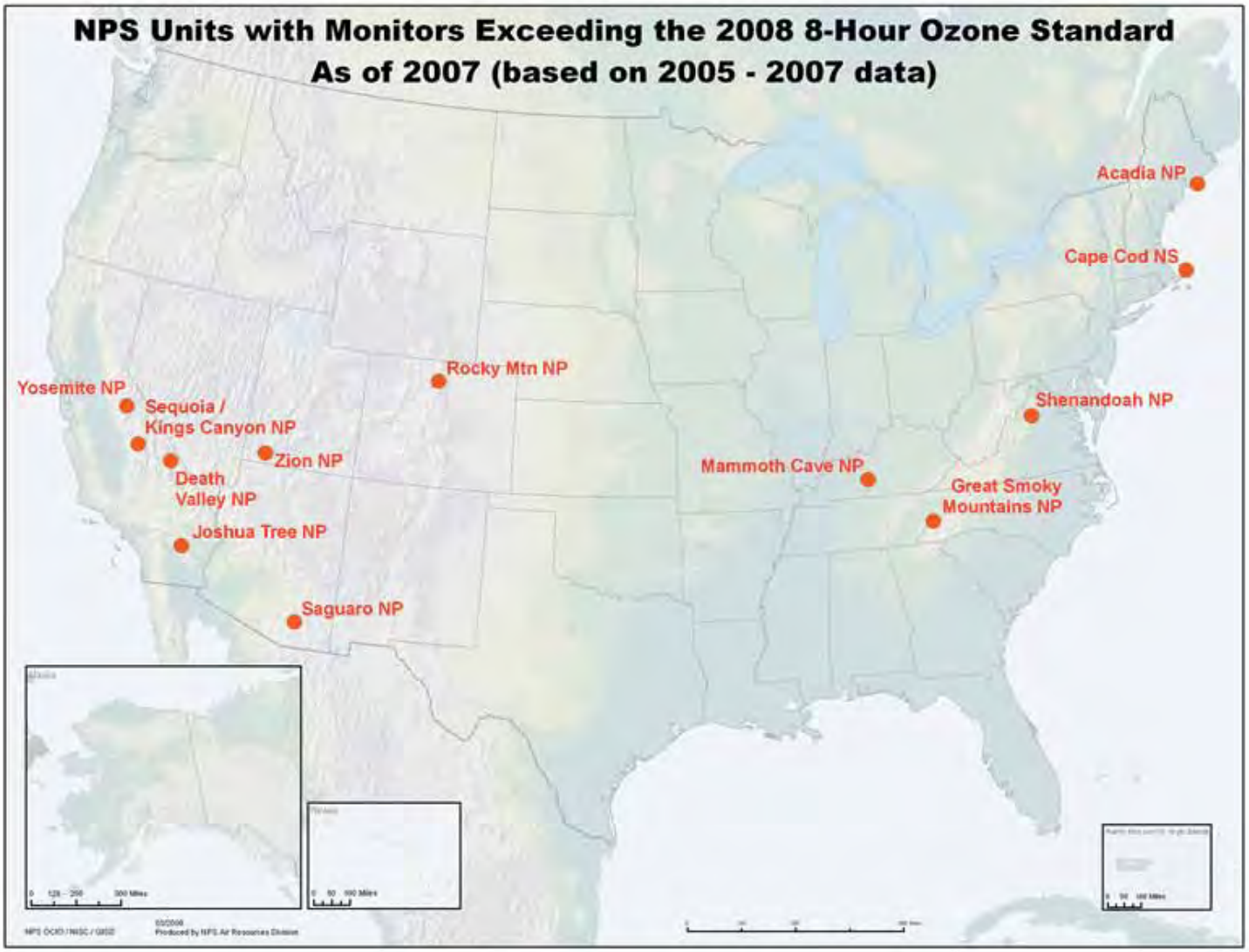


Figure 5. Park units that will violate the new ozone NAAQS based on NPS monitoring network data.

