

CODE RED

America's
Five
Most
Polluted
National
Parks



Great Smoky Mountains National Park, named for a naturally occurring blue mist emitted by lush plant life, is America's most polluted. More than 9 million people visit the Smokies annually, making it the most visited national park. A gray or yellowish haze, primarily pollution from power plants, frequently shrouds scenic vistas.

Code Red America's Five Most Polluted National Parks

Executive Summary

America's national parks are endangered by polluted air. In fact, many of these parks suffer some of the nation's dirtiest air, rivaling or even exceeding that of our most polluted cities, such as Atlanta and Los Angeles. This level of pollution occurs even though Congress in 1977 amended the Clean Air Act to ensure that certain national parks and wildlands, called Class I areas, would have the cleanest air in America. Although surveys show that Americans expect clean air in the parks,¹ the important promise of the Clean Air Act remains largely unfulfilled. This report examines the current state of air quality in our national parks.

Code Red: America's Five Most Polluted National Parks uses an air pollution index, originally developed by Appalachian Voices for two earlier editions of this report,² to rank the five most-polluted national parks based on three impacts—haze, ozone, and acid precipitation.

Numerous public lands in the United States, such as wilderness areas and wildlife refuges, also suffer from similar air-quality problems. Although these lands are not the focus of this report, the status of the five most-polluted parks is indicative of problems in these other areas and in our own communities as well.

The index compares data from ten national parks with the most extensive monitoring programs. We selected data for the years 1991 through 2001 to assess progress made during the decade since passage of the 1990 amendments to the Clean Air Act, the most recent provisions. The air pollution index shows that the following are the five most-polluted national parks:

1. Great Smoky Mountains National Park, Tennessee and North Carolina
 - ▲ Ozone pollution rivals that of Los Angeles, violating federal health standards more than 175 times since 1998 and damaging 30 species of plants.
 - ▲ Mountaintop clouds blanketing sensitive spruce-fir forests can be as acidic as vinegar, leading to nitrogen-saturated soils.
 - ▲ Appeared on the National Parks Conservation Association's lists of America's Ten Most Endangered National Parks, in large part because of air pollution.

Ozone exposure in Great Smoky Mountains National Park rivals that of Los Angeles, California.

2. Shenandoah National Park , Virginia

- ▲ Views from Skyline Drive and the Appalachian Trail are significantly degraded, shrinking to one mile on some summer days due to high levels of fine-particle pollution.
- ▲ Acidified streams place even the highly prized brook trout, an acid tolerant species, at risk.

3. Mammoth Cave National Park , Kentucky

- ▲ Three of every four park visitors come not for the cave but for ridge-top views, which they often find are among the haziest in the nation.
- ▲ On average, rainfall at the park is ten times more acidic than natural conditions.

4. Sequoia and Kings Canyon³ National P arks , California

- ▲ Ozone levels surpassed human-health standards on 61 summer days in 2001. This same pollutant harms sequoia seedlings.
- ▲ Hazy skies block views of spectacular Sierra scenery.

5. Acadia National Park , Maine

- ▲ Rocky soils like those at Acadia have little defense against acid rain, fog, and snow; one park lake is chronically acidified.
- ▲ Scenic views from Cadillac Mountain remain impaired.

The impacts of air pollution are evident throughout the National Park System. For example, Yosemite in California ranked third in the analysis for ozone exposure, and Big Bend in Texas has some of the worst visibility in the West, placing it on the National Parks Conservation Association's list of America's Ten Most Endangered National Parks. Many other parks are not included in the analysis because they lack complete monitoring data.

This report also addresses additional types of air pollution not included in the air pollution index. Mercury deposits pose risks at parks across the country from Acadia in Maine to the Everglades in South Florida. Similarly, the fine-particle pollution that reduces scenic views also contributes to as many as 30,000 premature human deaths nationally each year.⁴ Airborne pesticide residues from agricultural areas present threats to ecosystems in parks. Finally, global warming could greatly disrupt ecosystems in national parks, from rising sea levels to melting glaciers and changes in biodiversity, according to the Bush Administration's 2002 U.S. Climate Action Report.⁵ Some scientists predict that temperatures due in part to global warming could melt all the glaciers at Glacier National Park within 30 years.⁶

The air pollution from human sources that plagues national parks across the country comes primarily from burning fossil fuels—coal, oil, and gas.

Sources of Air Pollution

The air pollution generated from human sources that plagues national parks across the country comes primarily from burning fossil fuels—coal, oil, and, gas. Emissions come from power plants and industrial facilities as well as from cars, trucks, planes, trains, and construction equipment. Although the contribution of power plants varies from region to region, this one sector emits excessive amounts of pollution, especially in the eastern half of the country:

- ▲ Although coal-fired power plants emit more than 90 percent of the air pollution produced by the U.S. electric industry, they generate only slightly more than 50 percent of the nation's electricity. They emit 64 percent of the nation's sulfur dioxide, 23 percent of the nitrogen oxides, 33 percent of the mercury, and 35 percent of the carbon dioxide pollution.⁷

- ▲ The contribution of coal-fired power plants is especially disproportionate in the eastern half of the country, where the plants emit 78 percent of the sulfur dioxides and 39 percent of the nitrogen dioxides.⁸
- ▲ More than 17,000 older industry sources operate with pollution controls much weaker than those required at modern facilities. Outdated coal-fired power plants emit pollution at six to twelve times the rate of upgraded and newer facilities.⁹
- ▲ Tailpipe emissions from more than 200 million vehicles¹⁰ in the United States are also a concern, especially at parks such as Sequoia-Kings Canyon.

Fulfilling the Promise of Clean Air

Federal laws mandate that national parks should have the cleanest air in America, but this promise remains unfulfilled. Despite some progress, conditions at national parks remain significantly impaired, with many parks showing little or no improvement since the laws were enacted. The Bush Administration's legislative and administrative proposals make little progress toward this promise to parks and jeopardize public health. This report makes several recommendations critical to reversing park pollution, including the following:

1. The Bush Administration must implement and enforce existing programs of the Clean Air Act, such as the Regional Haze Rule, including the Best Available Retrofit Technology (BART) amendment and the New Source Review program. Current Administration proposals would eliminate these basic programs, weakening provisions to protect parks.
2. Federal legislation must be enacted to make sizeable cuts in power plant emissions in a timely manner. Reductions of sulfur dioxide, nitrogen oxides, mercury, and carbon dioxide are all critical for national parks. President Bush's plan for clean-air protection, called the Clear Skies Initiative, is far from sufficient in protecting air quality in our national parks.
3. Emissions from mobile sources must be reduced. Increases in vehicle miles traveled and rising sales of less efficient models, including sport-utility vehicles, present problems. Moreover, pollution from many diesel-burning vehicles, such as trucks, buses, and construction equipment, remains a substantial concern.
4. In the absence of strong federal action to reduce emissions, states must find ways to protect themselves. We encourage states to take action to control in-state sources of pollution in

Outdated coal-fired power plants emit pollution at six to twelve times the rate of upgraded and newer facilities.

states such as North Carolina, which recently passed the Clean Smokestacks Act, requiring significant cuts in power-plant pollution. Almost a dozen other states have passed or are considering legislation to reduce pollution from this sector. Similarly, California recently became the first state in the nation to control greenhouse gas emissions from tailpipes.

order to ensure that reductions begin in a timely fashion. They should follow the lead of

The National Park System has been called the best idea America ever had.¹¹ If this heritage is to be passed on to future generations unimpaired, America must fulfill the promise of clean air. If we save our parks, they may very well save us.

Introduction

Enforcing the Clean Air Act to Protect Parks and People

The Bush Administration must energetically enforce existing clean air laws in order to protect parks and people.

New Source Review Program

The single most effective step the Bush Administration could take to protect and restore air quality is to vigorously enforce the New Source Review (NSR) program. Congress adopted the NSR program in 1977 to require that significant new pollution sources such as power plants, refineries, and other industrial facilities use state-of-the-art pollution controls. The federal land managers of Class I areas participate in this process to ensure that pollution from new sources will not affect air quality at these parks and wilderness areas. At the same time, Congress allowed existing facilities to continue without additional controls as long as they did not make modifications which increased pollution. For years, the energy industry has fought even these modest requirements.

In 1999, the U.S. Department of Justice filed dozens of enforcement actions on behalf of EPA against companies alleged to have violated the Clean Air Act's NSR provisions by making major modifications without installing modern pollution controls. Vice-president Dick Cheney's National Energy Policy Development Group directed in May 2001 that the Justice Department review the legal basis for the lawsuits. In January 2002, the department announced that these enforcement actions were consistent with the Clean Air Act and stated that ongoing prosecutions would proceed,¹⁴ although most appear to be stalled.

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America's national parks are experiencing a crisis, and you can see it in the haze of distant vistas and in the browning of park trees. Unfortunately, the parks have become laboratories for studying the impacts of air pollution on humans and ecosystems. More than 280 million people visit the parks yearly, seeking refuge or inspiration.¹² They instead are often confronted with hazy skies and health warnings. From Acadia in Maine to Sequoia and Kings Canyon in California, air pollution problems persist throughout the park system. The five most-polluted national parks are Great Smoky Mountains, Shenandoah, Mammoth Cave, Sequoia-Kings Canyon, and Acadia national parks, as determined by data collected during the past 11 years.

From an early date, Congress sought to preserve the integrity of parks and recognized the importance of scenic vistas. The National Park Service became a federal agency in 1916 with the responsibility "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

The air pollution from human sources that plagues national parks across the country comes primarily from burning fossil fuels—coal, oil, and gas.

Over the years, air pollution began to damage ecosystems and scenery. In 1977, Congress addressed growing concerns about air pollution on public lands by creating special Clean Air Act provisions to protect parks and wilderness areas. At the same time, Congress designated 158 areas—including national parks larger than 6,000 acres and wilderness areas larger than 5,000 acres in existence as of August 7, 1977—as "Class I areas." These areas, which

today include 49 national park units, were to be given the greatest protection under the Clean Air Act, which established as a national goal “the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory federal Class I areas in which impairment results from man-made pollution.”

From Acadia in Maine to Sequoia-Kings Canyon in California, air pollution problems persist throughout the park system.

Congress also mandated that new stationary sources of air pollution, such as power plants, should have no “adverse impact” on the more extensive “air quality related values” of these Class I areas. The Bush Administration has proposed to eliminate this provision, specifically intended to protect sensitive areas. Air-quality-related values include visibility as well as protecting “scenic, cultural, biological, and recreation resources” from air pollution¹³ All ten of the national parks in this report are Class I areas.

More than 30 years have passed since Congress first established clean-air laws that led to sizeable emissions reductions. Despite some progress, conditions at the most-polluted parks remain significantly impaired, with many showing little or no improvement. These parks serve as reminders of the need for both stronger protections and

More than 17,000 outdated industrial facilities in the United States, including power plants, operate with minimal pollution controls.

more vigorous enforcement of existing law. More than 17,000 outdated industrial facilities, including power plants, operate with minimal pollution controls. Even the most recent amendments to the Clean Air Act fall short of solving that problem.

