Appendix B: Air Quality Monitoring

Overview

The primary purpose of the Clean Air Act is to provide ambient air quality standards that protect human health. Secondary standards were also set to protect the "national welfare," which is broadly defined to include parks and natural areas. Amendments to the Clean Air Act in 1977 added a "prevention of significant deterioration" (PSD) section, which charges federal land management agencies "to preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value." 42 U.S.C. Sec. 7470. Class I areas include national parks larger than 6,000 acres and national wilderness areas and national memorial parks which exceed 5,000 acres. All other clean air regions of the country are designated as Class II areas. (For a summary of the Clean Air Act, the protections Class I and Class II areas receive, and its relation to the National Park Service see The Clean Air Act, by Molly N. Ross, available at the following web site: http://www2.nature.nps.gov/air/regs/cleanAir.cfm.

Four SCPN parks are designated Class I areas (Bandelier, Grand Canyon, Mesa Verde, and Petrified Forest); the rest are designated Class II areas. Air quality information for the Class I areas has been summarized on the Air Resources Information System (ARIS) website: http://www2.nature.nps.gov/air/Permits/ARIS/index.htm.

Threats to Air Quality in the SCPN Region

The NPS Air Resources Division (ARD) has contracted with the University of Denver (DU) to produce GIS-based maps and an associated look-up table that provide baseline values for a set of air quality parameters for all Inventory and Monitoring parks in the U.S. These maps and tables are now available on the Air Atlas website (http://www2.nature.nps.gov/air/Maps/AirAtlas/index.cfm) and serve as the Air Quality Inventory for the parks. Air Atlas uses information from on-site monitoring within parks and from all the major air quality monitoring networks.

A table of selected Air Atlas data for the SCPN parks (Table B1) shows air quality parameters that may help determine the risk to air quality related values. Air quality related values (AQRVs) are those resources that are potentially sensitive to air pollution and include vegetation, wildlife, water quality, soils, and visibility.

A review of the air quality table for SCPN indicates that pollutants of concern include ozone, nitrogen and sulfur compounds, and visibility-reducing compounds. In addition, mercury (as deposited by the atmosphere) is a growing concern in the SCPN.

Ozone

According to the Air Atlas data, ozone concentrations and cumulative ozone doses (SUM60) are high enough in the SCPN region to induce ozone injury symptoms in sensitive plant species under certain conditions. Peak ozone concentrations exceed 100 ppb and cumulative ozone doses exceed 15,000 ppb-hrs in some parks, both thresholds for ozone injury. In addition, trend data show that ozone concentrations are significantly increasing in parks on the Colorado Plateau (Air Quality in the National Parks, 2nd ed.).

The draft Southern Colorado Plateau Ozone Risk Assessment produced by Air Resources Division indicates that many SCPN parks are at a low risk for foliar ozone injury to plants. Exceptions to this are Aztec Ruins and Canyon de Chelly National Monuments, which have a high risk for injury, and Petrified Forest National Park, Sunset Crater Volcano, Walnut Canyon, and Wupatki National Monuments, which have a moderate risk for injury. All SCPN parks have plant species known to be sensitive to ozone.

Table B1. Estimates for ozone, nitrogen and sulfur deposition, and visibility measurements for SCPN parks.