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

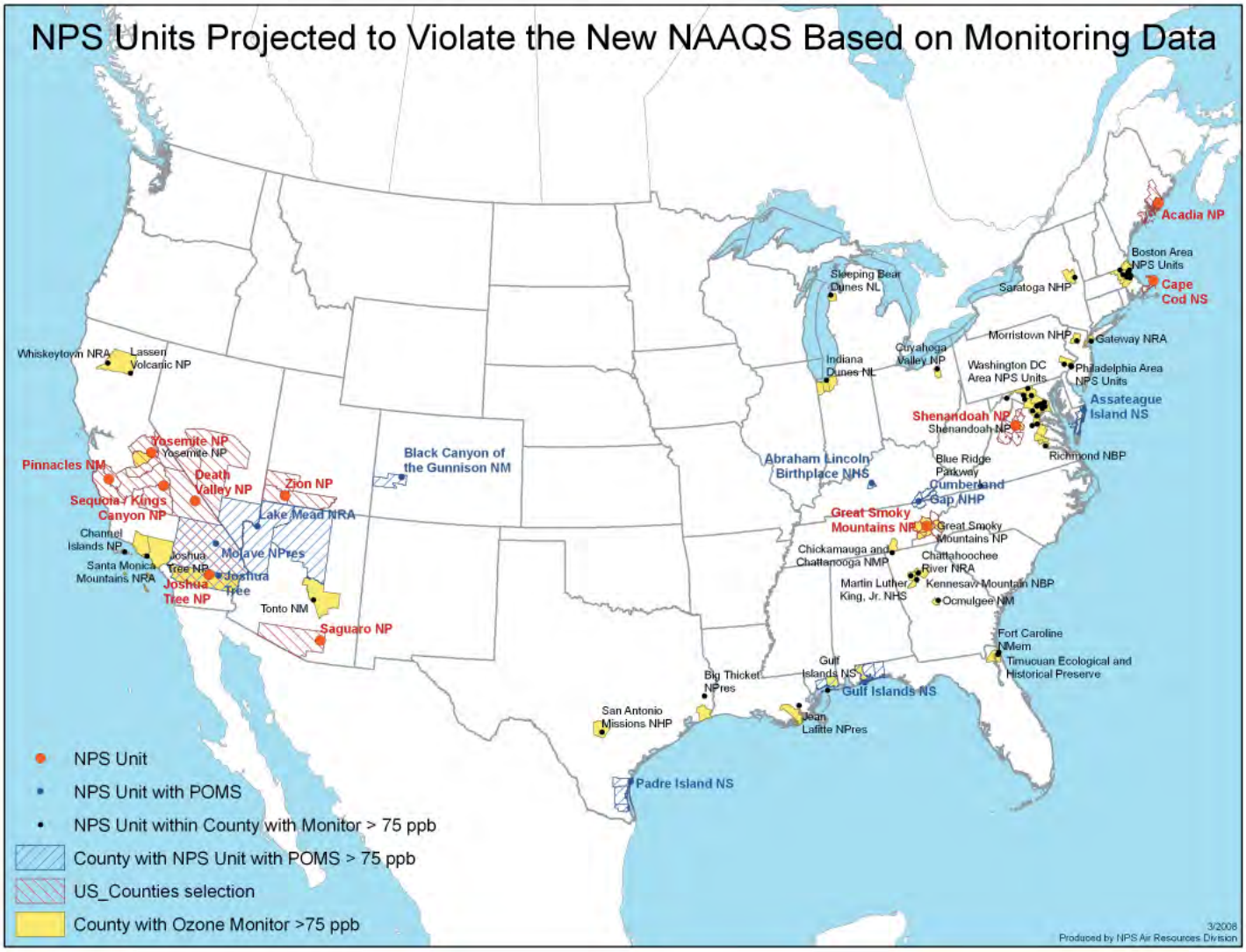
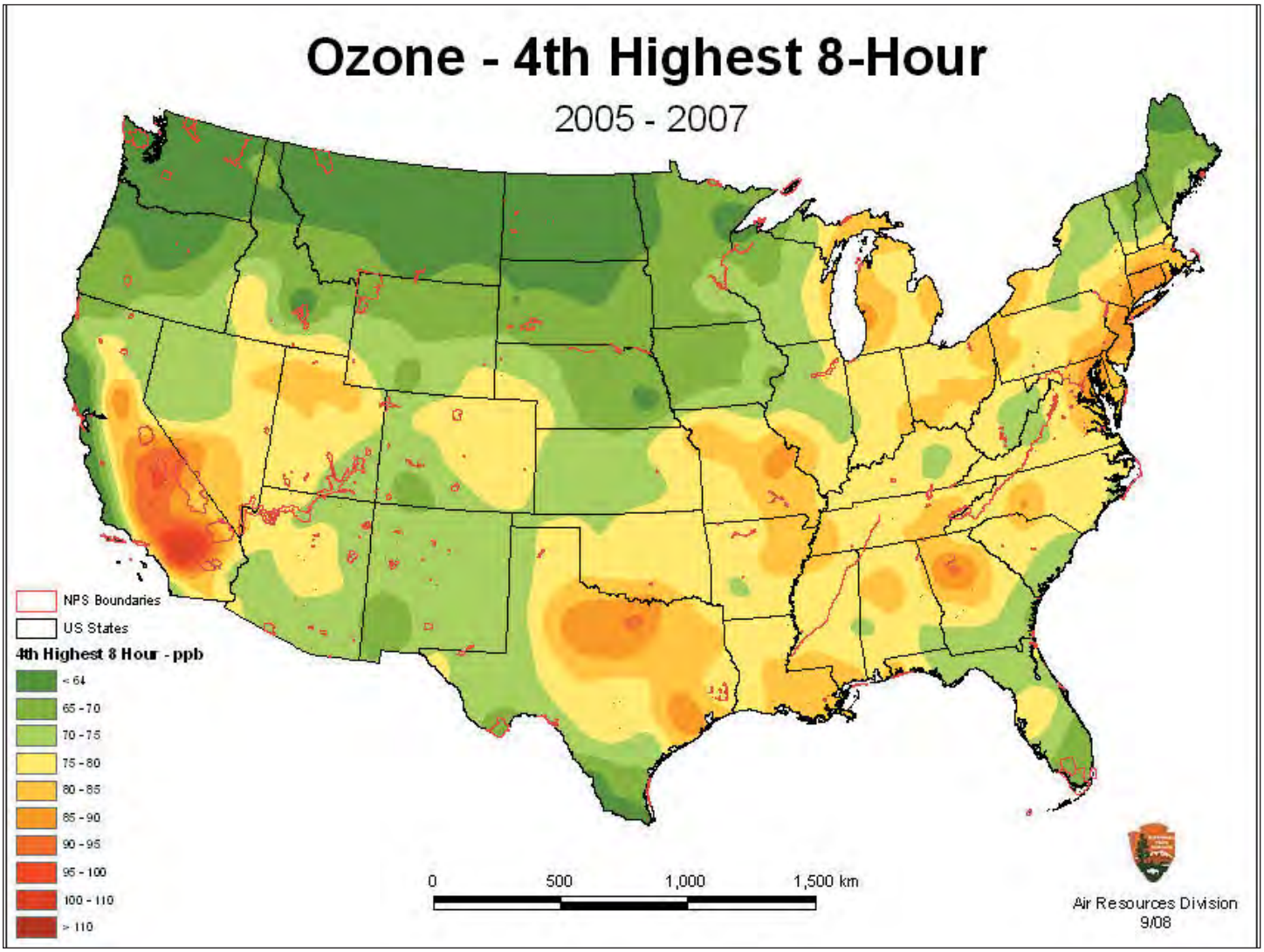


