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Natural Resource Program Center

Annual Data Summary 2008

Gaseous Pollutant Monitoring Program

Natural Resource Data Series NPS/NRPC/ARD/NRDS—2009/011

ON THE COVER

A clean air quality day in Canyonlands National Park as viewed from Dead Horse Point State Park, Utah.
Photograph by Debbie Miller

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The National Park Service, Natural Resource Program Center publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

Views, statements, findings, conclusions, recommendations, and data in this report are those of the author(s) and do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

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Gaseous Pollutant Monitoring Program 2008 Data Summary

The National Park Service Air Resources Division (NPS ARD) issues this annual data summary for their Gaseous Pollutant Monitoring Program (GPMP). These summaries present 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 is performed under the visibility and deposition programs and is reported separately.

Data collected by this network are incorporated into 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.*

GPMP Network Monitoring

The locations of the sites that operated during 2008 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 that 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 2.

In addition to monitoring for regulatory compliance, the NPS added portable ozone monitoring systems (POMS) to the GPMP in 2003. The POMS monitors are not EPA-certified analyzers, but 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. POMS site names in tables and figures have been underlined to distinguish them from monitoring sites meeting all EPA guidelines.

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.

Annual Ozone Summaries

In 2008 the primary NAAQS for ozone changed from 0.08 ppm (85 ppb equivalent) over an 8-hour period to 0.075 ppm (76 ppb equivelent) over an 8-hour period (*http://www.epa.gov/ttn/naaqs/standards/ozone/s_o3_index.html*). An exceedance of the standard occurs when an 8-hour average ozone concentration is greater than or equal to 76 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 76 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.

Table 3 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 8-hour standard. 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 standard during 2008. Note that other sites may have experienced fewer than four exceedances of the standard, and are not color coded. Ozone summary statistics for POMS are highlighted bold where exceedances occurred. These sites should be compared to EPA standards for reference purposes only.

The map in Figure 2 presents the annual fourth highest 8-hour average ozone concentrations for all network sites listed in Table 3. 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 (no color) 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 3. 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.

Ozone Violation Summaries
Table 4 presents ozone violation summaries for NPS-operated and cooperating sites for all 3-year periods over the last 10 years. Violations of the (old) 85 ppb standard are indicated in orange and red. Those values that would violate the new standard of 75 ppb are outlined with a black box.

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 76 ppb. Table values in parentheses indicate that EPA data completeness requirements for the 3-year period were not met. However, annual fourth highest daily maximum 8-hour ozone concentrations greater than or equal to 76 ppb for calendar years not meeting EPA data completeness requirements are included in the NAAQS violation computation.

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.
- 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.

Table 1 below displays the W126 and SUM06 thresholds for ozone effects to vegetation.

Table 1. W126 and SUM06 thresholds for ozone effects to vegetation

Growth Reduction	W126	SUM06
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 5 presents the ozone exposure indices summary statistics for 2008. Summaries for POMS are included for comparison only. Since portable sites are deployed for seasonal use, there may be significant biases in W126 and SUM06 exposure indices calculated from their data.

Figure 5 presents the 3-month maximum W126 exposure index for all network sites listed in Table 5. Figure 6 presents the annual 3-month maximum SUM06 exposure index for the same sites. Index values are color-coded to represent three distinct levels of cumulative exposure. Data from portable sites (no color) are included for reference only.

Sulfur Dioxide Summaries
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 6 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.

Kilauea Volcano is the source of sulfur dioxide in Hawaii Volcanoes National Park. Sulfur dioxide data are collected in the park 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.

$PM_{2.5}$ Data Summaries
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 $\mu g/m^3$. 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 $\mu g/m^3$.

Table 7 summarizes $PM_{2.5}$ measurements with respect to both the daily 24-hour average maximum concentrations and the annual arithmetic mean. 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.

PM_{10} Data Summaries
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 $\mu g/m^3$. 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.

Table 8 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 9 presents the same summaries for sites that collected PM_{10} using non-equivalency methods.

Table 10 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 EPA data completeness requirements were included in the NAAQS violation computation if the resulting 24-hour average exceeds the standard.

Meteorological Data Summaries
Table 11 presents a summary of selected meteorological data for all sites. The parameters included are wind speed, ambient temperature, relative humidity, and precipitation.

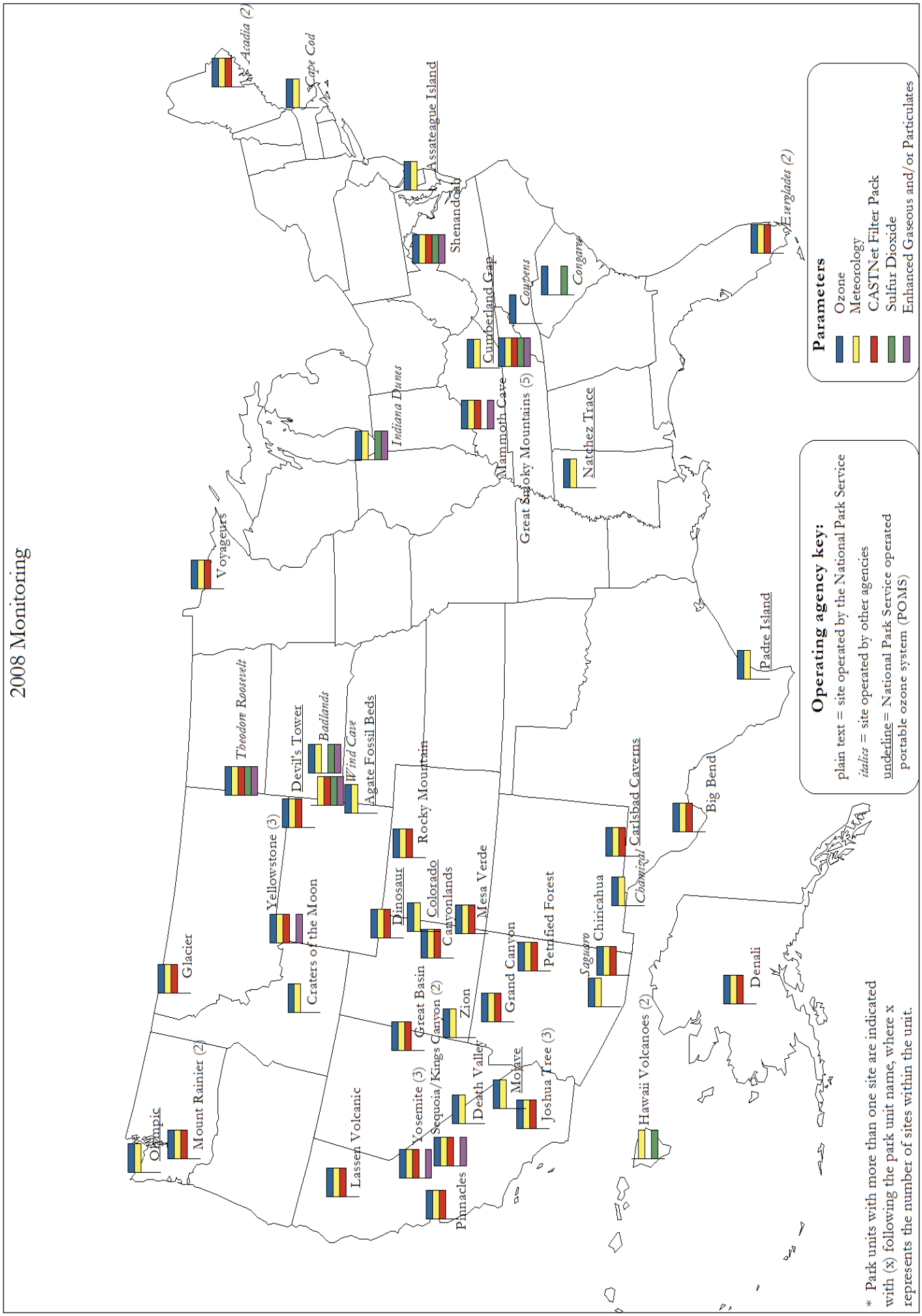

Figure 1. 2008 Air quality monitoring in or nearby park units.