This analysis highlights the state of key national parks during the decade after the 1990 amendments to the Clean

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The 51 facilities sued for NSR violations by the Department of Justice and EPA emit 24 percent of all the nitrogen oxides and 27 percent of all sulfur dioxide gas in the United States.¹⁵

Last June, the Bush Administration announced plans to significantly weaken the NSR program. For example, federal land managers, including the National Park Service, would no longer be able to examine the impact on parks of pollution from all new sources.

Those expressing concern about the Administration's proposed NSR rollbacks include the national association of state and local air-pollution-control officials and 44 bipartisan members of the U.S. Senate.

Best Available Retrofit Technology Program and the Regional Haze Rule

In 1977, Congress created the Best Available Retrofit Technology (BART) program specifically to protect parks and wilderness areas. BART required large sources of pollution built in a specific time period to install the best available retrofit technology if they were situated in close proximity to a Class I area and if it could be shown that their emissions were harming the park. Unfortunately, very few sources went through this process.

In 1990, Congress designated funds to study the regional haze problem, and to investigate “sources and source

regions” contributing to haze.

The results of these studies prompted EPA in 1999 to promulgate the Regional Haze Rule, which seeks to improve visibility by attempting to fulfill the national goal of “the prevention

of any future, and the remedying of any existing” visibility impairment by 2064. The agency set decade benchmarks to ensure that the least-impaired or clearest visibility days would suffer no degradation and that the most-impaired or haziest days would improve.

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Part of the Regional Haze Rule required that EPA revise the BART program. Because haze is a regional issue, the revised program expanded the geographic range of affected facilities, requiring specific sources to clean up if emissions from groups of sources contribute to visibility impairment in Class I areas. (See Figures 3 and 4 that show utility sources of sulfur and nitrogen pollution whose emissions would be reduced under BART.¹⁶)

Last May, a three-judge panel of the District of Columbia Circuit Court of Appeals remanded the BART amendment to EPA, stating that EPA usurped state authority by using a regional approach to identify sources required to comply with BART. EPA and the U.S. Department of Justice disagreed with the court and requested a rehearing before the complete nine-member Circuit Court, as have the states of Maine, New Hampshire, and Vermont, the National Tribal Environmental Council, and a coalition of conservation organizations, including NPCA.

Power Plants Must Reduce Pollution to Protect Parks and People

All regions of the country benefit from power-plant pollution reductions. Several legislative proposals include establishing a national cap on emissions and creating a trading system among power plants to achieve total reductions. Experience with the cap-and-trade system created by the Acid Rain Program demonstrates the potentially harmful affects of a national emissions cap without clear and enforceable protections against local hotspots.

Legislation must require significant and timely reductions in sulfur dioxides, nitrogen oxides, mercury, and carbon dioxide pollution from power plants, and must enforce existing Clean Air Act provisions such as NSR and BART.¹⁷ No trading in mercury should be allowed.

Significant reductions are needed to stop and reverse the degradation of sensitive ecosystems. Studies from the Northeast indicate that sulfur emissions must be reduced by at least 80 percent beyond Phase II of the Acid Rain Program to bring these ecosystems from acidic to a point where they can begin recovering within 20 to 25 years.¹⁸

The ten metropolitan areas with the highest mortality rate from power-plant pollution of all 272 metropolitan areas nationwide are located near the three most-polluted national parks.

Air Act, the most recent provisions. This analysis compares the severity of air pollution at ten national parks using an air pollution index first developed by Appalachian Voices for the 1999 and 2000 editions of this report. The index incorporates data from parks that monitor three types of air pollution: haze, ground-level ozone, and acid precipitation. Figure 1 shows the location of each park included in this report. Table 1 gives the ranking of these parks along with data for summer haze (visual range), exposure to ozone pollution, and acid precipitation (wet deposition).

Figure 2 is a map of the portion of the eastern United States that includes three of the most-polluted national parks—Great Smoky Mountains, Shenandoah, and Mammoth Cave. It shows the location of more than 100 coal-burning power plants and also indicates the human death rate from power-plant pollution in nearby cities. The ten metropolitan areas with the highest mortality rate from power-plant pollution of all 272 metropolitan areas nationwide are located near these three parks. (See rankings beside each of the top ten cities.)

The following sections give additional details on the various forms of air pollution affecting national parks.

Park	Visibility in Miles (June-August)	Acid Precipitation Kg/ha (NO ₃ + SO ₄)	Ozone (Sum of hourly values over 59 ppb)	Air Pollution Index - Scale 1-100	Rankings
Acadia	33.5	25.4	32,400	46	5
Big Bend	60.2	5.2	10,100	16	9
Glacier	61.0	5.4	900	13	10
Grand Canyon	90.1	5.3	40,100	20	7
Great Smoky Mountains	14.4	35.1	133,200	100	1
Mammoth Cave	14.4	34.0	45,100	77	3
Rocky Mountain	78.1	6.9	31,000	20	7
Sequoia/Kings Canyon	34.2	7.5	126,300	53	4
Shenandoah	15.4	29.6	90,800	82	2
Yosemite	64.3	7.1	98,400	39	6

Table 1: Air pollution index based on 1991-2001 data, comparing absolute numbers to calculate relative rankings. Summer visibility has been significantly reduced at Great Smoky Mountains National Park, the most polluted in this analysis. Under natural conditions, visual range averaged 77 miles, but has dropped to 14.4 miles. Similarly, the amount of nitrogen pollution deposited in the Smokies is six to seven times the amount that local soils can process naturally. Ozone exposure in the Smokies can be twice that of urban areas. Ozone exposure numbers are computed by adding the concentrations for all hours experiencing 60 parts per billion or greater for the months of April through October.

Ten National Parks in Study

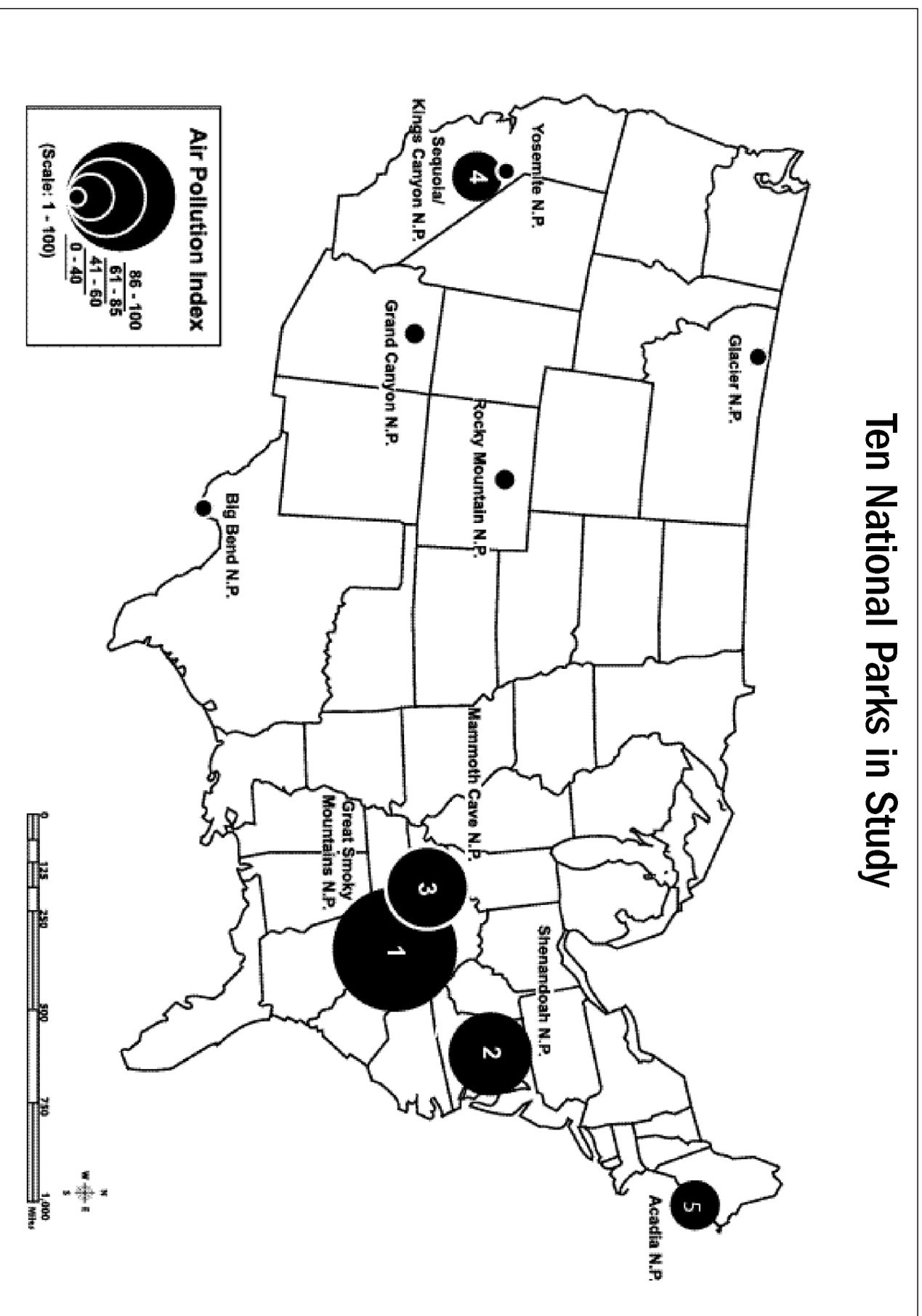


Figure 1: Location and relative ranking of the five most polluted parks according to analysis of 11 years of haze, ozone exposure, and acid precipitation monitoring data from selected national parks with extensive and comprehensive programs. Map also shows the five other parks in the analysis. Size of circles indicates relative ranking.