	Ozone (ppb)				(ppb-hrs)	NADP (kg/ha/yr)		Visibility - IMPROVE	
Park	**2ndHi1hr**	**4thHi8hr**	**#8hr>85**	**#1hr>100**	**Sum60_3Mo**	**Total S**	**Total N**	**bextClear**	**bextHazy**
AZRU	81.7	67.2	0.1	0.1	10,900	1.00	1.44	6	24
BAND	89.6	68.3	0.2	0.2	16,600	1.07	1.58	8	27
CACH	86.6	70.1	0.8	1.1	13,800	0.83	1.23	7	26
CHCU	86.2	68.1	0.2	0.2	13,300	0.98	1.42	7	26
ELMA	88.6	68.6	0.4	0.4	15,000	0.93	1.34	8	28
ELMO	88.6	69.2	0.6	0.6	15,000	0.90	1.30	8	28
GLCA	92.2	74.0	1.5	2.8	18,500	0.68	1.07	6	23
GRCA	95.0	77.6	2.2	3.5	24,700	0.60	1.21	6	25
HUTR	90.8	72.4	1.6	2.7	15,800	0.82	1.22	8	26
MEVE	80.6	67.2	0.1	0.1	11,100	0.93	1.35	6	24
NAVA	90.7	74.1	1.9	3.3	17,200	0.77	1.19	7	24
PEFO	101.2	78.2	3.3	6.4	34,600	0.80	1.18	9	27
PETR	89.8	68.3	0.2	0.2	13,900	1.05	1.51	8	28
RABR	90.8	74.7	1.8	2.9	18,800	0.72	1.14	6	24
SAPU	92.8	69.3	0.4	1.0	14,000	1.10	1.55	8	30
SUCR	104.8	81.7	4.1	7.9	32,300	0.62	1.10	7	25
WACA	106.1	82.2	4.3	8.3	33,600	0.60	1.06	7	26
WUPA	103.5	81.2	3.9	7.6	31,000	0.66	1.15	7	24
YUHO	80.7	67.4	0.1	0.1	11,300	0.93	1.35	7	25

Source: NPS Air Atlas

Ozone information represents 5-yr average of annual values from 1995-1999:

2ndHi1hr: 2nd highest 1 hour concentration of ozone; old standard of 120 ppb was based on this
4thHi8hr: 4th highest 8-hr concentration of ozone; new ozone standard of 80 ppb is based on this
#8hr>85: Number of 8-hr averages greater than 85 ppb; indicates how many times this site would exceed new standard
#hr>100: Number of 1-hr averages greater than 100 ppb; indicates high peaks in ozone concentration
SUM60_3mon: sum of 1-hr avg. concentrations ≥ 60 ppb over 3 mo. growing season; indicates cumulative ozone dose

NADP information represents 6-yr average of annual values from 1995-2000:

Total S – estimate of sulfur from sulfate deposited to ecosystem by precipitation
Total N - inorganic nitrogen (ammonium plus nitrate) deposited to ecosystem by precipitation

Visibility IMPROVE information represents 5-yr average of annual values from 1995-1999:

bextClear - measure of light scattering and absorption by particles in the air on an average clear day
bextHazy - measure of light scattering and absorption by particles in the air on an average hazy day

Nitrogen and Sulfur

Estimates of nitrogen and sulfur deposition in the SCPN, while relatively low, are substantially higher than natural estimates of deposition. In addition, trend information indicates that nitrogen deposition is increasing in parks on the Colorado Plateau. Sulfur, while decreasing somewhat, is still elevated above natural conditions.

Sulfur deposition can have an acidifying effect, and nitrogen deposition can have either an acidifying or fertilizing effect, or both. Nitrogen is a particular concern in the western U.S. due to the sensitivity of some ecosystems to low amounts of deposition (Meixner et al. 2002). Nitrogen has been found to cause changes in plant species composition, enhance growth of invasive species, and alter fire regimes (Fenn et al. 2003).

Precipitate-related acidification occurs in areas with low-buffering capacity (few available base cations). Surface waters and soils in the SCPN are likely to be well-buffered and, therefore, insensitive to acidification. However, this will need to be verified through water quality and soil inventories.

Both regional and local air pollution sources affect air quality in the SCPN. Large sources of nitrogen and sulfur compounds include the Navajo (AZ), Four Corners (NM), and Cholla (AZ) power plants, the San Juan Generating Station (NM), and the Salt River Project (AZ). In addition, numerous smaller generating stations, compressor plants, and other sources contribute to pollution in the area. A new coal-burning power plant, called Desert Rock, is proposed near Farmington, NM. According to the air quality/AQRV modeling analysis, emissions from the power plant could have a negative impact on sulfur deposition at AZRU, BAND, CACH, CHCU, ELMA, ELMO, GLCA, HUTR, MEVE, PETR, SAPU, and YUHO and on nitrogen deposition at AZRU, BAND, CACH, CHCU, and MEVE.