Table 2. 2008 Site specifications.

National Park Unit	Site Name	State	NPS Abbr.	CASTNet Abbr.	AQS ID Number	Latitude (degrees north)	Longitude (degrees west)	Elev. (m)	O_3 Years[a]	SO_2	PM	WD[b]	WS[c]	TMP	RH	RNF	WET	DTP	SOL	Filter Pack[d]
Sites operated by the National Park Service																				
Agate Fossil Beds	Residence Area	NE	AGFO-RA	---	31-165-1001	42.4283	103.7294	1344	2	---	---	X	X	X	X	X	---	---	X	---
Assateague Island	Maintenance Area	MD	ASIS-MA	---	24-047-1001	38.2511	75.1594	3	4	---	---	X	X	X	X	X	---	---	X	---
Big Bend	K-Bar Ranch Road	TX	BIBE-KB	BBE401	48-043-0101	29.3022	103.1772	1052	19	---	---	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	17	---	---	X	X	X	X	X	X	X	X	X
Carlsbad Caverns	Maintenance Area	NM	CAVE-MA	---	35-015-3001	32.1783	104.4406	1349	3	---	---	X	X	X	X	X	---	---	X	X
Chiricahua	Entrance Station	AZ	CHIR-ES	CHA467	04-003-8001	32.0092	109.3892	1570	18	---	---	X	X	X	X	X	X	X	X	X
Colorado	Maintenance Yard	CO	COLM-MY	---	08-077-1001	39.1067	108.7411	1740	3	---	---	X	X	X	X	X	---	---	X	---
Craters of the Moon	Visitor Center	ID	CRMO-VC	---	16-023-0101	43.4606	113.5622	1815	17	---	---	X	X	X	X	---	---	---	X	---
Cumberland Gap	Hensley Settlement	TN	CUGA-HS	---	21-013-1002	36.6719	83.5264	1013	3	---	---	X	X	X	X	X	---	---	X	---
Death Valley	Park Village	CA	DEVA-PV		06-027-0101	36.5092	116.8481	125	16	---	---	X	X	X	X	X	---	---	X	---
Denali	Headquarters	AK	DENA-HQ	DEN417	02-290-0003	63.7258	148.9633	661	22	---	---	X	X	X	X	X	X	X	X	X
Devil's Tower	Joyner Ridge Trail	WY	DETO-JR	---	56-011-1013	44.5969	104.7047	1200	1	---	---	X	X	X	X	X	---	---	X	X
Dinosaur	West Entrance Housing	UT	DINO-WE	---	49-047-1002	40.2917	108.9417	2072	4	---	---	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	17	---	---	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	16	---	---	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	16	---	---	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	16	---	---	X	X	X	X	X	---	---	X	---
Great Smoky Mountains	Cove Mountain	TN	GRSM-CM	---	47-155-0101	35.6967	83.6086	1243	21	X	---	X	X	X	X	X	---	---	---	---
Great Smoky Mountains	Look Rock	TN	GRSM-LR	GRS420	47-009-0101	35.6331	83.9422	793	21	---	X	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	16	---	---	X	X	X	X	X	X	X	X	X
Joshua Tree	Cottonwood Canyon	CA	JOTR-CC	---	06-065-0008	33.7411	115.8206	984	4	---	X	X	X	X	X	X	---	---	X	---
Joshua Tree	Pinto Wells	CA	JOTR-PW	---	06-065-1004	33.9397	115.4108	326	3	---	---	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	22	---	---	X	X	X	X	X	X	X	X	X
Mammoth Cave	Houchin Meadow	KY	MACA-HM	MAC426	21-061-0501	37.1317	86.1481	236	14	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	16	---	---	X	X	X	X	X	X	X	X	X
Mojave	Kelso Mountains	CA	MOJA-KM	---	06-071-1001	35.1019	115.7767	1212	2	---	---	X	X	X	X	X	---	---	X	---
Mount Rainier	Tahoma Woods	WA	MORA-TW	MOR409	53-053-1010	46.7583	122.1244	415	18	---	---	X	X	X	X	X	X	X	X	X

Table 2. 2008 Site specifications (continued).

National Park Unit	Site Name	State	NPS Abbr.	CASTNet Abbr.	AQS ID Number	Latitude (degrees north)	Longitude (degrees west)	Elev. (m)	O_3 Years[a]	SO_2	PM	WD[b]	WS[c]	TMP	RH	RNF	WET	DTP	SOL	Filter Pack[d]
Sites operated by the National Park Service																				
Natchez Trace Parkway	Dancy Ranger Station	MS	NATR-DR	---	28-155-1001	33.6636	89.0622	94	3	---	---	X	X	X	X	X	---	---	X	---
Olympic	Hurricane Ridge Portable	WA	OLYM-HP	---	53-009-1004	47.9706	123.5028	1543	5	---	---	X	X	X	X	X	---	---	X	---
Padre Island	Malaquite Visitor Center	TX	PAIS-MV	---	48-273-1001	27.4267	97.2983	6	4	---	---	X	X	X	X	X	---	---	X	---
Petrified Forest	South Entrance	AZ	PEFO-SE	PET427	04-017-0119	34.8225	109.8919	1723	7	---	---	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	22	---	---	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	24	---	---	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	10	---	X	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	25	---	---	X	X	X	X	X	---	---	X	---
Shenandoah	Big Meadows	VA	SHEN-BM	SHN418	51-113-0003	38.5231	78.4347	1073	26	---	X	X	X	X	X	X	X	X	X	X
Voyageurs	Sullivan Bay	MN	VOYA-SB	VOY413	27-137-0034	48.4128	92.8292	429	13	---	---	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	X	---	---	---	---	---
Yellowstone	Water Tank	WY	YELL-WT	YEL408	56-039-1011	44.5597	110.4006	2400	13	---	---	X	X	X	X	X	X	X	X	X
Yosemite	School Yard	CA	YOSE-SY	---	06-043-1004	37.7478	119.5917	1234	3	---	---	X	X	X	X	X	---	---	X	---
Yosemite	Turtleback Dome	CA	YOSE-TD	YOS404	06-043-0003	37.7133	119.7061	1605	16	---	---	X	X	X	X	X	X	X	X	X
Zion	Dalton's Wash	UT	ZION-DW	---	49-053-0130	37.1983	113.1506	1213	5	---	---	X	X	X	X	X	---	---	X	---
# active park units: 37	# active park sites: 45																			
Sites operated by cooperating state agencies																				
Acadia	Cadillac Mountain	ME	ACAD-CM	---	23-009-0102	44.3472	68.2278	466	14	---	---	X	X	X	X	---	---	---	---	---
Acadia	McFarland Hill	ME	ACAD-MH	ACA416	23-009-0103	44.3769	68.2608	158	11	---	X	X	X	X	X	X	X	X	X	X
Badlands	Visitor Center	SD	BADL-VC	---	46-071-0001	43.7436	101.9414	739	12	---	X	X	X	X	X	X	---	---	X	---
Cape Cod	Cape Cod	MA	CACO-XX	---	25-001-0002	41.9758	70.0247	41	22	---	---	X	X	X	X	---	---	---	X	---
Chamizal	Chamizal	TX	CHAM-XX	---	48-141-0044	31.7656	106.455	1128	17	---	---	X	X	X	X	---	---	---	X	---
Congaree	Congaree Bluff	SC	COSW-BL	---	45-079-0021	33.8147	80.7811	34	9	X	---	---	---	---	---	---	---	---	---	---
Cowpens	State Monitor	SC	COWP-SM	---	45-021-0002	35.1303	81.8164	296	21	---	---	---	---	---	---	---	---	---	---	---
Everglades	Cutler Road	FL	EVER-CR	---	12-086-0029	25.5861	80.3269	4	24	---	---	---	---	---	---	---	---	---	---	---
Great Smoky Mountains	Cades Cove	TN	GRSM-CC	---	47-009-0102	35.6042	83.7831	564	16	---	---	X	X	X	X	X	---	---	X	---
Great Smoky Mountains	Purchase Knob	NC	GRSM-PK	---	37-087-0036	35.59	83.0775	1500	14	---	---	---	---	---	---	---	---	---	---	---
Indiana Dunes	Ammunition Bunker	IN	INDU-AB	---	18-089-0022	41.5733	87.3047	183	16	---	X	X	X	X	X	---	---	---	X	---
Mount Rainier	Jackson Visitor's Center	WA	MORA-JV	---	53-053-0012	46.7853	121.7378	1615	11	---	---	---	---	---	---	---	---	---	---	---
Saguaro	Pima County	AZ	SAGU-PC	---	04-019-0021	32.1744	110.7364	938	17	---	---	---	---	---	---	---	---	---	---	---
Theodore Roosevelt	Painted Canyon Visitor Cntr	ND	THRO-VC	THR422	38-007-0002	46.8947	103.3778	850	11	X	X	X	X	X	X	X	X	X	X	X

Table 2. 2008 Site specifications (continued).