Figure 6. Counties and park units with monitoring data that support a possible violation of the new ozone NAAQS of 75 ppb. Only counties with NPS monitors or park units are shown. See Figure 9 for the urban counties EPA expects will violate the new standard.

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.



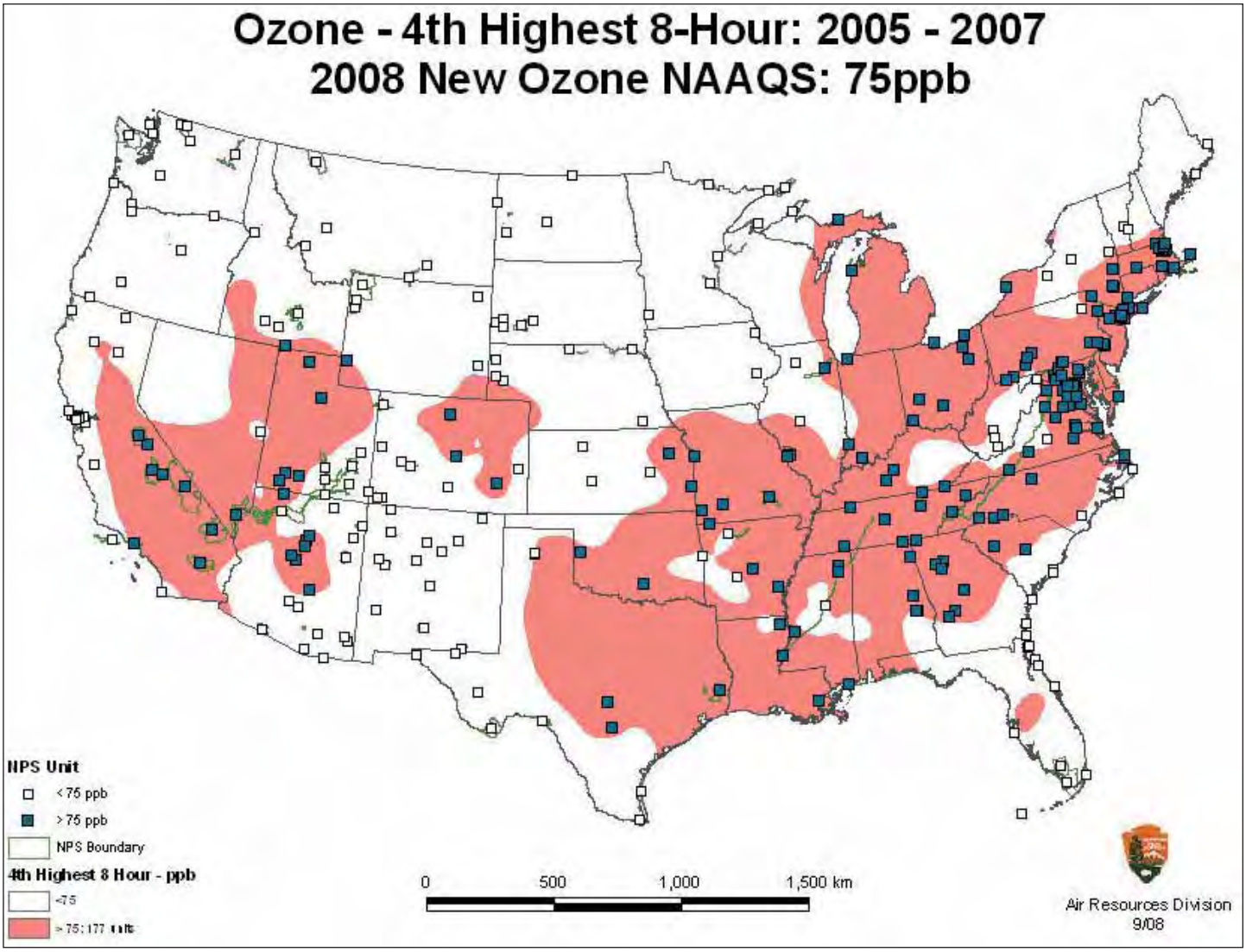


Figure 8. Violation areas are extracted from the Figure 6 map and the parks in the violation areas are shown.

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.