Visibility-reducing Pollutants

All units in the SCPN experience reduced visibility to some extent because of fine pollutant particles (haze). Visibility monitoring is conducted at the four Class I areas in the SCPN, as well as at several US Forest Service areas in the region.

The U.S. Environmental Protection Agency's Regional Haze regulations require states to establish goals for each Class I air quality area to improve visibility on the haziest days and to ensure no degradation occurs on the clearest days. An analysis of 1990-1999 data indicates that visibility in Mesa Verde NP is degrading on both the clearest and the haziest days. Visibility in Grand Canyon NP, Bandelier NM, and Petrified Forest NP is degrading on the haziest days and remaining stable or improving slightly on the clearest days.

The AQRV modeling analysis produced for the proposed Desert Rock power plant near Farmington, NM showed possible changes in visibility of greater than 5% at CHCU, GRCA, MEVE, and PEFO.

Mercury

With increasing numbers of fish consumption advisories issued because of elevated mercury levels, concern about mercury deposition on the Colorado Plateau is growing. Much of the mercury entering ecosystems comes from atmospheric deposition, unless there is a nearby mercury source (e.g., certain mining operations). Mercury in deposition comes from a variety of sources, including coal-burning power plants, incinerators, recycling plants, and forest fires (which re-emit anthropogenic mercury that has been previously deposited). Mercury in wet deposition has been monitored at one site in the SCPN, Mesa Verde NP. Monitoring in the park started in December 2001 as part of the Mercury Deposition Network (MDN). In 2002, concentrations of mercury in rainfall at MEVE were some of the highest in the country; however, because annual rainfall at MEVE was low, annual deposition of mercury was also low. Additional years of data are needed to accurately characterize mercury deposition in MEVE. Because mercury monitoring sites are so few, it is not possible to interpolate the data between sites and derive estimates for sites without monitoring.

Monitoring

The NPS participates in a number of nationwide air quality monitoring networks, as well as conducting its own air quality and visibility monitoring. Prior to 1986, the NPS visibility monitoring effort consisted of cameras which produced a photographic record of how the view changes under different weather, sunlight, and air pollution conditions; teleradiometer equipment that measured visibility levels in terms of contrast; and particulate samplers and laboratory analysis which measured particulates in the air. Visibility has been monitored as part of the Interagency Monitoring of Protected Visual Environments (IMPROVE) network since 1986. Every IMPROVE site deploys aerosol samplers to measure fine aerosols and particulate matter. Select sites also deploy transmissometers and nephelometers to measure light extinction and scattering respectively, as well as automatic camera systems to measure the "scene". Deposition of nitrogen and sulfur compounds in rain and snow (wet deposition) is monitored as part of the National Atmospheric Deposition Program/National Trends Network (NADP/NTN). Deposition of nitrogen and sulfur compounds in dryfall (dry deposition) is monitored as part of the Clean Air Status and Trends Network (CASTnet). Ozone is monitored as part of the NPS Gaseous Pollutant Monitoring Network (GPMN). Mercury deposition is monitored as part of the National Atmospheric Deposition Program/Mercury Deposition Network (NADP/MDN).

The four SCPN Class I areas are currently conducting monitoring as part of the IMPROVE and NADP/NTN networks. CASTnet and GPMN are currently implemented at Grand Canyon, Mesa Verde and Petrified Forest National Parks. GPMN was in place at Bandelier from 1989 to 1994. MDN is in place at Mesa Verde NP. Several SCPN Class II areas have had limited visibility monitoring in the past, and some passive ozone monitoring is occurring in the network. In addition, several special studies have been conducted in SCPN parks, including WHITEX (Winter Haze Intensive Tracer Experiment), MOHAVE (Project Measurement of Haze and Visibility Effects), the Intensive IMPROVE Study, and focused research projects. Table B2 shows current and past air quality and visibility monitoring conducted in SCPN parks.

In addition to monitoring within SCPN parks, other NPS units, federal, state and tribal agencies conduct air quality monitoring on the Colorado Plateau. See Figure B1 for a map of air quality monitoring sites in Arizona, Colorado, New Mexico and Utah.