National Park Unit	Site Name	State	NPS Abbr.	CASTNet Abbr.	AQS ID Number	Latitude (degrees north)	Longitude (degrees west)	Elev. (m)	O_3 Years[a]	SO_2	PM	WD[b]	WS[c]	TMP	RH	RNF	WET	DTP	SOL	Filter Pack[d]
Sites operated by cooperating state agencies																				
Wind Cave	Visitor Center	SD	WICA-VC	WNC429	46-033-0132	43.5578	103.4839	1292	5	---	X	X	X	X	X	X	X	X	X	X
Yellowstone	West Yellowstone	MT	YELL-WS	---	30-031-0017	44.6570	111.0896	2030	---	---	X	---	---	---	---	---	---	---	---	---
Yosemite	Village	CA	YOSE-VI	---	06-043-1001	37.7458	119.6028	1216	---	---	X	---	---	---	---	---	---	---	---	---
# active park units: 14	**# active park sites: 16**																			

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

[b] Cape Cod reports wind direction as scalar wind direction rather than vector wind direction.

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

[d] 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 (ppb)
SO_2 = sulfur dioxide analyzer (ppb)
PM = particulate matter ($\mu g/m^3$)
WD = wind direction (degrees)
WS = wind speed (m/s)
TMP = ambient temperature (degrees C)
RH = relative humidity (%)
RNF = precipitation (mm/hr)
WET = wetness (% on)
DTP = delta temperature (degrees C)
SOL = solar radiation (watts/m^2)

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

Table 3. 2008 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 ≥76 ppb[a]
Sites operated by the National Park Service								
Big Bend	K-Bar Ranch Road	349	69	68	67	65	65	0
Canyonlands	Island in the Sky	354	75	73	72	71	68	0
Chiricahua	Entrance Station	361	73	69	69	68	68	0
Craters of the Moon	Visitor Center	358	71	69	69	67	65	0
Death Valley	Park Village	349	94	87	80	77	77	5
Denali	Headquarters	354	76	72	69	68	67	1
Glacier	West Glacier Horse Stables	352	59	58	58	57	56	0
Grand Canyon	The Abyss	353	73	71	71	71	70	0
Great Basin	Maintenance Yard	328	76	73	73	71	71	1
Great Smoky Mountains	Clingmans Dome	185	86	86	85	80	78	9
Great Smoky Mountains	Cove Mountain	361	83	81	80	79	78	7
Great Smoky Mountains	Look Rock	357	87	83	83	82	82	14
Joshua Tree	Black Rock	352	110	107	106	105	105	72
Joshua Tree	Cottonwood Canyon	159	88	86	85	84	83	17
Lassen Volcanic	Manzanita Lake Fire Station	345	104	85	84	83	82	8
Mammoth Cave	Houchin Meadow	363	73	73	71	70	69	0
Mesa Verde	Resource Management Area	344	71	70	69	69	68	0
Mount Rainier	Tahoma Woods	350	64	57	57	54	53	0
Petrified Forest	South Entrance	323	75	74	73	72	71	0
Pinnacles	SW of East Entrance Station	354	94	87	87	86	84	12
Rocky Mountain	Long's Peak	355	81	77	77	76	73	4
Sequoia and Kings Canyon	Ash Mountain	262	121	120	112	112	111	74
Sequoia and Kings Canyon	Lower Kaweah	351	113	104	102	101	98	73
Shenandoah	Big Meadows	355	81	80	79	78	77	5
Voyageurs	Sullivan Bay	290	63	60	60	59	58	0
Yellowstone	Water Tank	329	68	67	65	65	65	0
Yosemite	Turtleback Dome	347	102	101	98	94	93	33
Zion	Dalton's Wash	352	76	74	73	72	72	1
Sites operated by cooperating state agencies								
Acadia	Cadillac Mountain	174	78	75	74	74	73	1
Acadia	McFarland Hill	360	70	67	65	64	62	0
Badlands	Visitor Center	361	56	55	54	53	52	0
Cape Cod	Cape Cod	179	106	86	82	75	75	3
Chamizal	Chamizal	342	84	84	80	74	73	3
Congaree	Congaree Bluff	355	74	74	74	73	72	0
Cowpens	State Monitor	342	86	81	80	79	77	5
Everglades	Cutler Road	350	81	77	77	74	73	3
Great Smoky Mountains	Cades Cove	223	78	75	72	72	71	1
Great Smoky Mountains	Purchase Knob	206	89	85	81	80	79	5
Indiana Dunes	Ammunition Bunker	170	77	67	63	62	61	1
Mount Rainier	Jackson Visitor's Center	193	58	52	52	51	51	0
Saguaro	Pima County	365	80	74	74	74	73	1
Theodore Roosevelt	Painted Canyon Visitor Cntr	364	66	62	62	61	61	0
Wind Cave	Visitor Center	353	63	62	60	59	59	0

Table 3. 2008 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 ≥76 ppb[a]
Portable ozone monitoring systems[b]								
Agate Fossil Beds	Residence Area	125	72	71	69	66	65	0
Assateague Island	Maintenance Area	159	83	79	76	74	73	3
Carlsbad Caverns	Maintenance Area	154	75	73	72	72	72	0
Colorado	Maintenance Yard	172	71	69	69	67	67	0
Cumberland Gap	Hensley Settlement	156	76	75	71	70	70	1
Devil's Tower	Joyner Ridge Trail	106	62	62	62	62	62	0
Dinosaur	West Entrance Housing	165	69	67	67	66	66	0
Joshua Tree	Pinto Wells	178	85	83	82	**81**	81	13
Mojave	Kelso Mountains	181	100	96	90	**86**	86	35
Natchez Trace Parkway	Dancy Ranger Station	90	60	59	59	58	58	0
Olympic	Hurricane Ridge Portable	82	69	67	59	58	52	0
Padre Island	Malaquite Visitor Center	82	75	70	67	65	60	0
Yosemite	School Yard	124	105	79	77	74	73	3

[a] The primary and secondary National Ambient Air Quality Standard for ozone is 0.075 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 76 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 76 ppb.) Exceedances of the standard are highlighted here in orange or red.

[b] The Gaseous Pollutant Monitoring Program Portable Ozone Monitoring Systems (POMS) do not meet EPA standards for regulatory monitoring. However, ozone summary statistics from portable systems can be compared to EPA standards for reference purposes.