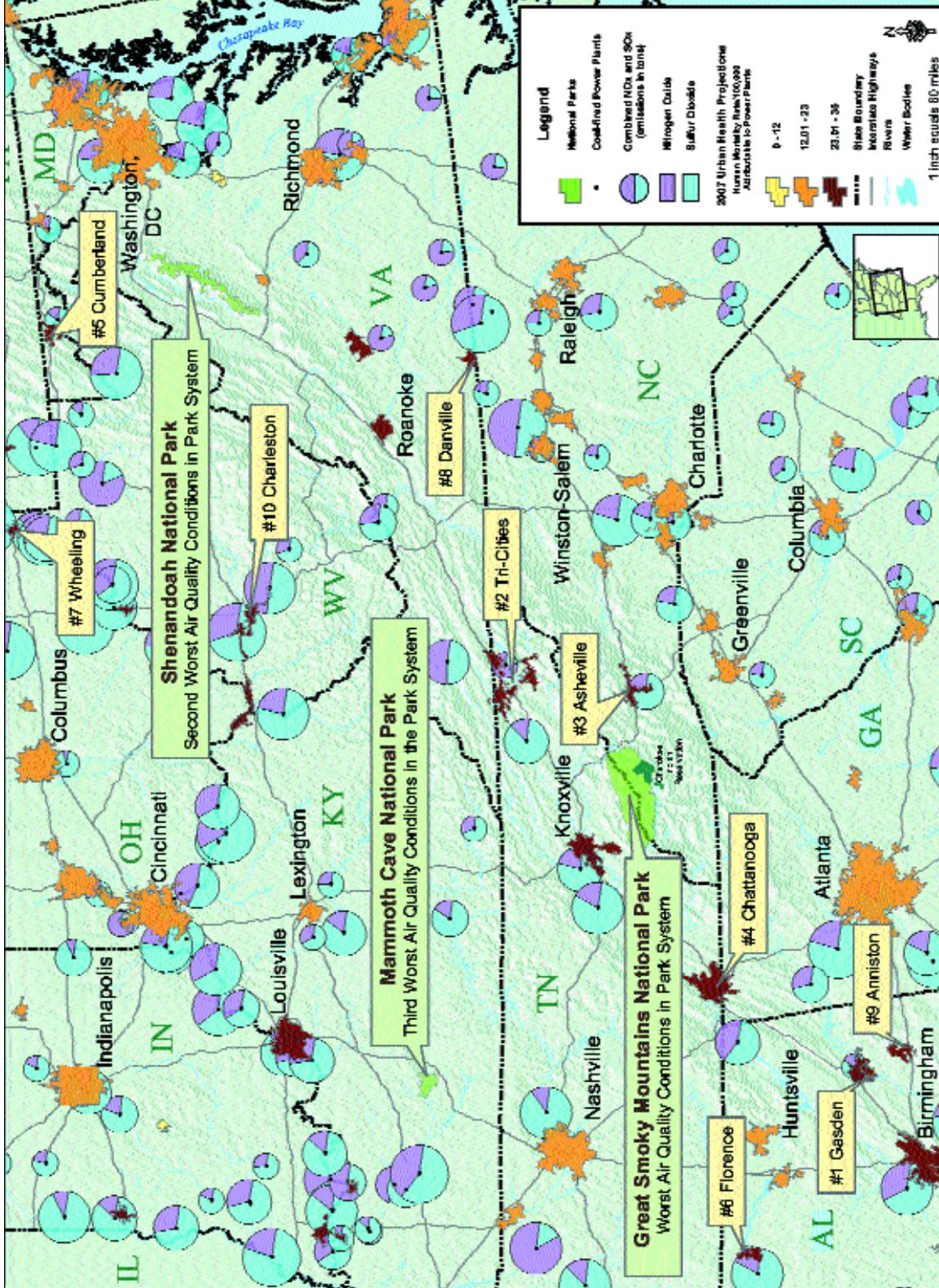


Figure 2: Power plant pollution harms parks and communities.

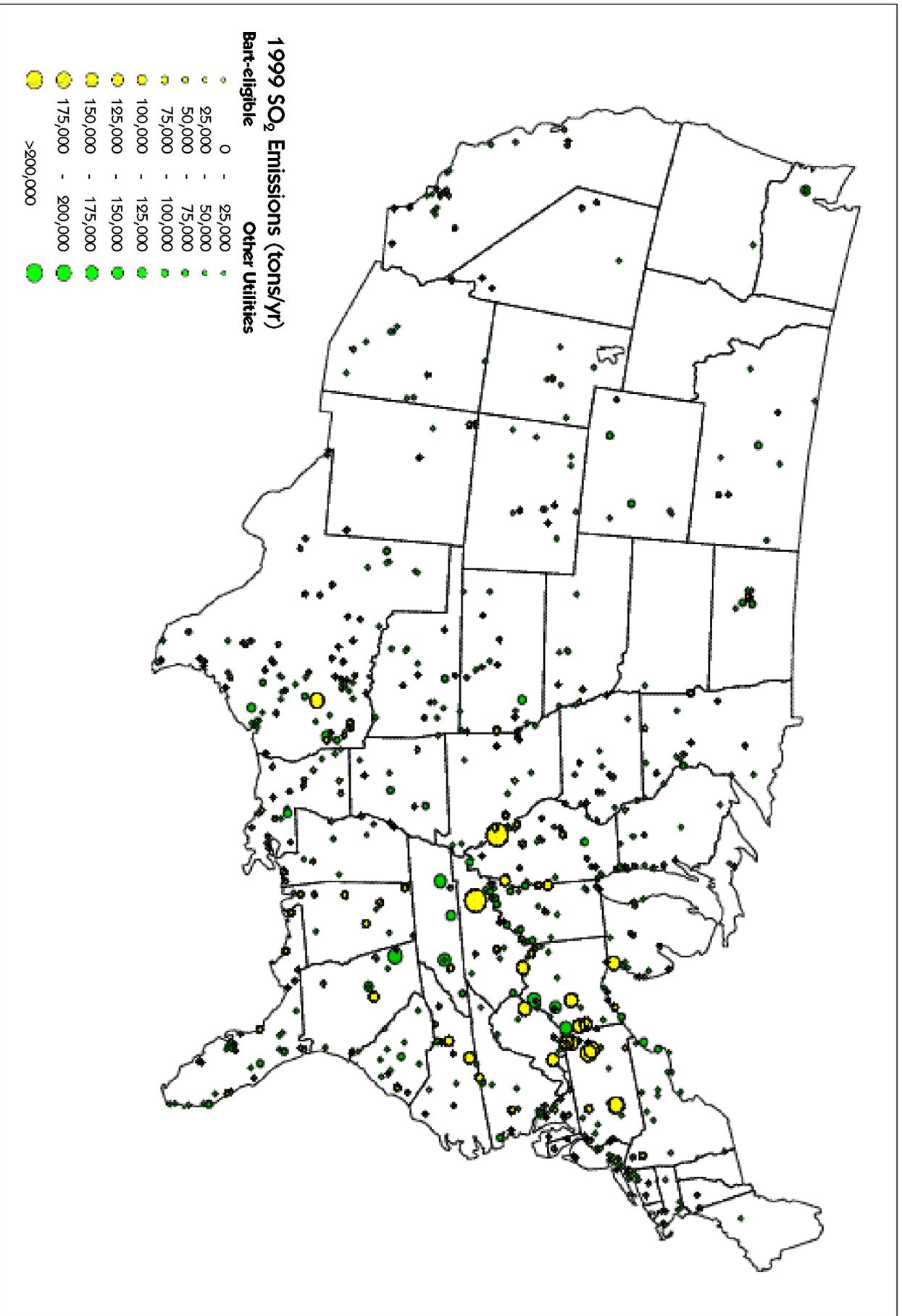


Figure 3: Sulfur dioxide emissions, in tons, produced by utilities in 1999. Yellow circles show coal- and oil-burning utilities built 1962-1977. A Clean Air Act loophole allows these facilities to produce pollution at rates six to twelve times higher than comparable new facilities. These sources would be required to meet modern pollution control standards under the Best Available Retrofit Technology (BART) rule.

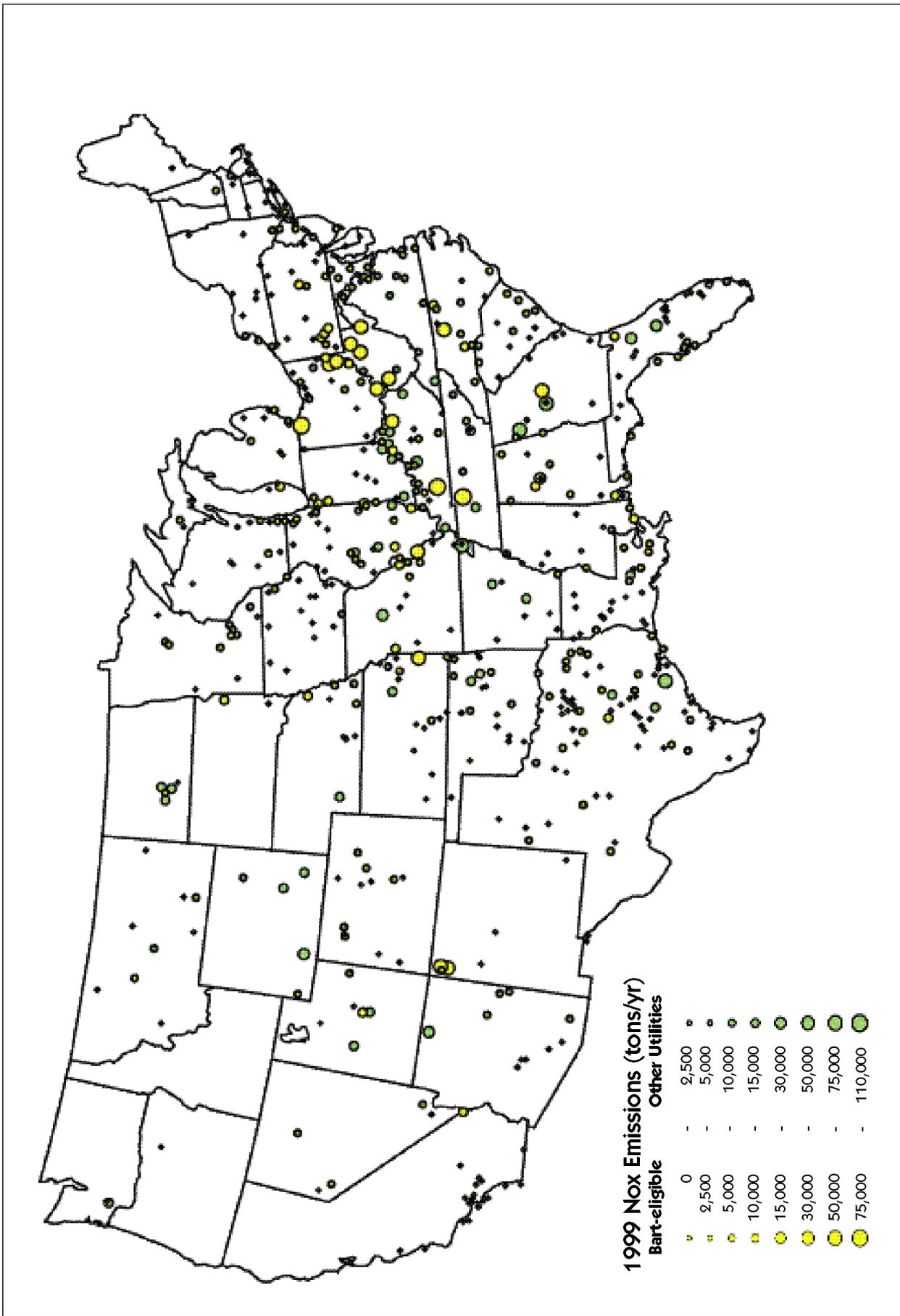


Figure 4: Nitrogen oxide emissions, in tons, produced by utilities in 1999. Yellow circles show coal- and oil-burning utilities built 1962-1977. A Clean Air Act loophole allows these facilities to produce pollution at rates six to twelve times higher than comparable new facilities. These sources would be required to meet modern pollution control standards under the Best Available Retrofit Technology (BART) rule.

Regional Haze Shrouds Scenic Vistas



Courtesy of Shenandoah National Park

When Shenandoah became a national park, congressional documents noted that the Washington Monument could be spotted 70 miles in the distance. Without human-made pollution, views extended for 100 miles throughout the year, but now visitors can expect views of only 25 miles for most of the year. During the summer months, visual range averages a mere 15 miles.