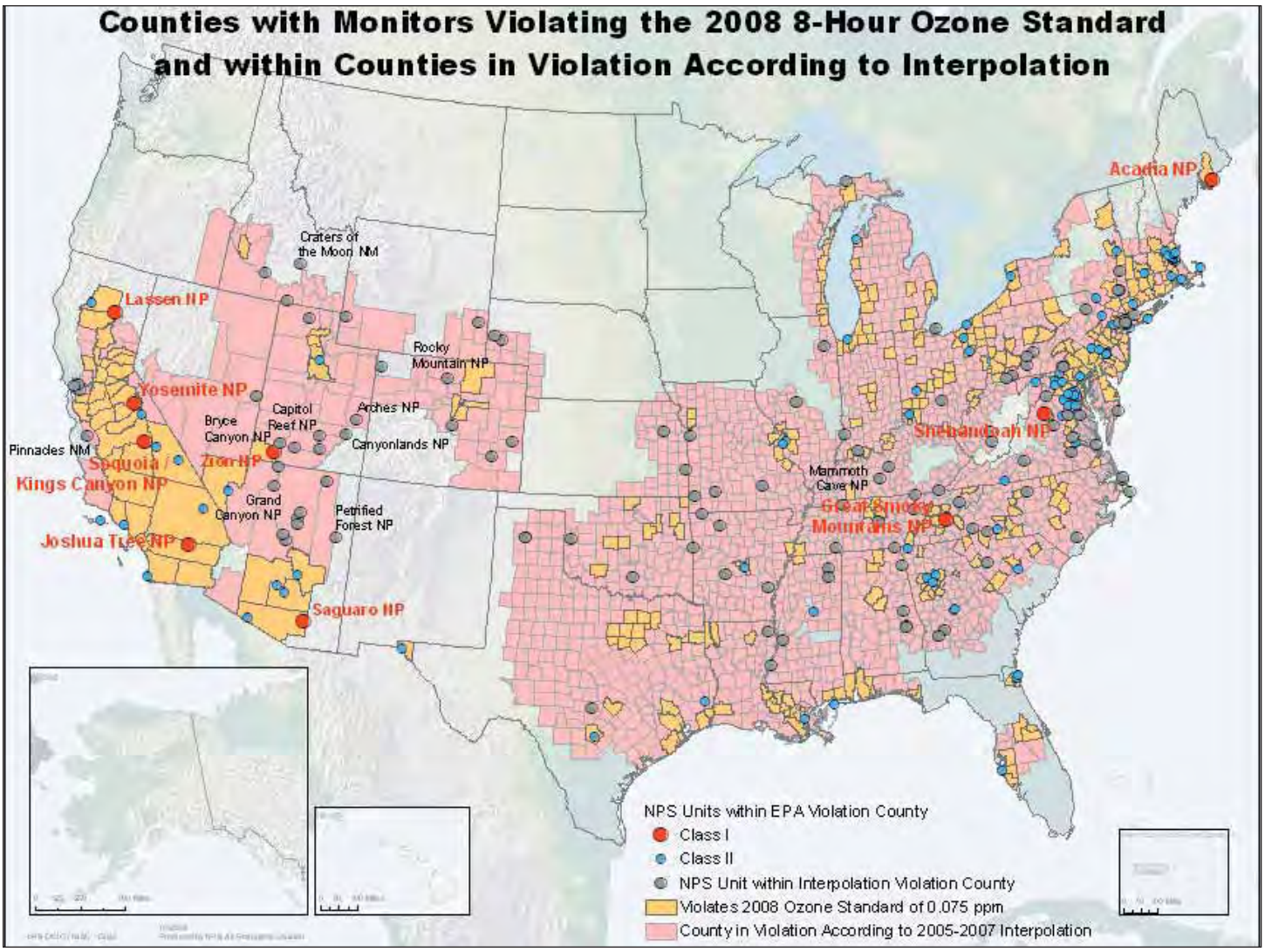


Figure 9. This map combines the counties EPA projects to violate the new standard (orange) and the counties projected from Air Atlas (rose color) as potentially in violation. The red, blue, and gray dots are park locations. Many rural counties have the potential to violate the standard.

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.