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 = 76 - 104 ppb ozone concentration; ≥ 105 ppb ozone concentration

days with 8-hour average ≥76 ppb = 4 - 10 days; > 10 days

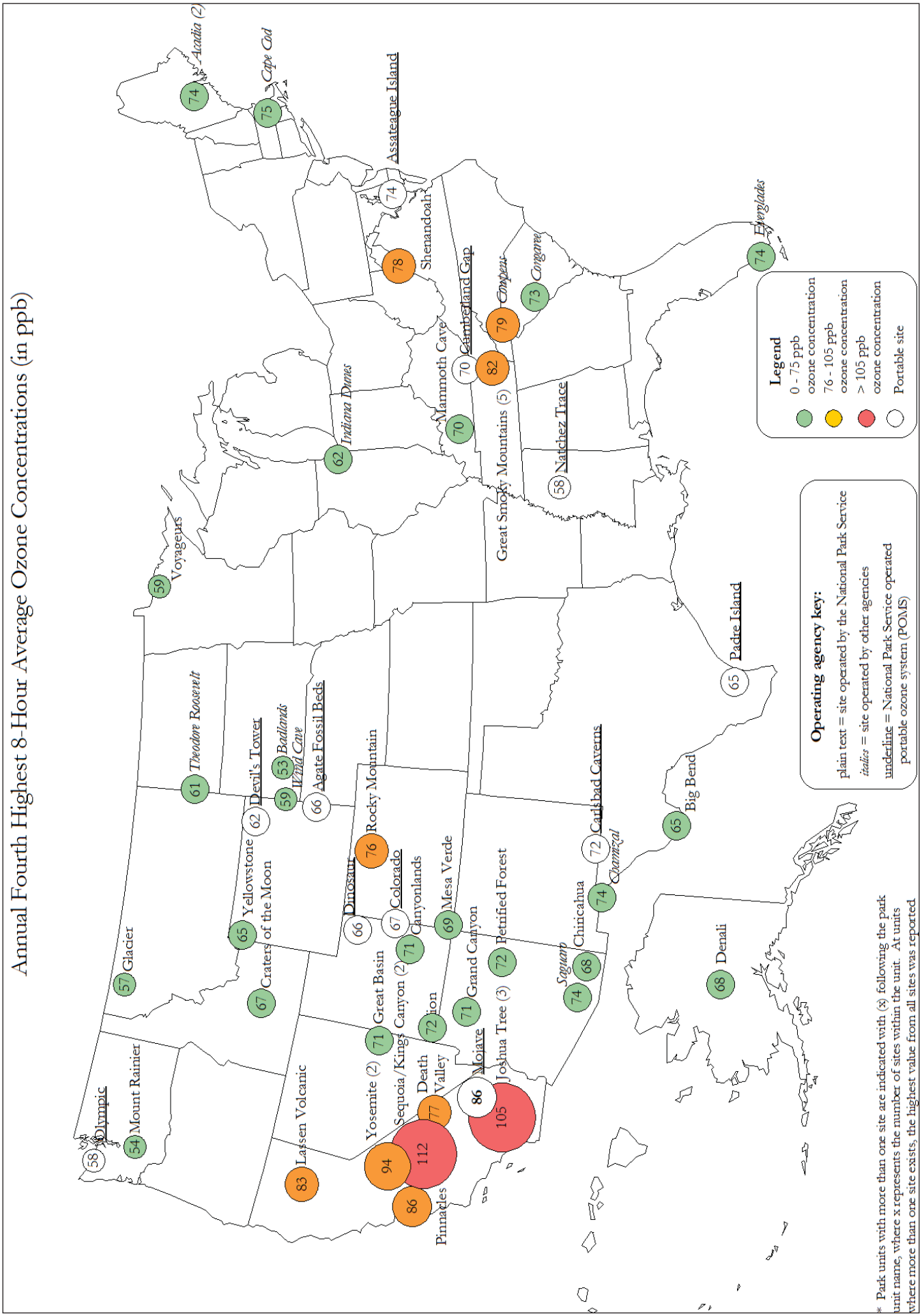

Figure 2. 2008 Annual fourth highest daily maximum 8-hour average ozone concentrations (in ppb).

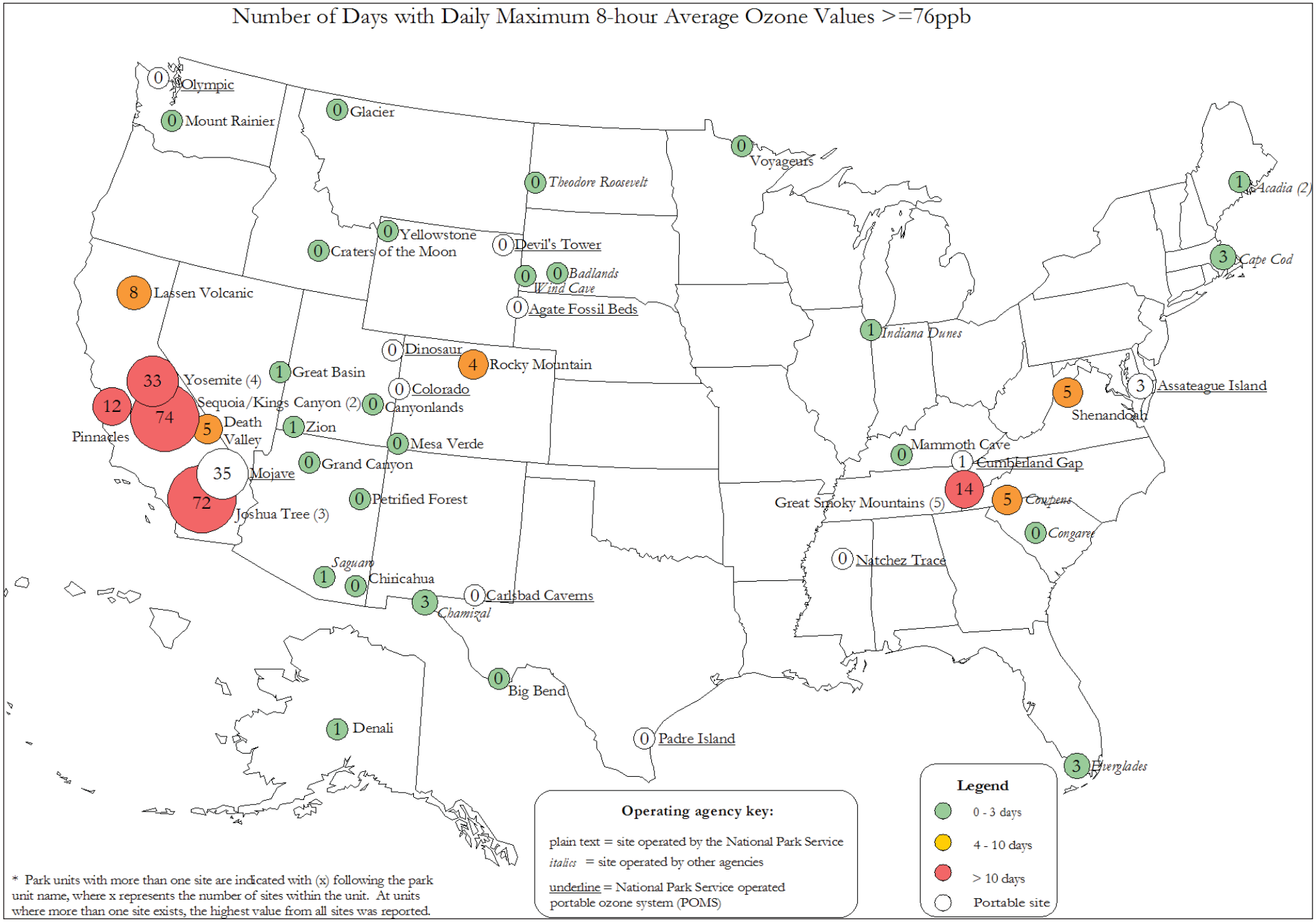

Figure 3. 2008 Annual number of days with daily maximum 8-hour average ozone values ≥76 ppb.