Twenty-five years after Congress established a national visibility goal, human-generated haze continues to shroud scenic vistas at national parks throughout the nation.¹⁹ Although some parks, such as Shenandoah and Acadia, have seen improvements on the haziest days, visibility remains significantly impaired. Other parks have seen virtually no improvement, and some, including Big Bend and Yosemite, have declined slightly.²⁰ According to the Department of the Interior, “Visibility impairment is the most ubiquitous

Summer views at the nation’s most visited national park, Great Smoky Mountains, have been reduced 80 percent from natural conditions.

air pollution-related problem in our national parks and refuges... all areas monitored for visibility show frequent regional haze impairment.”²¹

Poor visibility occurs when particles in the air absorb and scatter light rays, reducing the distance a viewer can see and also interfering with color, clarity, and other scenic

qualities. Natural factors, such as windblown soil or soot from wildfires, have historically contributed to impairment. In recent times, human-caused pollution has greatly increased the amounts of particles in the air, reducing visibility throughout the park system.²²

Sulfate pollution accounts for up to 86 percent of haze in the East but much less in West, where carbon and nitrates are largely responsible for reduced visibility.²³

In the past, scenic views encompassed much greater distances than they generally do today. For example, Shenandoah National Park was established in part to preserve its spectacular vistas for public enjoyment. Congressional documents related to its creation state that visitors looking east from the mountains might see the Washington Monument, some 70 miles distant. Decades ago, annual average visibility at Shenandoah was more than 100 miles, but today it averages less than 25 miles. Visitors to Shenandoah often find hazy conditions that reduce summer views to an average of about 15 miles, less than a quarter of natural summer visibility. On particularly bad days, visibility may drop to less than a mile.

Visibility in the West was historically better than in the eastern half of the country, largely because of differences in humidity. Under pristine conditions, natural views in the West extended for 120 to 180 miles, but this distance has dropped to an annual average of 48 miles in recent times.

Visitors to Shenandoah National Park often find hazy conditions that reduce summer views to an average of about 15 miles, less than a quarter of natural summer visibility.

Certain particles, most notably sulfates, absorb water and increase their size in humid conditions. The much clearer West is typically drier, with relative humidity averaging 50

to 60 percent annually compared to 70 to 80 percent for the East. This also explains why visibility tends to be more impaired during the humid summer months.²⁴

This year, Great Smoky Mountains and Mammoth Cave share the title of haziest national park, with Shenandoah a close second. Summer views at the nation's most visited national park, Great Smoky Mountains, have been reduced 80 percent from natural conditions. Those that climb the popular Mt. Leconte or stop at overlooks along the Foothills Parkway often find gray or yellowish

The five haziest parks, based on average visibility from June through August, peak tourist season, during the 11-year period analyzed:

1. Great Smoky Mountains National Park: 14.4 miles
2. Mammoth Cave National Park: 14.4 miles
3. Shenandoah National Park: 15.4 miles
4. Acadia National Park: 33.5 miles
5. Sequoia-Kings Canyon National Parks: 34.2 miles

haze covering nearby ridges in Great Smoky Mountains National Park. Of the 2 million people who come yearly to Mammoth Cave, 1.5 million never venture underground. Instead, they enjoy more than 70 miles of trails through forested, rolling hills or paddle down the Green River. Often, these visitors find some of the haziest skies in the park system. Similarly, Shenandoah visitors are often disappointed when haze blocks grand views from Skyline Drive or the Appalachian Trail.

Four of the five haziest national parks are located in the eastern United States, where power plants and other industrial sources emit 78 percent of the pollution largely responsible for reduced visibility.²⁵ In this half of the country, sulfate particles alone account for roughly two-thirds of the visibility impairment.²⁶ The three haziest parks—Great Smoky Mountains, Mammoth Cave, and Shenandoah—are situated close to many of the country's most-polluting coal-fired power plants, located in the Ohio and Tennessee River

valleys. (Figure 2). Pollution from other regions is also the cause of haze at Acadia National Park. More than 70 percent of the pollution obscuring views of the rugged coast and granite-domed peaks blows into the park from the Midwest and surrounding Northeast

states.²⁷ Views from such popular lookouts as the park's Cadillac Mountain are frequently degraded.²⁸ In contrast, particles from industrial-scale agricultural activities in

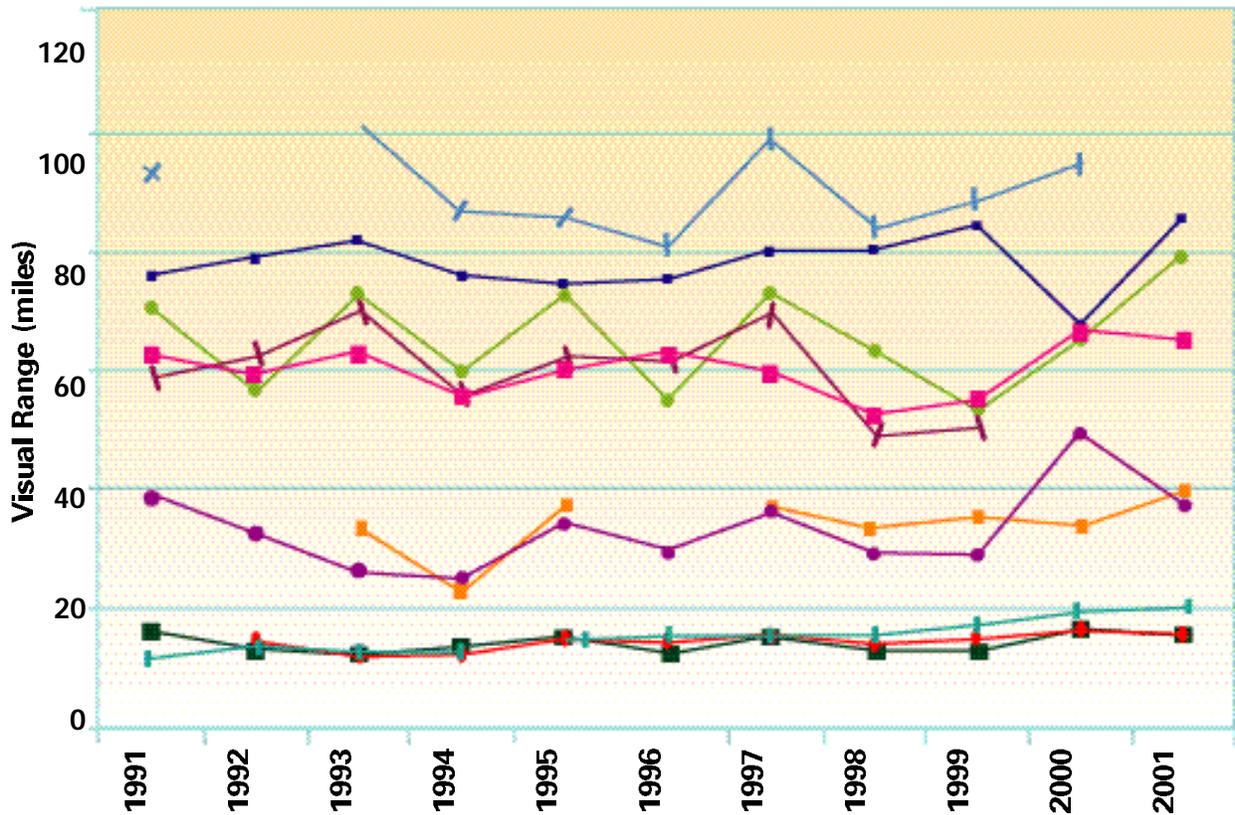


Figure 5: Estimated natural summer visibility in the East is approximately 70 miles, and in the West 150 miles. Visibility in Virginia's Shenandoah National Park (SHEN) can be as low as 1 mile in the summer, while in Texas, summer visibility in Big Bend National Park (BIBE) can be as low as 18 miles.

California's Central Valley as well as cars and trucks cause most of the haze at Sequoia-Kings Canyon.

Although Big Bend National Park in Texas was not one of the five haziest parks, a considerable problem exists there. It is staggering to note that visibility at Big Bend drops to a mere 18 miles or less on the worst days even though visual range tends to be much greater at western parks.

The Value of a View

National park visitors consistently rate clear scenic vistas as one of the most important aspects of their experience. A

recent report found that declines in park visibility could reduce visitation to these national treasures. The report also found that for Great Smoky Mountains National Park "increases in visibility could raise park visitation by as much as 25 percent. This could yield \$160 million in additional concession sales also adding nearly \$700 million in retail sales to the economies around the park, \$53 million in local tax revenue, and create 15,896 jobs."²⁹

National Park Service (NPS) analysts estimated that the 1.4 million visitors to Shenandoah National Park in 1992 spent more than \$45 million in surrounding counties. In addition, combined spending by NPS and by the conces-

sionaire operating businesses on Skyline Drive was estimated at \$10.2 million.³⁰ According to the Clean Air Task Force, a 10 to 25 percent increase in annual visitation at Shenandoah due to enhanced visibility would result in an additional \$13 million to \$32 million in income to local businesses, and 300 to 700 new jobs. Nationally, travel-related expenditures by visitors to all Department of Interior lands generated an average of \$35 billion (in 1996 dollars) in annual travel-related expenditures and created about half a million jobs.³¹

A study by Abt Associates examined the economic impact of power plant emissions by calculating people's willingness to pay for clear views. The total for Class I areas came to \$4.3 billion (1999 dollars). The visibility benefits from the ten parks in this study are worth \$2.8 billion, with Great Smoky Mountains National Park a staggering \$1.8 billion.³²

Inhaling the View

In addition to impaired scenic vistas, recent scientific studies indicate with growing certainty that pollution in the form of small particles, called fine particulate matter, poses significant risks to human health, including premature death. These tiny pollution particles, many times smaller than the width of a single human hair, embed deeply in the lining of the lungs and enter the blood stream. Hundreds of thousands of Americans suffer from asthma attacks, cardiac problems, and upper and lower respiratory illnesses because of these particles. The elderly, children, and those with respiratory problems are most affected by this form of pollution.³³

According to a recent study, sulfur and nitrogen emissions from coal-burning power plants alone are responsible for an estimated 30,000 premature deaths yearly.