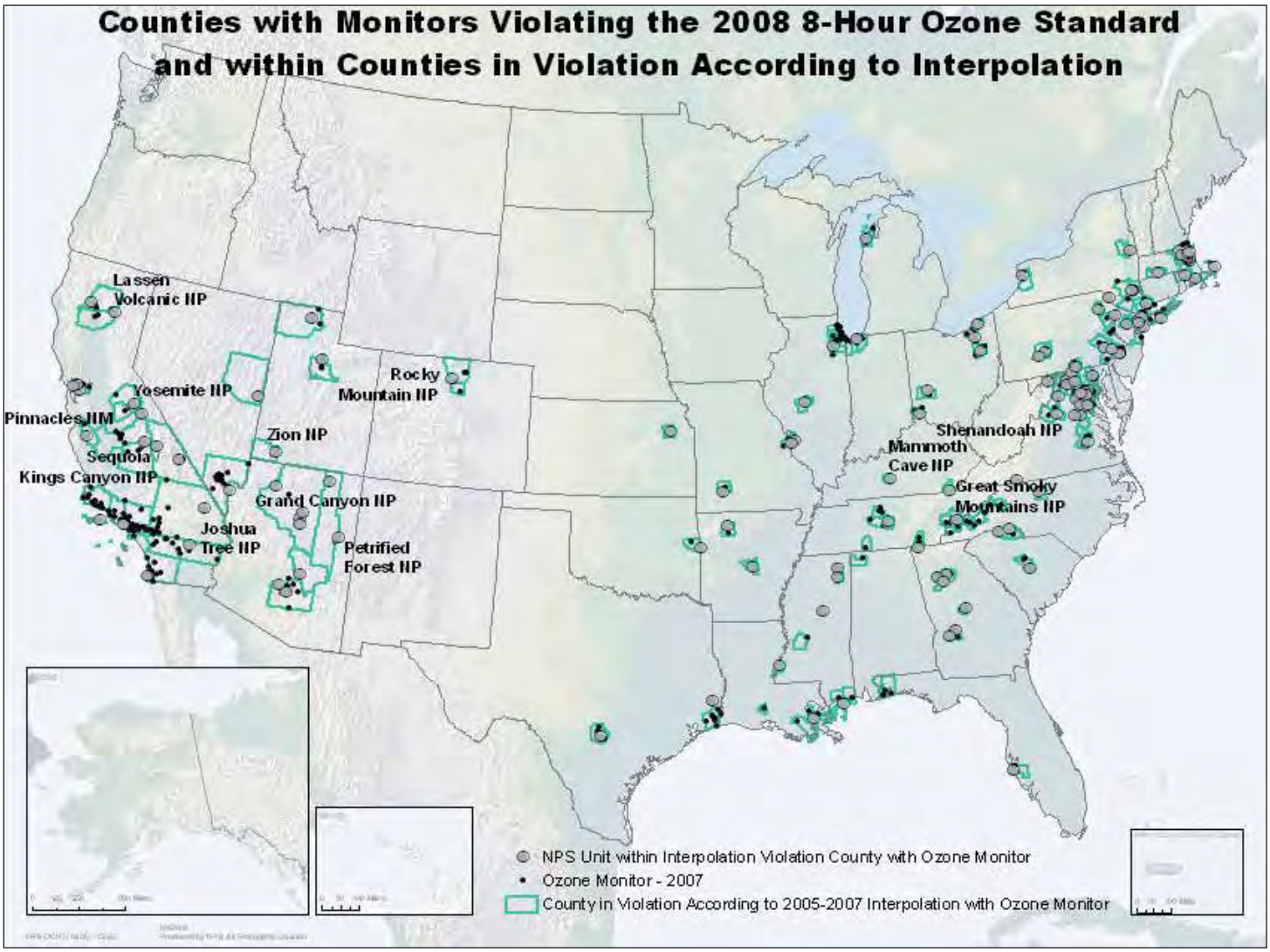


Table 8. Frequency of exceedances (mean number of days) where the daily maximum 8-hour average was greater than 75 ppb based on 2005-2007 data. This mean is based on a simple count of the days. No annual completeness criteria (such as a minimum number of valid daily 8-hour maximums) were applied.