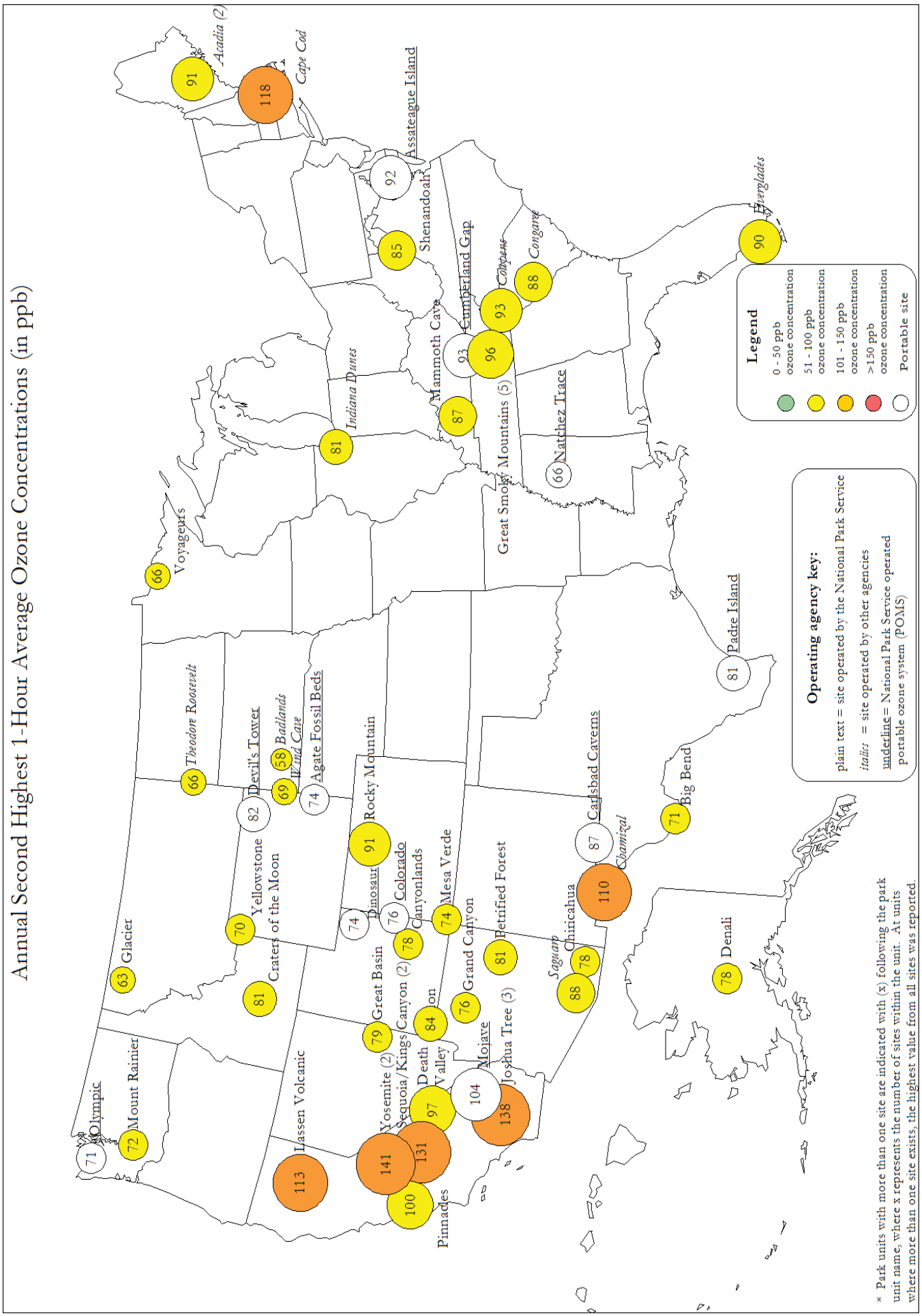

Figure 4. 2008 Annual second highest 1-hour average ozone concentrations (in ppb).

Table 4. 2008 Ozone violation summary - primary standard[a,b].

National Park Unit	Site Name	2006–2008	2005–2007	2004–2006	2003–2005	2002–2004	2001–2003	2000–2002	1999–2001
Sites operated by the National Park Service									
Big Bend	K-Bar Ranch Road	66	66	63	63	62	62	(62)	(63)
Canyonlands	Island in the Sky	71	69	69	71	72	70	(71)	(71)
Chiricahua	Entrance Station	69	71	72	71	70	69	69	70
Craters of the Moon	Visitor Center	(67)	(67)	---	---	67	(65)	(63)	(63)
Death Valley	Park Village	81	84	82	81	80	81	81	79
Denali	Headquarters	58	52	51	52	53	54	49	49
Glacier	West Glacier Horse Stables	53	55	54	56	55	53	49	48
Grand Canyon	The Abyss	70	72	73	74	74	74	73	72
Great Basin	Maintenance Yard	72	73	72	72	72	70	(72)	72
Great Smoky Mountains	Clingmans Dome	(84)	(83)	(80)	(79)	(87)	(92)	(98)	(98)
Great Smoky Mountains	Cove Mountain	82	82	77	78	86	92	96	96
Great Smoky Mountains	Look Rock	85	86	84	86	91	92	94	96
Joshua Tree	Black Rock	104	103	103	105	106	99	94	92
Joshua Tree	Cottonwood Canyon	(79)	(66)	(62)	(45)	---	---	---	---
Lassen Volcanic	Manzanita Lake Fire Station	77	72	69	68	71	72	74	77
Mammoth Cave	Houchin Meadow	74	76	72	73	77	80	84	88
Mesa Verde	Resource Management Area	71	73	73	70	68	67	69	69
Mount Rainier	Tahoma Woods	58	(56)	(58)	(61)	63	61	56	60
Petrified Forest	South Entrance	(70)	(70)	(70)	(71)	(66)	(64)	(55)	---
Pinnacles	SW of East Entrance Station	79	74	75	75	80	81	81	(79)
Rocky Mountain	Long's Peak	76	75	74	77	82	81	78	74
Sequoia and Kings Canyon	Ash Mountain	(105)	(103)	(103)	(105)	(105)	(107)	(105)	(104)
Sequoia and Kings Canyon	Lower Kaweah	96	95	96	97	101	101	98	(94)
Shenandoah	Big Meadows	76	77	77	(80)	82	87	85	87
Voyageurs	Sullivan Bay	(61)	(65)	64	66	64	65	(64)	67
Yellowstone	Water Tank	66	64	63	61	63	65	65	67
Yosemite	Turtleback Dome	(89)	86	86	88	90	90	89	86
Zion	Dalton's Wash	71	78	79	(82)	(74)	---	---	---
# park units with violations (0.08 ppm standard):		**4**	**4**	**3**	**4**	**4**	**5**	**5**	**6**
# sites with violations:		**5**	**5**	**4**	**5**	**7**	**8**	**8**	**9**
Sites operated by cooperating state agencies									
Acadia	Cadillac Mountain	79	82	80	82	88	94	93	89
Acadia	McFarland Hill	72	74	71	74	80	87	84	85
Badlands	Visitor Center	62	68	67	(66)	(64)	(67)	---	---
Cape Cod	Cape Cod	79	84	84	86	88	95	93	96
Chamizal	Chamizal	75	74	73	72	78	79	81	75
Congaree	Congaree Bluff	71	71	71	71	74	77	77	(74)
Cowpens	State Monitor	74	73	74	75	80	84	87	87
Everglades	Cutler Road	72	69	68	66	---	---	---	---
Great Smoky Mountains	Cades Cove	72	70	67	(67)	73	76	79	81
Great Smoky Mountains	Purchase Knob	77	77	75	78	82	86	88	87
Indiana Dunes	Ammunition Bunker	73	82	75	76	---	---	---	---
Mount Rainier	Jackson Visitor's Center	(59)	61	(60)	(59)	---	---	---	---
Saguaro	Pima County	74	76	76	(76)	(75)	(73)	72	69

Table 4. 2008 Ozone violation summary - primary standard[a,b] (continued).

National Park Unit	Site Name	2006–2008	2005–2007	2004–2006	2003–2005	2002–2004	2001–2003	2000–2002	1999–2001
Sites operated by cooperating state agencies									
Theodore Roosevelt	Painted Canyon Visitor Cntr	63	63	(60)	(59)	60	61	59	58
Wind Cave	Visitor Center	66	70	(71)	(70)	---	---	---	---
# park units with violations (0.08 ppm standard):		**0**	**0**	**0**	**1**	**2**	**3**	**4**	**4**
# sites with violations:		**0**	**0**	**0**	**1**	**2**	**4**	**4**	**5**

[a] The new primary and secondary National Ambient Air Quality Standard for ozone is 0.075 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 76 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 76 ppb.) For reference, values that would violate the new standard are outlined with a black box. The first 3-year period that the new standard will apply to is 2008-2010.