Current monitoring programs in Class I SCPN parks will continue to be the primary air quality monitoring for the Southern Colorado Plateau Network. The air quality vital sign was ranked moderate to low by most parks within the network. Current monitoring, by NPS and other agencies, will be used to determine trends for the entire region and to indicate potential problems at parks where no air quality monitoring is being conducted.

Table B2. Past and current air quality and visibility monitoring in SCPN parks.

Current Monitoring Activities					
Area Name	**Location**	**ID**	**Parameter Category**	**Time Period**	**Years Active**
Bandelier NM	Rim Fire Tower	5	Meteorological Factors*	10/5/1988-present	17.2
			Visibility/Haze (IMPROVE v2)	4/1/2000-present	5.7
	Rim Fire Tower - NADP site	6	Wet/Dry Atmospheric Dep.	6/1/1982-present	23.5
Flagstaff Cluster	Sunset Crater Volcano	49	Passive Ozone	7/1/1996—present	10
	Walnut Canyon	50	Passive Ozone	7/1/1996—present	10
	Wupatki	51	Passive Ozone	7/1/1996—present	10
Grand Canyon NP	Hance Station	60	Meteorological Factors	12/1/1997-present	8
			Sulfur Dioxide	12/1/1988-present	17
			Visibility/Haze (IMPROVE v2)	4/1/2000-present	5.7
	Hopi Point Fire Tower - NADP site	62	Dry/Wet Atmospheric Dep.	8/1/1981-present	24.4
	Yavapai Museum	63	Meteorological Factors	12/13/1989-present	16
			Sulfur Dioxide	3/1/1991-present	14.8
			Visibility/Haze (IMPROVE v2)	7/1/2000-present	5.4
	Desert View Tower	67	Visibility/Haze	10/1/1979-present	26.2
	South Rim	68	Meteorological Factors	12/18/1986-present	19
			Visibility/Haze	12/18/1986-present	19
	The Abyss	69	Dry Atmospheric Dep.	3/28/1995-present	10.7
			Meteorological Factors	8/1/1989-present†	16.4
			Ozone	1/1/1993-present	12.9
Mesa Verde NP	Resource Management Area (Maintenance Yard)	84	Dry Atmospheric Dep.	1/10/1995-present	10.9
			Meteorological Factors	4/1/1993-present	12.7
			Ozone	6/1/1993-present	12.5
	Resource Management Area - IMPROVE site	85	Visibility/Haze (IMPROVE v2)	4/1/2000-present	5.7
	Chapin Mesa	86	Dry/ Wet Atmospheric Dep.	4/1/1981-present	24.7
			Dry/ Wet Atmospheric Dep. plus mercury	12/1/2001-present	4