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

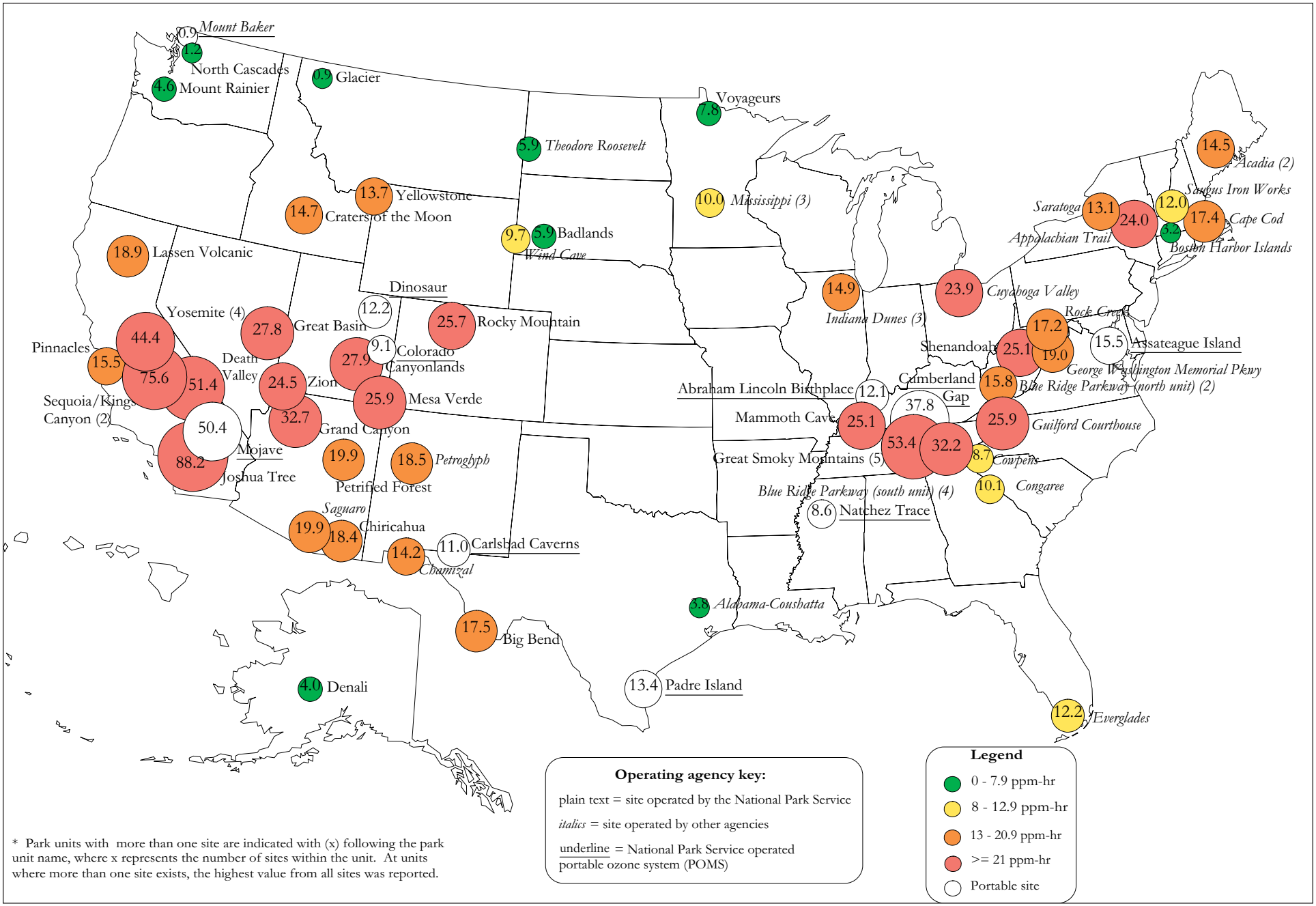


Figure 11. 2007 3-month maximum W126 exposure index during the ozone season (0800-2000 hourly concentrations).