[b] The old 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.) Violations of the old standard are highlighted here in orange and red. The old standard applies to all 3-year periods prior to 2008-2010.

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 - 104 ppb ozone concentration

≥ 105 ppb ozone concentration

≥ 76 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.

Table 5. 2008 Summary of indices for resource injury (SUM06 and W126).

National Park Unit	Site Name	O_3% Valid	SUM06[a] (ppm-hr)	W126[b] (ppm-hr)
Sites operated by the National Park Service				
Big Bend	K-Bar Ranch Road	97.6	10	10
Canyonlands	Island in the Sky	97.8	22	16
Chiricahua	Entrance Station	99.2	27	17
Craters of the Moon	Visitor Center	98.8	13	10
Death Valley	Park Village	98.4	40	25
Denali	Headquarters	98.4	4	4
Glacier	West Glacier Horse Stables	98.7	0	1
Grand Canyon	The Abyss	99.1	25	17
Great Basin	Maintenance Yard	92.7	26	17
Great Smoky Mountains	Clingmans Dome	99.2	21	16
Great Smoky Mountains	Cove Mountain	99.3	19	14
Great Smoky Mountains	Look Rock	99.2	25	18
Joshua Tree	Black Rock	98.1	67	51
Joshua Tree	Cottonwood Canyon	43.3	---[c]	---[c]
Lassen Volcanic	Manzanita Lake Fire Station	96.4	25	19
Mammoth Cave	Houchin Meadow	99.9	18	12
Mesa Verde	Resource Management Area	97.0	17	13
Mount Rainier	Tahoma Woods	98.7	1	1
Petrified Forest	South Entrance	93.8	30	19
Pinnacles	SW of East Entrance Station	98.5	26	19
Rocky Mountain	Long's Peak	98.8	24	18
Sequoia and Kings Canyon	Ash Mountain	73.6	51	40
Sequoia and Kings Canyon	Lower Kaweah	97.0	72	57
Shenandoah	Big Meadows	98.6	12	11
Voyageurs	Sullivan Bay	87.4	1	2
Yellowstone	Water Tank	95.1	8	8
Yosemite	Turtleback Dome	95.5	57	41
Zion	Dalton's Wash	98.0	28	18
Sites operated by cooperating state agencies				
Acadia	Cadillac Mountain	99.7	9	7
Acadia	McFarland Hill	99.1	4	4
Badlands	Visitor Center	99.1	0	2
Cape Cod	Cape Cod	97.3	15	12
Chamizal	Chamizal	98.0	12	10
Congaree	Congaree Bluff	99.0	11	9
Cowpens	State Monitor	97.0	22	16
Everglades	Cutler Road	97.3	7	6
Great Smoky Mountains	Cades Cove	99.4	13	10
Great Smoky Mountains	Purchase Knob	95.5	14	11
Indiana Dunes	Ammunition Bunker	97.7	2	3
Mount Rainier	Jackson Visitor's Center	52.0	0	1
Saguaro	Pima County	99.7	30	20

Table 5. 2008 Summary of indices for resource injury (SUM06 and W126) (continued).

National Park Unit	Site Name	O_3% Valid	SUM06[a] (ppm-hr)	W126[b] (ppm-hr)
Sites operated by cooperating state agencies				
Theodore Roosevelt	Painted Canyon Visitor Center	99.9	2	4
Wind Cave	Visitor Center	97.3	2	5
Portable ozone monitoring systems				
Agate Fossil Beds	Residence Area	80.4	N/A	N/A
Assateague Island	Maintenance Area	99.8	14	11
Carlsbad Caverns	Maintenance Area	94.1	19	13
Colorado	Maintenance Yard	98.6	19	14
Cumberland Gap	Hensley Settlement	98.4	11	9
Devil's Tower	Joyner Ridge Trail	96.7	8	7
Dinosaur	West Entrance Housing	91.0	15	10
Joshua Tree	Pinto Wells	99.5	44	28
Mojave	Kelso Mountains	99.9	58	37
Natchez Trace Parkway	Dancy Ranger Station	63.6	N/A	N/A
Olympic	Hurricane Ridge Portable	99.8	N/A	N/A
Padre Island	Malaquite Visitor Center	83.8	N/A	N/A
Yosemite	School Yard	85.9	18	14

[a] 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.

[b] 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*.

[c] In 2008, data capture at this station was not high enough to present values in this table.

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

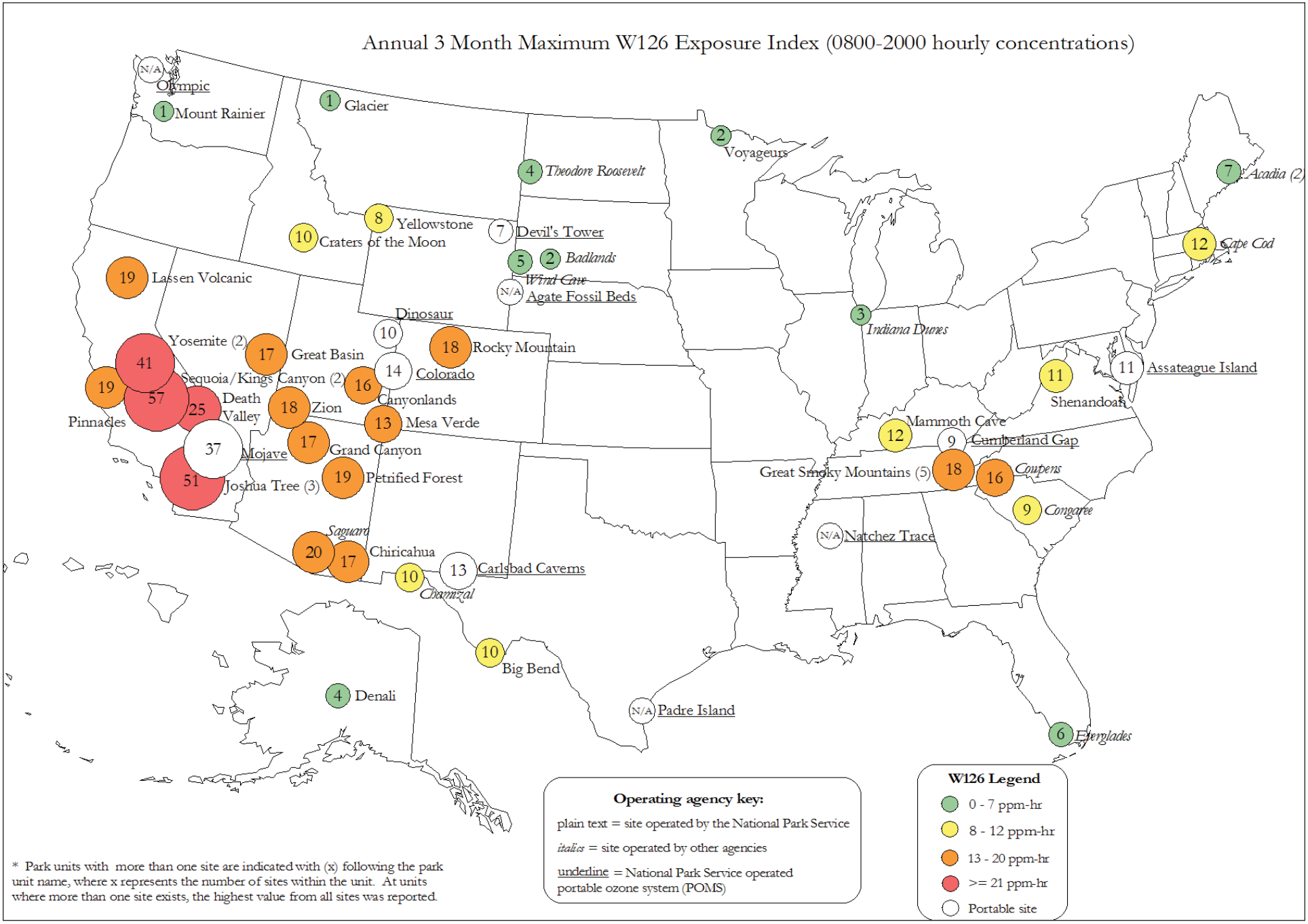

Figure 5. 2008 3-month maximum W126 exposure index during the ozone season (0800-2000 hourly concentrations).