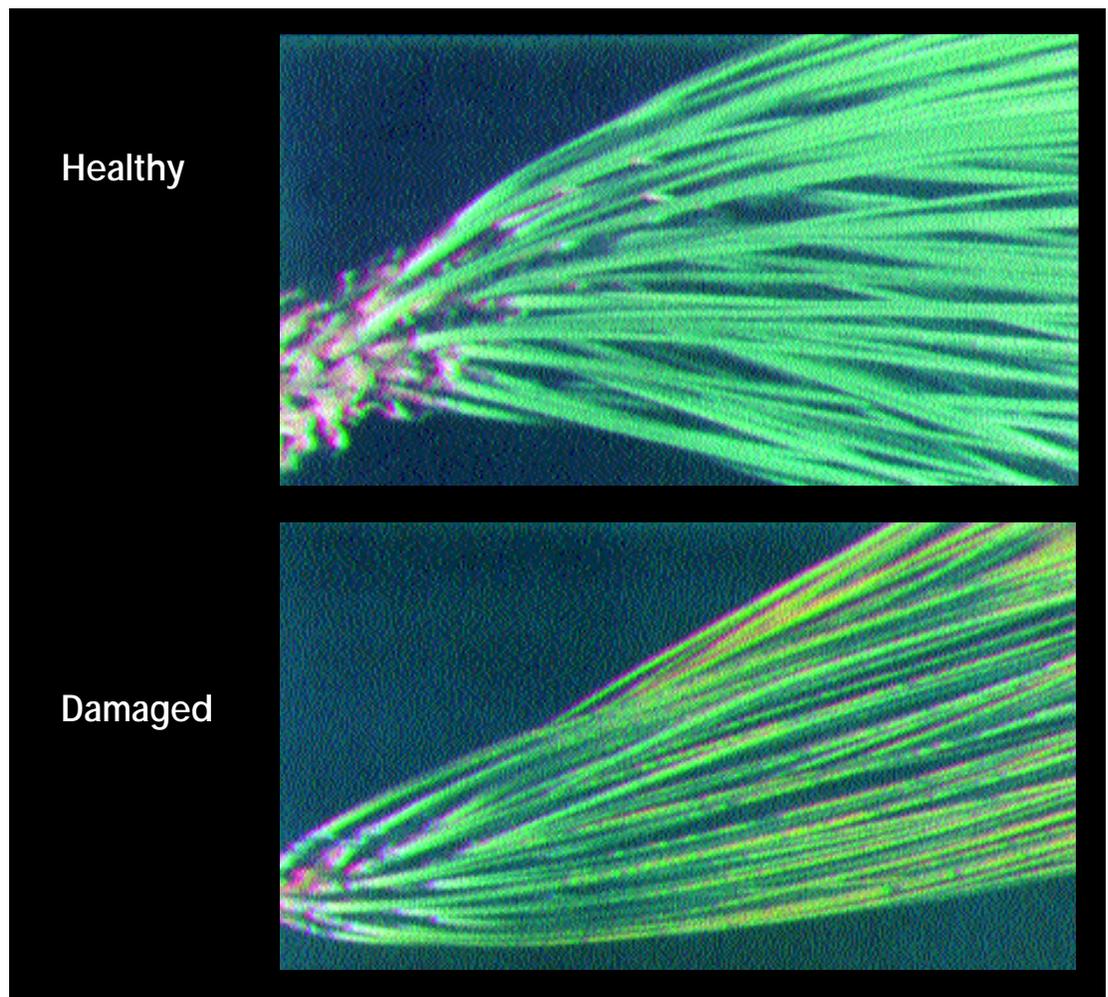
Although particulate matter includes everything from pollen, soil, and dust, a large portion of this pollution comes from automobiles, industries, and power plants. According to a recent study, sulfur and nitrogen emissions from coal-burning power plants alone are responsible for an estimated 30,000 premature deaths, 20,000 hospitalizations, 600,000 asthma attacks, and more than 5,000,000 lost work days yearly.³⁴ Researchers at the Harvard School

Four of the five haziest national parks are located in the eastern United States, where power plants and other industrial sources emit 78 percent of the pollution largely responsible for reduced visibility.

of Public Health found that air pollution from Chicago-area power plants was responsible for approximately 400 deaths annually.³⁵

The National Park Service for 20 years has monitored coarse and fine particles at park sites as a means to measure visibility. The three parks with the highest readings are Mammoth Cave, Great Smoky Mountains, and Shenandoah.³⁶ In 1999, the Environmental Protection Agency (EPA) and its state, tribal, and local-agency partners established a broad nationwide monitoring network for fine particulates. While EPA requires three years of data before assessing whether areas exceed health-based limits for fine particles, two years of data indicate that many areas across the Southeast, Midwest, and Mid-Atlantic regions and in California have unhealthy levels of fine-particle pollution.³⁷

Ground-level Ozone Harms Humans and Plants



The seedlings of giant sequoia trees show signs of ozone injury at levels present almost constantly in summer.

A colorless gas, upper atmospheric ozone blocks harmful ultraviolet rays from the sun providing a vital, protective layer 10 to 30 miles above the Earth's surface. In contrast, ozone in the lower atmosphere, referred to as ground-level ozone, poses threats to human

health when inhaled. Ground-level ozone forms when nitrogen oxide pollution from automobiles, power plants, and industries combines in the air with volatile organic compounds, many of which occur naturally. This process requires sunlight, and the sunny months of April through

October mark the ozone season.

Exposure to high levels of ozone can inflame and damage the lining of the lungs. Other symptoms include shortness of breath, chest pain, wheezing, and coughing, while long-term exposure may decrease the lungs' ability to function. Recent studies suggest that

ozone not only aggravates, but also may cause, asthma.³⁸ One out of every three people is at higher risk for ozone-related health effects, including children, anyone with heart or lung disease, and adults who work

or exercise outdoors. A Harvard School of Public Health study examined hikers climbing the Northeast's highest peak, Mt. Washington. It showed that the lung function of healthy adults declined even at ozone levels below the federal health standard.³⁹ In urban areas, local officials issue health warnings when ozone reaches unhealthy levels. On increasingly more-common "Code Red" days, even healthy adults are at risk.⁴⁰ Many residents have learned to limit outdoor activities and help reduce pollution by carpooling or fueling automobiles in the evening.

One out of every three people is at higher risk for ozone-related health effects—including children, anyone with heart or lung disease, and adults who work or exercise outdoors.

Most people are surprised to discover that park officials across the country must now issue these same health warnings in many of our beloved national parks. On too many occasions each year, both visitors and park employees are forced to limit their activities in places where they should enjoy pristine air. Acadia National Park has been posting ozone levels since 1988. Sequoia-Kings Canyon recorded 61 days in 2001 when the air was unhealthy because of ozone, more than any other park that year. In Great Smoky Mountains National Park, officials have recorded more

than 175 episodes of ozone exceeding dangerous levels since 1998. Levels at Shenandoah often rival those in traffic-clogged Northern Virginia and Richmond.

Ozone pollution not only affects humans but also damages plants at somewhat lower concentrations. It can

decrease yields of agricultural crops, reduce forest growth, and make trees and other plants more susceptible to disease, drought, and pests. Because national parks were created in part to protect natural resources, including plant life, this report uses the plant ozone-exposure

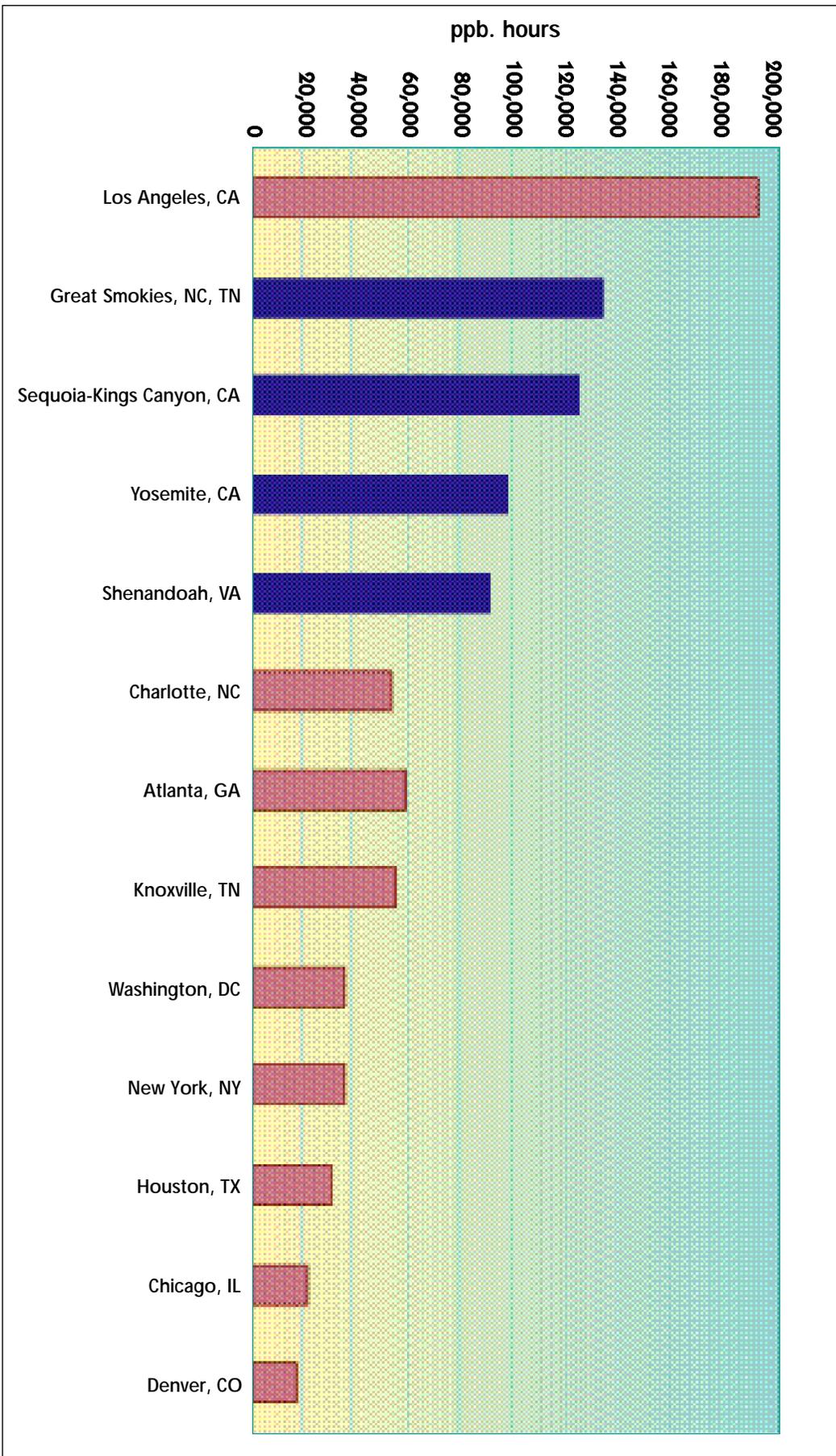
The five most ozone ridden national parks:	
1. Great Smoky Mountains National Park:	133,200 ppb hours
2. Sequoia-Kings Canyon National Park:	126,300 ppb hours
3. Yosemite National Park:	98,400 ppb hours
4. Shenandoah National Park:	90,800 ppb hours
5. Mammoth Cave National Park:	45,100 ppb hours

standard (60 parts per billion) for comparison purposes, a threshold lower than the human health standard (85 parts per billion for 8 hours or 125 parts per billion for one hour). The report's ozone exposure numbers are computed by adding the concentrations for all hours experiencing 60 parts per billion or greater for the months of April through October. Like poor visibility, high ozone levels occur during peak visitor months at each of the parks listed above. In many cases, the ozone and haze levels are high on the same days. At Great Smoky Mountains, the ozone exposures in this analysis far surpass even the most-polluted

eastern urban areas. During the 11-year study period, the park had more than two times the ozone exposure found in Knoxville, Tennessee, and Atlanta, Georgia—two of the region's most ozone-ridden cities. Figure 6 indicates that the four worst parks in the

analysis surpass all but one city included in our analysis, Los Angeles, California. If the comparison were limited to data collected during only the past five years, ozone exposure in the Smokies would have surpassed even that of Los Angeles. (Figure 7).