Area Name	Location	ID	Parameter Category	Time Period	Years Active
Petrified Forest NP	1 mile N of Park Headquarters	101	Visibility/Haze (IMPROVE v2)	4/1/2000-present	5.7
	Horse Barn	102	Dry Atmospheric Dep.	10/1/2002-present	3.2
			Meteorological Factors	10/1/2002-present	3.2
			Ozone	10/1/2002-present	3.2
	Horse Barn visibility site	103	Meteorological Factors	11/1/2003-present	2.1
Past Monitoring Activities					
Bandelier National Monument	Rim Fire Tower	5	Meteorological Factors	10/2/1982--2/9/1985	2.4
			Sulfur Dioxide	3/1/1988--1/25/1992	3.9
			Visibility/Haze	7/29/1978--4/30/1995‡	16.8
			Visibility/Haze (IMPROVE A-D)	3/1/1988--4/1/2000	12.1
	Site No. 01	7	Meteorological Factors	4/19/1990--12/31/1993†	3.7
			Nitrogen Dioxide	9/1/1990--12/1/1993	3.3
			Ozone	10/1/1989--12/1/1994	5.2
			Sulfur Dioxide	5/1/1990--12/31/1993	3.7
Chaco Culture National Historic Park	Pueblo Alto Ruins	34	Visibility/Haze	8/1/1978--12/2/1991‡	13.3
Glen Canyon National Recreation Area	Site No. 01	55	Visibility/Haze	3/30/1984--4/10/1992‡	8
Grand Canyon NP	Grand View (Passive O3 site)	59	Passive Ozone	5/1/2003-9/1/2003	0.4
	Grand Canyon - portable	58	Meteorological Factors	5/1/2003--10/1/2003	0.4
			Portable Ozone	5/1/2003--10/1/2003	0.4
	Hance Station	60	Visibility/Haze (IMPROVE A-D)	8/1/1997--4/1/2000	2.7
	Hopi Point Fire Tower	61	Meteorological Factors	8/3/1979--11/28/1987†	8.3
			Visibility/Haze (IMPROVE A-D)	3/1/1988--8/1/1998	10.4
	Indian Gardens (Grand Canyon West)	63	Visibility/Haze (IMPROVE A-D)	10/4/1989--5/1/2000	10.6
	Indian Gardens (Passive O3 site)	64	Passive Ozone	5/1/2003-9/1/2003	0.4
	Phantom Ranch (Passive O3 site)	65	Passive Ozone	5/1/2003-9/1/2003	0.4
	Pierce Ferry (Passive O3 site)	66	Passive Ozone	5/1/2003-9/1/2003	0.4
	Site No. 02	67	Visibility/Haze	7/1/1978--2/28/1987‡	8.7
	The Abyss	69	Meteorological Factors	8/1/1989--3/31/1995	5.7
			Ozone	7/1/1981--9/30/1981	0.2
				4/1/1983--11/30/1983	0.7
			Passive Ozone	5/1/2003-9/1/2003	0.4

Area Name	Location	ID	Parameter Category	Time Period	Years Active
Grand Canyon NP (cont.)	Tuweep (Passive O3 site)		Passive Ozone	5/1/2003-9/1/2003	0.4
			Meteorological Factors	5/1/2003-9/1/2003	0.4
Mesa Verde National Park	Far View Visitor Center	83	Visibility/Haze	7/25/1978--4/14/1995‡	16.7
	Resource Management Area (Maintenance Yard)	84	Meteorological Factors	10/30/1982--12/5/1987†	5.2
				4/1/1993--10/31/1994	1.6
	Resource Management Area - IMPROVE site	85	Sulfur Dioxide	7/1/1993--7/1/1995	2
			Visibility/Haze (IMPROVE A-D)	3/1/1988--4/1/2000	12.1
	Soda Canyon Rim	87	Meteorological Factors	7/19/1991-7/28/1993	2
			Visibility/Haze	7/19/1991-7/28/1993	2
	Water Tank		Visibility/Haze	9/15/1988-7/23/1990	1.9
Navajo National Monument	Water Tower	93	Visibility/Haze	8/24/1978--5/27/1986‡	7.8
Petrified Forest National Park	1 mile N of Park Headquarters	101	Meteorological Factors	7/30/1979--8/31/1981	2.1
				11/1/1986--1/31/1992†	5.1
			Ozone	4/1/1987--1/31/1992	4.8
			Sulfur Dioxide	3/1/1988--3/20/1993	5.1
			Visibility/Haze	8/15/1986--4/10/1995‡	8.7
			Visibility/Haze (IMPROVE A-D)	3/1/1988--4/1/2000	12.1
	S of Park Headquarters		Meteorological Factors	7/1/1987-11/30/2004	17.4
			Visibility/Haze	7/1/1987-11/30/2004	17.4
Wupatki National Monument	Cinderhill Visitor Center	144	Visibility/Haze	8/1/1978--9/30/1982	4.2

* Meteorological factors may include dew point, extinction coefficient, humidity, precipitation, solar radiation, wind direction, wind speed. Not all factors are measured at all sites

† This time period represents the cumulative amount of time that meteorological factors were measured; not all factors were measured the entire time period.

‡This parameter was being monitored in some way throughout this time period, although different techniques may have been used.