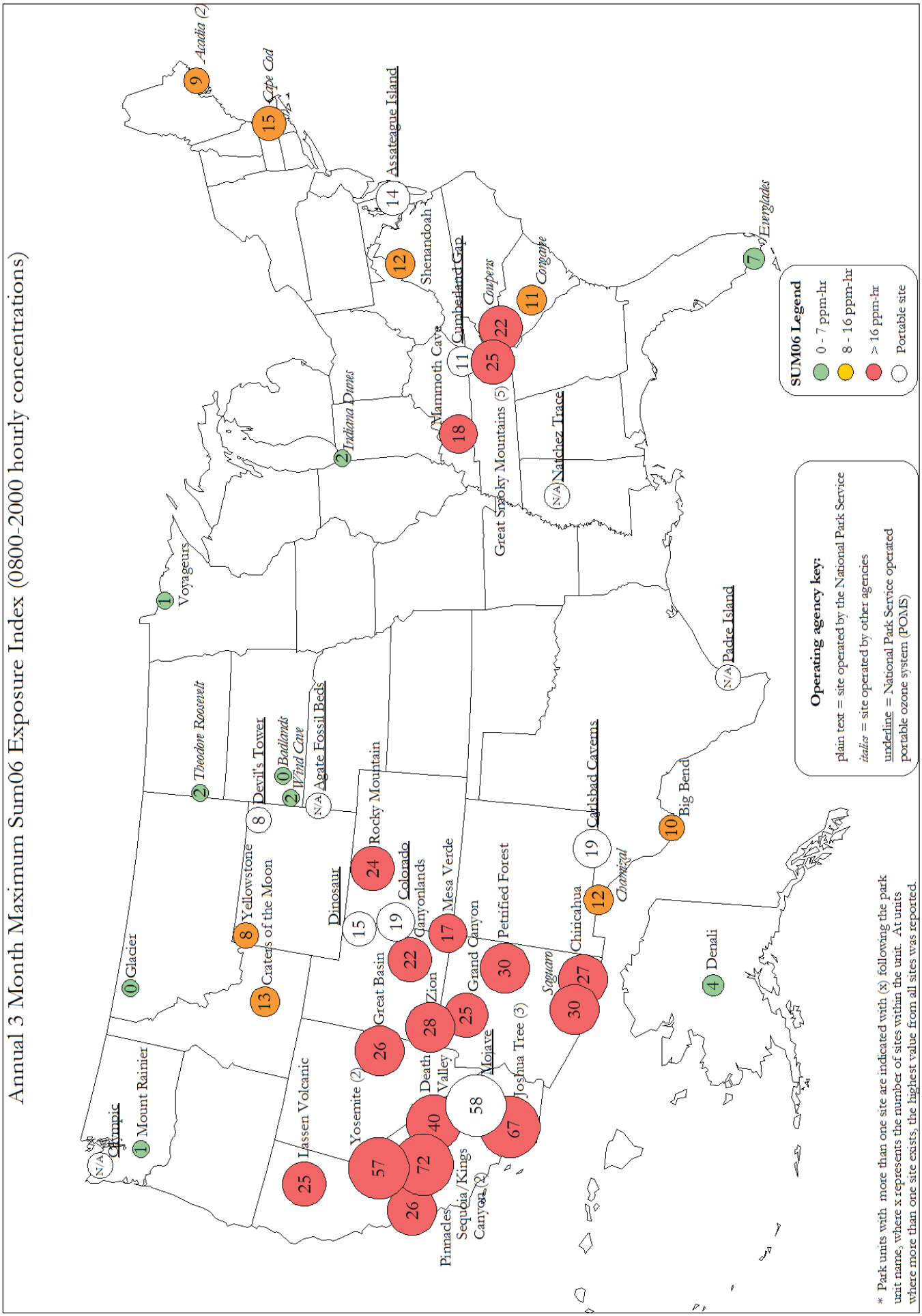

Figure 6. 2008 3-month maximum SUM06 exposure index during the ozone season (0800-2000 hourly concentrations).

Table 6. 2008 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	7	5	4	4	0	13	12	12	11	0	19	17	16	16
Hawaii Volcanoes *	Observatory	37	480	457	415	373	30	2541	1927	1573	1396	28	4765	2742	2542	2401
Hawaii Volcanoes *	Visitor Center	19	349	309	231	217	10	1186	932	922	676	5	2476	2466	1452	1288
Sites operated by cooperating state agencies																
Badlands	Visitor Center	1	6	5	4	4	0	6	6	6	6	0	7	6	5	5
Congaree	Congaree Bluff	1	10	9	7	6	0	46	43	33	31	0	73	71	53	49
Indiana Dunes	Ammunition Bunker	3	19	17	16	15	0	95	44	41	41	0	150	80	67	67
Theodore Roosevelt	Painted Canyon Visitor Ctr	0	3	1	1	1	0	6	6	5	4	0	14	9	8	6
Wind Cave	Visitor Center	0	1	1	1	1	0	3	3	2	2	0	4	4	3	3

[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 $\mu g/m^3$ 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 $\mu g/m^3$ 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 $\mu g/m^3$ 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

Table 7. 2008 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										
Great Smoky Mountains	Look Rock	TEOM	98.6	12.0	40	35	34	33	28	1
Sequoia and Kings Canyon	Ash Mountain	BAM	81.3	16.0	65	63	55	41	40	10
Shenandoah	Big Meadows	TEOM	95.6	5.8	23	23	21	21	20	0
Yellowstone	Old Faithful	BAM	84.3	4.5	17	16	16	14	13	0
Sites operated by cooperating state agencies										
Acadia	McFarland Hill	TEOM	96.3	3.0	29	21	17	17	13	0
Badlands	Visitor Center	BAM	93.9	4.0	49	23	17	14	13	1
Indiana Dunes	Ammunition Bunker	TEOM	99.4	12.0	34	32	31	30	27	0
Theodore Roosevelt	Painted Canyon Visitor Ctr	TEOM	98.3	5.8	40	32	18	17	12	1
Wind Cave	Visitor Center	BAM	98.2	3.8	43	38	21	15	11	2
Yellowstone	West Entrance	BAM	97.6	1.5	8	7	6	6	6	0
Yosemite	Village	BAM	94.9	12.8	130	104	84	75	59	15

[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

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

Color shading key: Annual arithmetic mean > 15 µg/m³
98th percentile value > 35 µg/m³

Table 8. 2008 Summary of PM_{10} 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	No. of Days with 24-Hour Average >150 µg/m³
Sites operated by cooperating state agencies									
Badlands	Visitor Center	BAM	96.3	10	90	60	40	40	0
Wind Cave	Visitor Center	BAM	99.4	9	50	50	40	30	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 annual National Ambient Air Quality Standard for PM_{10} is an annual arithmetic mean of 50 µg/m³. (An exceedance of the standard occurs when an annual arithmetic mean of PM_{10} concentrations is greater than 50 µg/m³. A violation of the standard occurs when the 3-year average of the weighted annual mean PM_{10} concentrations is greater than 50 µg/m³ (40 CFR 50.6.)