Figure 6: Average annual ozone exposure at elevated levels was higher in four parks than in most major metropolitan areas.



Ozone Pollution and Plants

In sites throughout Great Smoky Mountains National Park, up to 90 percent of the black cherry trees and tall milkweed plants show leaf symptoms of ozone injury.⁴¹ During controlled studies, an additional 28 species show similar signs when exposed to levels of ozone frequently found in the park.⁴² In the field, sensitive tulip poplars show reduced growth.⁴³

- ▲ In Sequoia-Kings Canyon, Jeffrey and ponderosa pines are among 28 plant species especially susceptible to ozone damage.⁴⁴ The seedlings of giant sequoia trees are sensitive to ozone at levels present almost constantly in summer.⁴⁵ Scientists are not sure how this may effect seedling survival and the development of mature trees.
- ▲ At Yosemite National Park, 16 plant species, from lichens and wildflowers to ponderosa pines and quaking aspen, are vulnerable to ozone damage.⁴⁶
- ▲ Researchers at Shenandoah have found 40 plant species, including green ash and American sycamore, which are sensitive to damage from ozone.⁴⁷
- ▲ Scientists are beginning to investigate whether ozone exposure at Mammoth Cave reduces growth in black cherry and sycamore trees, both ozone-sensitive species that provide key nesting grounds for an endangered species, the Indiana bat.⁴⁸
- ▲ Numerous plant species at Acadia, including black cherry, quaking aspen, and white ash, are harmed by ozone pollution. A correlation occurs between ozone exposure and decreased growth rates in eastern white pine, the official tree of Maine and a dominant species in the park.⁴⁹

During the 11-year study period, Great Smoky Mountains National Park had more than two times the ozone exposure found in Knoxville, Tennessee, and Atlanta, Georgia—two of the region's most ozone-ridden cities.

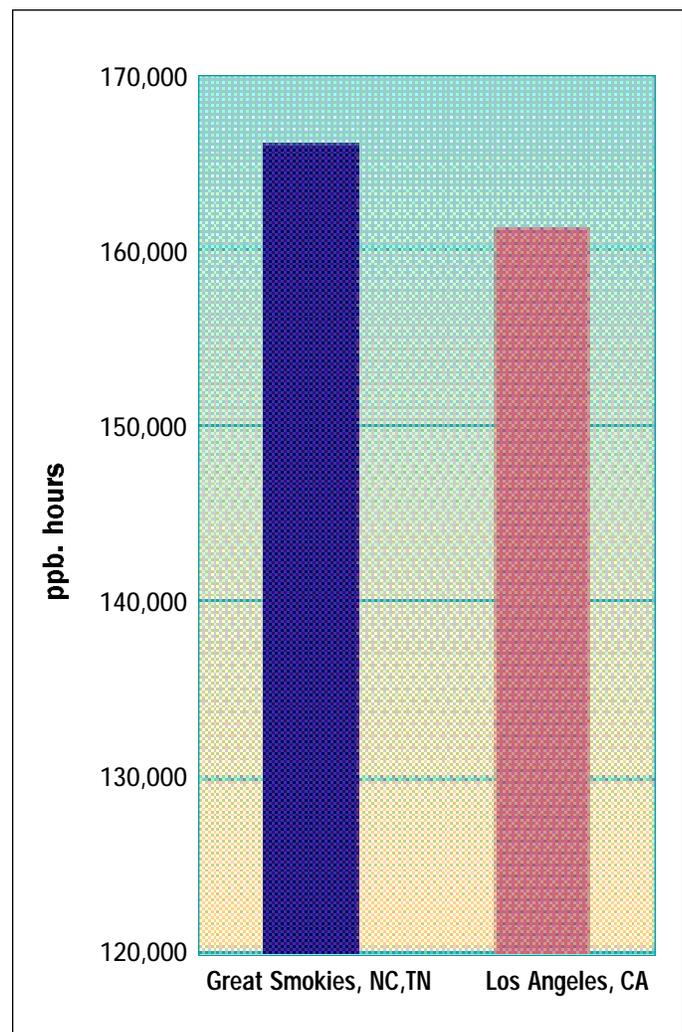


Figure 7: Average annual ozone exposure at elevated levels were higher at Great Smoky Mountains National Park 1997-2001 than in Los Angeles, California.

Acid Rain, Sleet, and Snow Sour Soils and Streams



Courtesy of Acadia National Park

At Acadia National Park, fog over mixed conifer forests on offshore islands is often more acidic than snow or rainfall. Measuring precipitation only, the data used in this report understates the problem because pollution deposited in fog, clouds, and other forms is not included.

Rainfall in Great Smoky Mountains National Park, the park with the

highest levels of acid precipitation in this analysis, is five to tentimes more acidic than normal rainwater on average.⁵⁰ Even now, a dozen years after Congress passed the 1990

The average rainfall in Mammoth Cave National Park is ten times more acidic than natural.

Amendments to the Clean Air Act specifically to reduce acid rain, certain national park soils and streams continue to suffer from acidification. This analysis examines the effects

The Acid Rain Program Falls Short

During the past 30 years, federal clean-air laws have led to substantial emission reductions. Sulfur dioxide has been reduced by one third during the three decades, and sulfate deposition has decreased in the Northeast. Despite these reductions, conditions in some parts of the country, such as the southern Appalachians, have not changed substantially.

Congress established the federal Acid Rain Program in 1990 to reduce pollutants contributing to acid rain. It required a 2-million-ton reduction of nitrogen oxides by 2000 and established a national cap for sulfur dioxide at 10 million tons below 1980 levels, with utilities allowed to emit a total of 8.95 million tons annually.⁶¹

The Acid Rain Program divided reductions of sulfur dioxide into two periods, Phase I, beginning in 1995, and Phase II, beginning in 2000. The affected facilities, mostly coal-burning power plants, reduced sulfur dioxide emissions during Phase I by 40 percent below the required level, but in 2001 released 11.2 million tons of sulfur dioxide as many spent allowances they had “put in the bank” during the first phase. Hotspots, local areas downwind of these sources, showed little improvement despite overall national reductions. For example, the Tennessee Valley Authority emitted approximately 700,000 tons of sulfur dioxide in 1999, 300,000 tons above their Phase II allocation. As a result of this, conditions in and around Great Smoky Mountains National Park have not improved and still remain consistently impaired. Similarly, Florida power plants increased their sulfur emissions from 1995 to 2000.⁶²

The amount of sulfates and nitrates deposited on parks far exceeds what ecosystems can handle even after reductions from the Acid Rain Program. For instance, the amount of nitrogen pollution deposited at Great Smoky Mountains National Park is six to seven times the amount that local soils can process naturally. According to recent studies in the Northeast, sulfur emissions must be reduced by at least 80 percent beyond Phase II of the Acid Rain Program to bring these ecosystems from acidic to a point where they can begin recovering within 20 to 25 years.⁶³

of acid precipitation—rain, snow, and sleet—on natural resources. Limiting the analysis to these forms of precipitation measures only a portion of the overall acid deposition problem. Sulfates and nitrates are deposited in our parks in other ways. For example, fog hanging over mixed conifer forests on offshore islands at Acadia is often more acidic than snow or rainfall.⁵¹ Clouds hanging over the sensitive spruce-fir forests found on Clingmans Dome, the highest peak in Great Smoky Mountains National Park, can be as acidic as

vinegar, with pH levels as low as 2.0. It can also fall out of the atmosphere as a dry deposit of tiny particles. The

Based on this analysis, the five parks with the highest annual average acid precipitation (rain, sleet, and snow) in pounds per acre are:

- | | |
|---|-------------|
| 1. Great Smoky Mountains National Park: | 31 lbs/acre |
| 2. Mammoth Cave National Park: | 30 lbs/acre |
| 3. Shenandoah National Park: | 25 lbs/acre |
| 4. Acadia National Park: | 22 lbs/acre |
| 5. Sequoia-Kings Canyon: | 7 lbs/acre |

amount of acid precipitation deposited at the four worst parks poses significant risk for soils and streams. Unfortunately, this precipitation accounts for only a portion of the total amount. At high elevations, such as

Clingmans Dome in Great Smoky Mountains, about half of all the sulfates and nitrates are deposited from blanketing



Courtesy of Acadia National Park

Fog at Acadia National Park moves through the forest. Acadia's rocky soils give streams little protection from acid rain. The Park Service has recorded fog with pH 3.0.

Clouds hanging over the sensitive spruce-fir forests found on Clingmans Dome, the highest peak in Great Smoky Mountains National Park, can be as acidic as vinegar, with pH levels as low as 2.0.

clouds, not from precipitation. The total amount of sulfates and nitrates deposited at this park (including dry deposition) is an astounding 184 kg/ha per year (a kilogram [kg.] equals about 2.2 pounds; a hectare [ha.] is 2.47 acres), four to five times more than the amount in this analysis. Great Smoky Mountains records the highest levels of acid depo-

sition (wet and dry) of any monitored site in North America.⁵⁵ At these levels of deposition, the soils can process only about 15 percent of those nitrates, so the remaining 85 percent goes directly into the streams, leaving soils chronically saturated with nitrogen.

Similar conditions are found at other parks:

- ▲ Mammoth Cave has one of the highest combined nitrate and sulfate loadings of any national park. Average rainfall in the park is ten times more acidic than natural, and park scientists are concerned about the impacts of this acid deposition on several endangered species.
- ▲ In 2001, the conservation group American Rivers named Paine Run, a stream in Shenandoah National Park, one of America's most endangered rivers. Paine

Scientists recently predicted that future losses of acid-tolerant brook trout populations in western Virginia streams will be substantial unless emissions are reduced beyond the levels created in the most recent amendments to the Clean Air Act.

Run and numerous other streams in the park and throughout the Appalachians continue to become more acidic and less capable of supporting fish. Scientists recently predicted that future losses of acid-tolerant brook trout populations in western Virginia streams will be substantial unless emissions are reduced beyond the levels created in the most recent amendments to the Clean Air Act.⁵⁶

- ▲ Acadia's rocky soils give streams little protection from acid rain. Some of the park's headwater streams have experienced episodic acidification,⁵⁷ with a pH less than 5.0—between that of black coffee and tomato juice. At least one high-elevation lake, Sargent Mountain Pond, is experiencing chronic acidification.⁵⁸ Although natural ion exchange of marine salts is a factor in acidity levels, pollution is the key contributor. For the past two decades, the average pH of park precipitation has ranged between 4.4 and 4.6. The Park Service has recorded park fog with pH 3.0.⁵⁹
- ▲ At Sequoia and Kings Canyon National Parks, 90 percent of precipitation comes in the form of snow. The Sierra's high-elevation streams are extremely susceptible to acidification, particularly from snowmelt,⁶⁰ and are episodically acidified.