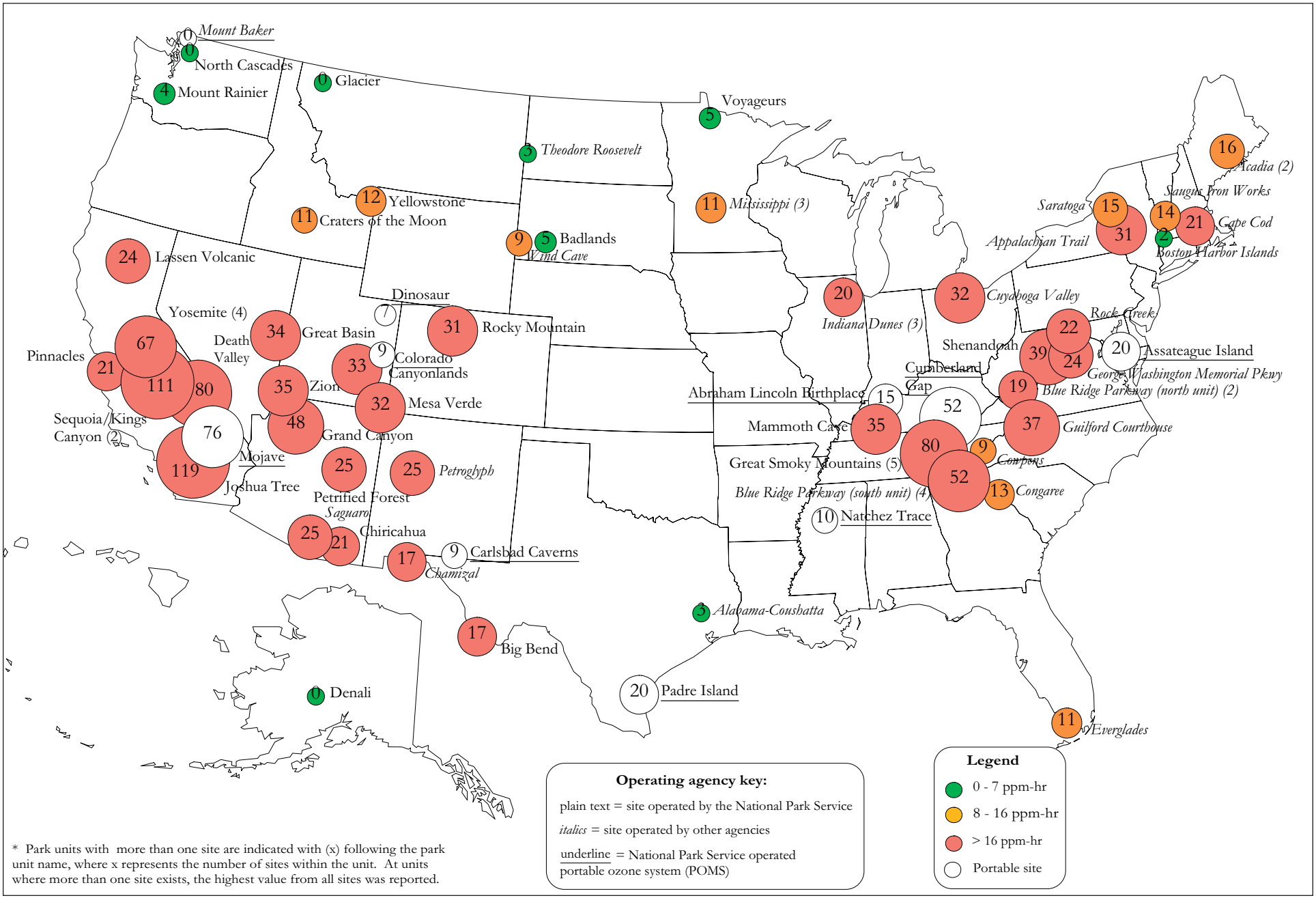


Figure 12. 2007 3-month maximum SUM06 exposure index during the ozone season (0800-2000 hourly concentrations).

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 98th 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 98th 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	Maximum	Minimum	Relative Humidity (%) Average	Maximum	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) Average	Ambient Temperature (degrees C) Average	Maximum	Minimum	Relative Humidity (%) Average	Maximum	Minimum	Precipitation (mm) 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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