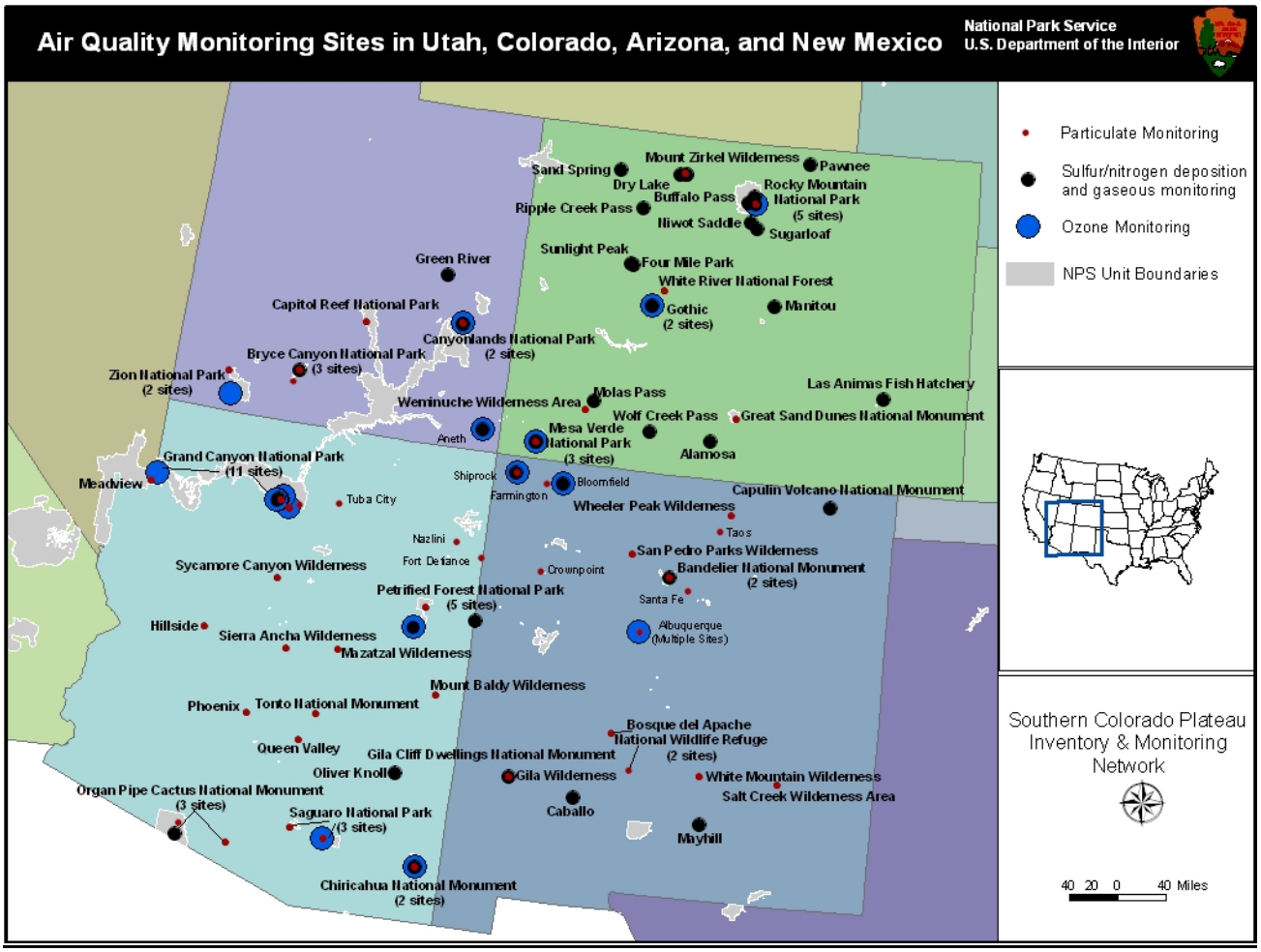

Figure B1. Air quality monitoring locations in or near SCPN parks. For detailed information about park based air quality monitoring, see Table B1.

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Relevant Websites

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CASTNet - http://www.epa.gov/castnet/
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NPS Ozone Monitoring Data - http://www2.nature.nps.gov/air/data/current/index.cfm
Ozone - http://www.epa.gov/air/data/index.html
Mercury - http://nadp.sws.uiuc.edu/mdn