How Acid Deposits Harm Ecosystems

In the atmosphere, the sulfur dioxide and nitrogen oxide gases emitted from industries and transportation sources become sulfate and nitrate particles. Although the pollution may fall directly to land surfaces or water bodies, it also may be deposited in the form of rainfall, snow, fog, or even clouds.

These acids percolate through soils, harming ecosystems by removing critical soil nutrients, such as calcium and magnesium, which act as buffers against acidification. Also, aluminum is released from the soil and becomes toxic when absorbed by plants. This can lead to reduced growth and renders plants more vulnerable to disease, drought, and pests. For example, evidence suggests that damage and death to the red spruce throughout the southern Appalachians can be attributed to acid deposition.⁵² In essence, acidified soils begin to starve plants of nutrients and poison them with toxic aluminum at the same time.

Sulfate and nitrate particles harm freshwater bodies in a similar manner. Although some lakes and streams may be slightly acidic naturally, most have pH levels between 6 and 8.⁵³ As more sulfates and nitrates are deposited, the pH lowers, either throughout a particular season or after a sudden occurrence such as heavy rain or snowmelt. This short burst is called "episodic acidification" or "acid shock." Not only do sulfates and nitrates fall directly onto water bodies, but excess acidic precipitation that runs off of land, often laden with toxic aluminum, flows into them as well. The lowered pH, along with the aluminum, can kill or reduce the hardiness of fish and other aquatic species. Some species of snails, along with rainbow trout, begin to die at a pH of 6. Everything from frogs to mayflies is affected as the pH drops even lower.⁵⁴

Additional Impacts from Air Pollution



Courtesy of GSF Archives



Courtesy of GSF Archives, Photo by G. Grant

Global Warming

Human-made pollutants called green-

house gases are accumulating in the Earth's atmosphere, acting like a blanket around the planet and holding in the sun's heat. Atmospheric carbon dioxide accounts for 82 percent of the greenhouse gases emitted in the United States,⁶⁴ with power plants responsible for 40 percent.⁶⁵

Global warming poses a serious threat to park ecosystems. Over the last century the temperature at Glacier National Park has increased 1.8°F. Boulder Glacier, as seen in 1932, is no longer present in the park. The bottom photo, taken in 1988, shows the same area.

Sunlight passes through these gases in the same way that it would filter through the plastic sheath of a greenhouse, warming everything underneath. As a result, many regions

of the globe are experiencing or may soon experience increases in annual temperature, changes in weather patterns, fluctuations in sea levels, and shifts in biodiversity. Some signs are already apparent in national parks. If trends continue, the effects could alter the basic functions of these natural, cultural, and historic refuges. Below are two examples of national parks at risk from global warming.

▲ **Glacier National Park:** This park in Montana encompasses more than a million acres of forests, alpine meadows, and lakes. Its spectacular glaciated landscape lies in one of the largest intact ecosystems in the lower 48 states.⁶⁶ However, global warming may already be changing this park. The most expansive glaciers have been reduced by a third since 1850, with smaller ones no longer present. One study estimates that all of the park's glaciers may disappear completely in 30 years. Since 1900, Glacier National Park's average summer temperatures have increased by about 1.8 degrees Fahrenheit.⁶⁷

▲ **Everglades National Park:** The Florida Everglades ecosystem is the largest remaining subtropical wilderness in the United States, but water management and development systems have disrupted the ecosystem's natural balances. In addition, sea levels along the Florida coast are rising today at a rate equivalent to 8 to 16 inches per century, six to ten times faster than the average rate for this area over the past 3,000 years. EPA researchers estimate that South Florida seas probably will rise 20 inches above 1990 levels by 2100. Rising sea levels could wash away the nation's investment in a \$7.8-billion Everglades ecosystem restoration plan and destroy critical habitat for a vast array of birds and fish.⁶⁸

The four national parks and preserves of South Florida are home to 16 endangered and six threatened species.

U.S. power plants emit 40 percent of the carbon dioxide released into the atmosphere, contributing to global warming.

Scientists are concerned that remaining populations of endangered species, such as the Florida panther and Key deer, are likely to be pushed closer to extinction as their habitats are increasingly restricted by rising seas and sprawling human settlements.⁶⁹

Toxic Mercury Accumulates in the Food Chain

Mercury is a dangerous toxic element that accumulates through the food chain and can damage the nervous systems of young children and the unborn. Power plants are the largest uncontrolled source of U.S. mercury emissions. Given the nature of this toxic element, mercury pollution demands an aggressive policy response.

Scientists in national parks across the country, including Isle Royale in Michigan, Acadia, Shenandoah, and Big Bend, are studying the effects of mercury contamination on fish and wildlife. This year, Mammoth Cave, Great Smoky Mountains, Sequoia-Kings Canyon, and Shenandoah national parks have begun or will soon begin monitoring mercury levels. The following show the potential impacts of mercury on national parks.

- ▲ High levels of mercury have been documented in fish found in Acadia's lakes since the early 1990s. Scientists measured some of the highest mercury concentrations found anywhere in the country in this park's warm-water fish species, such as bass, perch, and pickerel.⁷⁰
- ▲ Scientists at Big Bend believe that mercury and other toxic compounds may be implicated in reproductive failures among peregrine falcons. This bird, once listed as endangered because of impacts from the pesticide DDT, was removed from the list in 1999 after fully recovering. Mercury reduces egg-laying as well as clutch size and increases nest desertion in some bird species. Although harmful levels of mercury relative to peregrine falcons have not been established, a 1997 study at Big Bend revealed that five different peregrine prey species all contained mercury levels harmful to some bird species.⁷¹
- ▲ High levels of mercury in largemouth bass and other species led the State of Florida to issue fish-consumption

advisories for areas in Everglades National Park. Mammoth Cave and Acadia also have been affected by statewide advisories. These advisories warn pregnant mothers, children, and even healthy adults to limit consumption of fish. In all, 41 states and territories

have issued fish-consumption advisories because of mercury contamination.



Courtesy of Roger DiSilvestro, NPCA

Forty-one states and territories have posted fish consumption advisories, like this one in Everglades National Park, due to toxic mercury contamination. Affected areas include streams and lakes found in national parks such as Everglades, Acadia, and Mammoth Cave.

Airborne Pesticide Residues

Parks may be exposed to agricultural pesticides that become suspended in the atmosphere as particulates, drift on prevailing winds, and land in locations both near and far from the source. In 1997, millions of tons of pesticides were applied in the United States, according to EPA figures.⁷² Agricultural production accounts for approximately three-quarters of the volume. Consequently, pesticides can be found in rain, snow, dry particles, and surface water. These toxic chemicals can end up in the tissues of plants and animals.⁷³ Recent declines in several amphibian species have scientists searching for a possible cause-and-effect link between that decline and pesticide fallout. Below are examples of this potential threat to national parks.

- ▲ In California's Sierra Nevada, four species of native frogs have dramatically declined in numbers and distribution in Yosemite, Sequoia, and Kings Canyon national parks.⁷⁴ These parks are located adjacent to one of the heaviest pesticide-use areas in the country, the Central Valley.⁷⁵ Because of this proximity, pesticides and other contaminants are suspected of harming the natural resources found in these parks.⁷⁶
- ▲ On a global scale, persistent organic pollutants such as DDT, PCBs, and dioxin are traveling on large jet streams from one continent to another. These contaminants increase the risk of adverse effects to wildlife, ecosystems, and human health⁷⁷ both in Alaska and the western United States. Biological effects might include threats to reproductive success, growth, immunology/disease, and behavior.
- ▲ In 2002, the National Park Service will begin an air-toxics assessment project in six western parks: Gates of the Arctic, Denali, Glacier, Olympic, Rocky Mountain, and Sequoia-Kings Canyon. Efforts will include documenting exposure and accumulation, assessing effects, studying design and integration, and communicating, consulting, and cooperating with stakeholders.⁷⁸

Conclusions and Recommendations

The air pollution index, combining data on the three primary pollution types discussed above, reveals that the five most-polluted national parks in the United States are:

1. Great Smoky Mountains National Park, Tennessee and North Carolina
 - ▲ Ozone pollution rivals that of Los Angeles, violating federal health standards more than 175 times since 1998 and damaging 30 species of plants.
 - ▲ Mountaintop clouds blanketing sensitive spruce-fir forests can be as acidic as vinegar, leading to nitrogen-saturated soils.
 - ▲ Appeared on the National Parks Conservation Association's lists of America's Most Endangered National Parks, in large part because of air pollution.
2. Shenandoah National Park, Virginia
 - ▲ Views from Skyline Drive and the Appalachian Trail are significantly degraded, shrinking to one mile on some summer days due to high levels of fine-particle pollution.
 - ▲ Acidified streams place even the highly prized brook trout, an acid tolerant species, at risk.
3. Mammoth Cave National Park, Kentucky
 - ▲ Three of every four park visitors come not for the cave but for ridge-top views, which they often find are among the haziest in the nation.
 - ▲ On average, rainfall at the park is ten times more acidic than natural conditions.
4. Sequoia and Kings Canyon⁷⁹ National Parks, California
 - ▲ Ozone levels surpassed human-health standards on 61 summer days in 2001. This same pollutant harms sequoia seedlings.
 - ▲ Hazy skies block views of spectacular Sierra mountain scenery.
5. Acadia National Park, Maine
 - ▲ Rocky soils like those at Acadia have little defense against acid rain, fog, and snow; one park lake is chronically acidified.
 - ▲ Scenic views from Cadillac Mountain remain impaired.

Despite an overall reduction of emissions, *Code Red: America's Five Most Polluted National Parks* clearly indicates that a number of our national parks have serious air-pollution problems, rivaling the most-polluted urban areas. Based on the rankings computed in this report, four of the five most air-polluted national parks are found in the eastern United States. The three most polluted parks also are located downwind from clusters of coal-fired power plants. Furthermore, these parks are surrounded by the ten cities suffering from the highest rates of premature death in the United States due to particulate matter formed from coal-fired power plant emissions. Clearly, protecting our parks also means protecting our communities.

While pollution sources in the eastern United States differ from those in the West, all regions of the country need considerable reductions of pollution. Pollution streaming from more than 200 million vehicles and 26 different categories of industry, from power plants to smelters to refineries, amounts to more than 160 million tons yearly, not counting carbon dioxide pollution. Carbon dioxide pollution from power plants alone amounts to more than 2 billion tons annually. More than 121 million Americans currently live in areas with unhealthy air.⁸⁰

Loopholes in the nation's clean-air laws that allow extraordinary amounts of pollution are particularly troubling. While a multitude of sources produce this problem, power plants are responsible for a significant portion of the air pollution across the country. The influence of power plants is especially heavy in the East, where coal-fired utilities produce 78 percent of the sulfur dioxide and 39 percent of the nitrogen oxide.⁸¹ Requiring outdated power plants to meet modern standards could reduce pollution significantly.