[c] The primary daily National Ambient Air Quality Standard for PM_{10} is a 24-hour average concentration of 150 µg/m³. (An exceedance of the standard occurs when a 24-hour average PM_{10} concentration is greater than 150 µg/m³. A violation of the standard occurs when a 24-hour average concentration greater than 150 µg/m³ 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 µg/m³ annual arithmetic mean, >150 µg/m³ 24-hour average

italics = site operated by a state agency

Table 9. 2008 Summary of PM_{10} data from non-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	No. of Days with 24-Hour Average >150 µg/m³
Sites operated by the National Park Service									
Joshua Tree	Cottonwood Canyon	E-sampler	9.5	---[d]	---	---	---	---	---

[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_{10} is an annual arithmetic mean of 50 µg/m³. (An exceedance of the standard occurs when an annual arithmetic mean of PM_{10} concentrations is greater than 50 µg/m³. A violation of the standard occurs when the 3-year average of the weighted annual mean PM_{10} concentrations is greater than 50 µg/m³ (40 CFR 50.6.)

[c] The primary daily National Ambient Air Quality Standard for PM_{10} is a 24-hour average concentration of 150 µg/m³. (An exceedance of the standard occurs when a 24-hour average PM_{10} concentration is greater than 150 µg/m³. A violation of the standard occurs when a 24-hour average concentration greater than 150 µg/m³ occurs more than once in a calendar year.) (40 CFR 50.6.)

[d] In 2008, data capture at this station was not high enough to present values in this table.

Color shading key: >50 µg/m³ annual arithmetic mean, >150 µg/m³ 24-hour average

Table 10. PM_{10} summary - maximum daily 24-hour average concentration in 2006-2008 (µg/m³)[a].

National Park Unit	Site Name	Sampler Type*	2008	2007	2006
Sites operated by cooperating state agencies					
Badlands	Visitor Center	BAM	90	50	30
Wind Cave	Visitor Center	BAM	50	40	30

[a] The primary daily National Ambient Air Quality Standard for PM_{10} is a 24-hour average concentration of 150 µg/m³. (An exceedance of the standard occurs when a 24-hour average PM_{10} concentration is greater than 150 µg/m³. A violation of the standard occurs when a 24-hour average concentration greater than 150 µg/m³ 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 µg/m³

italics = site operated by a state agency

Table 11. 2008 Annual summary of selected meteorological data.

		Wind Speed (Scalar[a]) (m/s)	Ambient Temperature (degrees C)			Relative Humidity (%)			Precipitation (mm)
National Park Unit	Site Name	Average	Average	Maximum	Minimum	Average	Maximum	Minimum	Annual Accumulation
Sites operated by the National Park Service									
Big Bend	K-Bar Ranch Road	3.6	20.3	40.1	-3.2	40	100	2	280
Canyonlands	Island in the Sky	2.9	11.8	35.0	-12.3	38	100	4	183
Chiricahua	Entrance Station	3.0	15.4	35.3	-9.2	42	100	6	404
Craters of the Moon	Visitor Center	3.4	5.5	32.6	-21.7	52	99	8	---
Death Valley	Park Village	3.9	26.3	48.6	5.1	18	99	1	37
Denali	Headquarters	1.2	-3.2	24.4	-34.8	69	95	18	238
Everglades	Beard Center	2.4	23.1	32.4	0.2	80	100	23	929
Glacier	West Glacier Horse Stables	0.9	4.7	34.8	-29.3	73	95	15	551
Grand Canyon	The Abyss	2.8	3.7	21.6	-12.1	39	98	5	358
Great Basin	Maintenance Yard	2.8	10.9	32.3	-18.2	40	97	4	215
Great Smoky Mountains	Clingmans Dome	3.7	12.5	23.6	-8.3	83	100	2	837
Great Smoky Mountains	Cove Mountain	4.8	10.9	27.0	-18.3	70	100	3	955
Great Smoky Mountains	Look Rock	2.5	12.9	29.2	-15.8	70	100	15	1167
Hawaii Volcanoes	Observatory	4.8	15.6	25.9	8.2	85	100	17	1435
Hawaii Volcanoes	Visitor Center	3.6	15.2	24.1	7.8	90	100	14	2177
Joshua Tree	Black Rock	3.9	16.5	36.4	-3.8	32	94	1	65
Joshua Tree	Cottonwood Canyon	3.7	21.1	39.4	-1.0	30	100	4	69
Lassen Volcanic	Manzanita Lake Fire Station	2.0	7.4	30.9	-15.3	57	100	7	823
Mammoth Cave	Houchin Meadow	1.9	13.8	37.3	-14.7	68	100	18	1253
Mesa Verde	Resource Management Area	3.2	9.9	30.5	-16.4	40	97	5	403
Mount Rainier	Tahoma Woods	0.9	7.9	33.2	-13.0	84	100	14	1223
Petrified Forest	South Entrance	4.1	12.5	34.0	-14.4	40	100	3	107
Pinnacles	SW of East Entrance Station	2.3	14.4	41.9	-3.6	56	95	4	286
Rocky Mountain	Long's Peak	3.0	3.7	26.4	-23.4	48	100	4	429
Sequoia and Kings Canyon	Ash Mountain	2.5	16.0	38.9	-0.2	52	97	11	335
Sequoia and Kings Canyon	Lower Kaweah	1.7	9.8	28.7	-10.8	56	100	9	848
Shenandoah	Big Meadows	2.4	8.2	27.5	-17.5	72	100	8	1346
Voyageurs	Sullivan Bay	2.8	2.5	31.3	-31.5	72	99	15	747
Yellowstone	Old Faithful	1.7	1.6	27.5	-33.9	67	100	10	---
Yellowstone	Water Tank	1.7	0.6	25.7	-29.3	65	97	10	635
Yosemite	Turtleback Dome	4.1	11.3	32.6	-8.8	46	98	8	746
Zion	Dalton's Wash	3.1	15.8	40.1	-9.4	35	100	3	237
Sites operated by cooperating state agencies									
Acadia	Cadillac Mountain	5.7	13.9	26.2	-0.5	85	100	25	---
Acadia	McFarland Hill	3.0	7.2	28.8	-19.5	75	100	14	1340
Cape Cod	Cape Cod	2.3	10.0	33.9	-11.2	70	90	7	---
Chamizal	Chamizal	3.4	19.1	39.9	-4.1	32	96	3	---
Great Smoky Mountains	Cades Cove	1.4	13.6	30.9	-12.7	73	100	12	1244
Indiana Dunes	Ammunition Bunker	3.6	9.5	33.9	-21.3	71	100	19	---
Saguaro	Pima County	---	21.3	41.9	-1.0	34	97	4	---
Theodore Roosevelt	Painted Canyon Visitor Cntr	5.4	5.9	36.0	-31.4	61	99	10	238
Wind Cave	Visitor Center	2.9	7.9	33.3	-28.7	56	100	10	505

Table 11. 2008 Annual 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
Portable ozone monitoring systems (seasonal)									
Agate Fossil Beds	Residence Area	3.5	16.9	36.9	-10.1	61	100	10	216
Assateague Island	Maintenance Area	1.5	22.0	34.7	7.9	78	100	32	470
Carlsbad Caverns	Maintenance Area	4.3	23.4	39.0	4.1	46	100	5	313
Colorado	Maintenance Yard	1.7	20.4	36.9	-1.7	28	98	6	72
Cumberland Gap	Hensley Settlement	2.3	18.2	27.6	-2.9	74	100	27	415
Devil's Tower	Joyner Ridge Trail	1.4	18.8	36.5	-2.6	59	100	10	173
Dinosaur	West Entrance Housing	1.4	18.4	38.0	-6.2	39	97	8	86
Joshua Tree	Pinto Wells	3.4	30.7	45.2	8.7	20	88	3	18
Mojave	Kelso Mountains	3.7	24.6	37.7	3.4	23	92	5	18
Natchez Trace Parkway	Dancy Ranger Station	0.3	23.6	35.6	4.9	79	99	29	601
Olympic	Hurricane Ridge Portable	0.6	10.7	26.9	-1.5	67	100	10	82
Padre Island	Malaquite Visitor Center	6.3	26.4	29.7	14.0	84	99	29	99
Yosemite	School Yard	0.8	19.3	37.5	3.2	50	97	10	39

[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

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