Despite reductions required by the federal Acid Rain Program, Great Smoky Mountains, Shenandoah, and Mammoth Cave national parks all show increased levels of pollution based on trends from the air pollution index used in this study. This analysis shows that each of the three parks had a slight decrease in pollution during the first half of the 1990s, followed by an increase during the second half through 2001. The increase in total pollution is driven by steadily rising chronic ozone exposure. For most parks, neither visibility nor acid precipitation show an apparent trend either up or

More than 121 million Americans currently live in areas with unhealthy air.

down—surprising, given that overall power-plant sulfur emissions are declining in compliance with the Acid Rain Program.

The air pollution crisis in America's national parks is a national problem that demands national solutions. Present clean-air laws must be strengthened to reduce pollution further, including mandatory reductions of carbon dioxide pollution. Without additional requirements to cut emissions from all sectors, our national parks and our communities will remain in peril. Below are measures that must be taken to protect our parks and ourselves.

1. The Bush Administration must implement and enforce existing programs of the Clean Air Act, such as the Regional Haze Rule, including the Best Available Retrofit Technology amendment and the New Source Review Program. Current Administration proposals would eliminate these basic programs, weakening provisions to protect parks.
2. Federal legislation must be enacted to make sizeable cuts from power-plant emissions in a timely manner. Reductions of sulfur dioxide, nitrogen oxides, mercury, and carbon dioxide are all critical for national parks. President Bush's plan for clean air protection, called the Clear Skies Initiative, is far from sufficient in protecting air quality in our national parks.
3. Emissions from mobile sources must be reduced. Increases in vehicle miles traveled and rising sales of less-efficient models, including sport-utility vehicles, present problems. Moreover, pollution from many diesel-burning vehicles, such as trucks, buses and construction equipment, remains a substantial concern.

4. In the absence of strong federal action to reduce emissions, states

The three most polluted national parks are situated downwind from clusters of coal-fired power plants.

must find ways to protect themselves. We encourage states to take action to control in-state sources of pollution in order to ensure that reductions begin in a timely fashion. State officials should follow the lead of states such as North Carolina, which recently passed the Clean Smokestacks Act requiring significant cuts in power plant pollution. Almost a dozen other states have passed or are considering legislation to reduce pollution from this sector. Similarly, California recently became the first state in the nation to control greenhouse gas emissions from tailpipes.⁸²

Park	Visibility in Miles (June-August)	Acid Precip Kg/ha (NO₃ + SO₄)	Ozone (Sum of hourly values over 59 ppb)	Air Poll Index	Deviation for Visibility	Deviation for Acid Precip	Deviation for Ozone	Deviation for Index	Total of Standard Deviations	Rankings
Acadia	33.5	25.4	32,400	46	0.47191	0.70721	-0.59753	-0.0194	0.56219	5
Big Bend	60.2	5.2	10,100	16	-0.48554	-0.83719	-1.06623	-0.98942	-3.37837	8
Glacier	61.0	5.4	900	13	-0.51423	-0.82190	-1.25959	-1.08642	-3.68213	9
Grand Canyon	90.1	5.3	40,100	20	-1.55774	-0.82954	-0.43570	-0.86009	-3.68306	10
Great Smoky Mountains	14.4	35.1	133,200	100	1.15683	1.44883	1.52105	1.72664	5.85335	1
Mammoth Cave	14.4	34.0	45,100	77	1.15683	1.36473	-0.33061	0.98295	3.17390	3
Rocky Mountain	78.1	6.9	31,000	20	-1.12742	-0.70721	-0.62696	-0.86009	-3.32168	7
Sequoia/Kings Canyon	34.2	7.5	126,300	53	0.44681	-0.66134	1.37603	0.20694	1.36844	4
Shenandoah	15.4	29.6	90,800	82	1.12097	1.02833	0.62990	1.14463	3.92382	2
Yosemite	64.3	7.1	98,400	39	-0.66842	-0.69192	0.78963	-0.24574	-0.81645	6

Table 2: Air pollution index based on 1991-2001 data, using standard deviations to calculate relative rankings.

Appendix 1: Methodology and Further Analysis

Appalachian Voices, a non-profit conservation organization focused on protecting forests and communities of the Appalachian Mountain region, prepared *Polluted Parks in Peril*, a report in 1999 and 2000 on air pollution in the national parks. This year, the National Parks Conservation Association, the only private, nonprofit national advocacy organization dedicated exclusively to protecting, restoring, and enhancing national parks, and Our Children's Earth, dedicated to protecting the public from the harmful effects of air pollution, partnered with Appalachian Voices to produce the third annual report, *Code Red: America's Five Most Polluted National Parks*.

The organizations obtained air-quality data from the National Park Service (NPS) for ten parks with extensive monitoring programs for haze, ground-level ozone, and acid precipitation. Monitoring occurs at these and other parks because of the special protection parks receive under the Clean Air Act.

This analysis evaluated NPS data from all the national parks that use the Interagency Monitoring of Protected Visual Environments (IMPROVE-visibility data), NPS Gaseous Air Pollutant Monitoring Network (ozone data), and the National Atmospheric Deposition Program (NADP-acid precipitation data) to monitor the three pollutants reviewed in this study.

The ten national parks were ranked using two different approaches. One was the calculation of an air-pollution index. The most polluted site was given a score of 100 for each of the three air-pollution characteristics—visibility, ozone, and acid precipitation. The other nine parks were expressed as a percentage of the highest pollution level observed. The three percentages for each park were then averaged to compute the air-pollution index. The highest possible index score of 100 would indicate that one park displayed the worst conditions for all three types of pollution, which was, in fact, the case with Great Smoky Mountains. Values for the air pollution index ranged from 100 for Great Smoky Mountains National Park to 13 for Glacier National Park.

The second ranking approach calculated what statisticians call the “standard deviation from the mean” for each of the three pollution measures (Table 2). These also were compiled to determine rank. The higher the standard deviation from the mean, the worse the pollution. Here, a value of zero indicates the average across all the parks. Individual park values ranged from (+5.85335) for Great Smoky Mountains National Park to (-3.68306) for Grand Canyon National Park.

These two approaches yielded different rankings among the cleaner parks, but not for the five most-polluted parks. Numbers one through six were identically ranked, while numbers seven through ten shifted places. Because the study sought to identify the five most-polluted national parks, the correspondence between the two approaches gives confidence in the rankings of the top five.

Endnotes

- 1 In a 1996 survey, 84 percent of visitors at Great Smoky Mountains National Park responded that scenic views are “extremely important.” Great Smoky Mountains Natural History Association and the National Park Service (NPS), Great Smoky Mountains National Park Management Folio #2: Air Quality, 1997, p. 2. NPS conducted similar studies in the mid 1980s, surveying visitors at five parks on the importance of various park features to their recreational experience. At all five parks - Grand Canyon, Mount Rainier, Everglades, Mesa Verde, and Great Smoky Mountains- “clean, clear air” ranked among the top-four valued features. NPS Air Quality Division, *Air Quality in the National Parks, Natural Resources Report 98-1*.
- 2 Harvard Ayers, *First Annual Report of Polluted Parks in Peril: The Five Most Air Polluted Parks in the United States*, 1999, *Second Annual Report of Polluted Parks in Peril: The Five Most Air Polluted National Parks in the United States*, 2000.
- 3 These neighboring but separate parks are managed as one unit.
- 4 Abt Associates, *The Particulate-Related Health Benefits of Reducing Power Plant Emissions*, October 2000. For key findings of the Abt Associates study, see Clear the Air, *Death, Disease, & Dirty Power: Mortality and Health Damage Due to Air Pollution from Power Plants*, October 2000, p. 3.
- 5 U.S. Department of State, *U.S. Climate Action Report 2002*, Washington, D.C., May 2002, Chapter 6: Vulnerabilities, at <http://www.epa.gov/globalwarming/publications/car/ch6.pdf>
- 6 U.S. EPA, http://www.epa.gov/globalwarming/impacts/mountains/cs_wmnt1.html.
- 7 National Environmental Trust and Clear the Air, *Cleaning up Air Pollution from America's Power Plants: The Facts*, 2002, p. 10-11.
- 8 National Research Council, *Protecting Visibility in National Parks and Wilderness Areas*, Washington, D.C., 1993, p. 216.
- 9 National Environmental Trust and Clear the Air, *Cleaning up Air Pollution from America's Power Plants: The Facts*, 2002, p. 20.
- 10 U.S. EPA, *Latest Findings on National Air Quality: 2000 Status and Trends*, September 2001, p. 2.
- 11 Wallace Stegner. The full quote is, “National parks are the best idea we ever had. Absolutely American, absolutely democratic, they reflect us at our best rather than our worst.”
- 12 National Park Service, Public Use Statistics Office, *National Park Service Statistical Abstract 2001*, Land Resource Division, Washington, D.C.
- 13 NPS Air Quality Glossary, <http://www2.nature.nps.gov/ard/glossary.htm>.
- 14 See www.usdoj.gov/olp for complete statement.
- 15 Clean Air Task Force, *Power to Kill: Death and disease from power plants charged with violating the Clean Air Act*, 2001, at http://clnatf.org/publications/reports/power_to_kill.html
- 16 Northeast States for Coordinated Air Use Management, *A Basis of Control of BART-Eligible Sources*, July 2001, at <http://www.nescaum.org/committees/haze.html>
- 17 See <http://thomas.loc.gov/> for information on Clean Air legislation, including bill text, list of cosponsors, and committee action.
- 18 C.T. Driscoll et al. *Acid Rain Revisited: Advances in scientific understanding since the passage of the 1970 and 1990 Clean Air Act Amendments*. Hubbard Brook Research Foundation. Science Links Publication. 1(1), 2001.
- 19 For current conditions, including visibility, at national parks, this National Park Service Air Resource Division Web site has links to Web cams for Great Smoky Mountains, Mammoth Cave, Acadia, and others: <http://www2.nature.nps.gov/ard/cams/index.htm>. The IMPROVE Web site also contains photos with visibility conditions at national parks. See http://vista.cira.colostate.edu/improve/Data/IMPROVE/Data_IMPRPhot.htm
- 20 IMPROVE, at <http://vista.cira.colostate.edu/improve/Data/GraphicViewer/Trends.htm>
- 21 U.S. Department of the Interior, letter to U.S. EPA, Docket No. A-2000-28, September 17, 2001.
- 22 For more information on the causes and effects of visibility impairment, see *Introduction to Visibility* by Bill Malm, NPS Air Resources Division, at http://www2.nature.nps.gov/ard/vis/intro_to_visibility.pdf.
- 23 U.S. EPA, *Latest Findings on National Air Quality: 2000 Status and Trends*, September 2001, p. 18-19.
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The National Parks Conservation Association, with 300,000 members nationwide, is the only private, nonprofit national advocacy organization dedicated exclusively to protecting, restoring, and enhancing national parks. For more information see www.eparks.org.

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America's Five Most Polluted National Parks:

1. Great Smoky Mountains National Park, Tennessee and North Carolina
2. Shenandoah National Park, Virginia
3. Mammoth Cave National Park, Kentucky
4. Sequoia and Kings Canyon National Parks, California
5. Acadia National Park, Maine

