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Cleaning America's Air: Progress and Challenges

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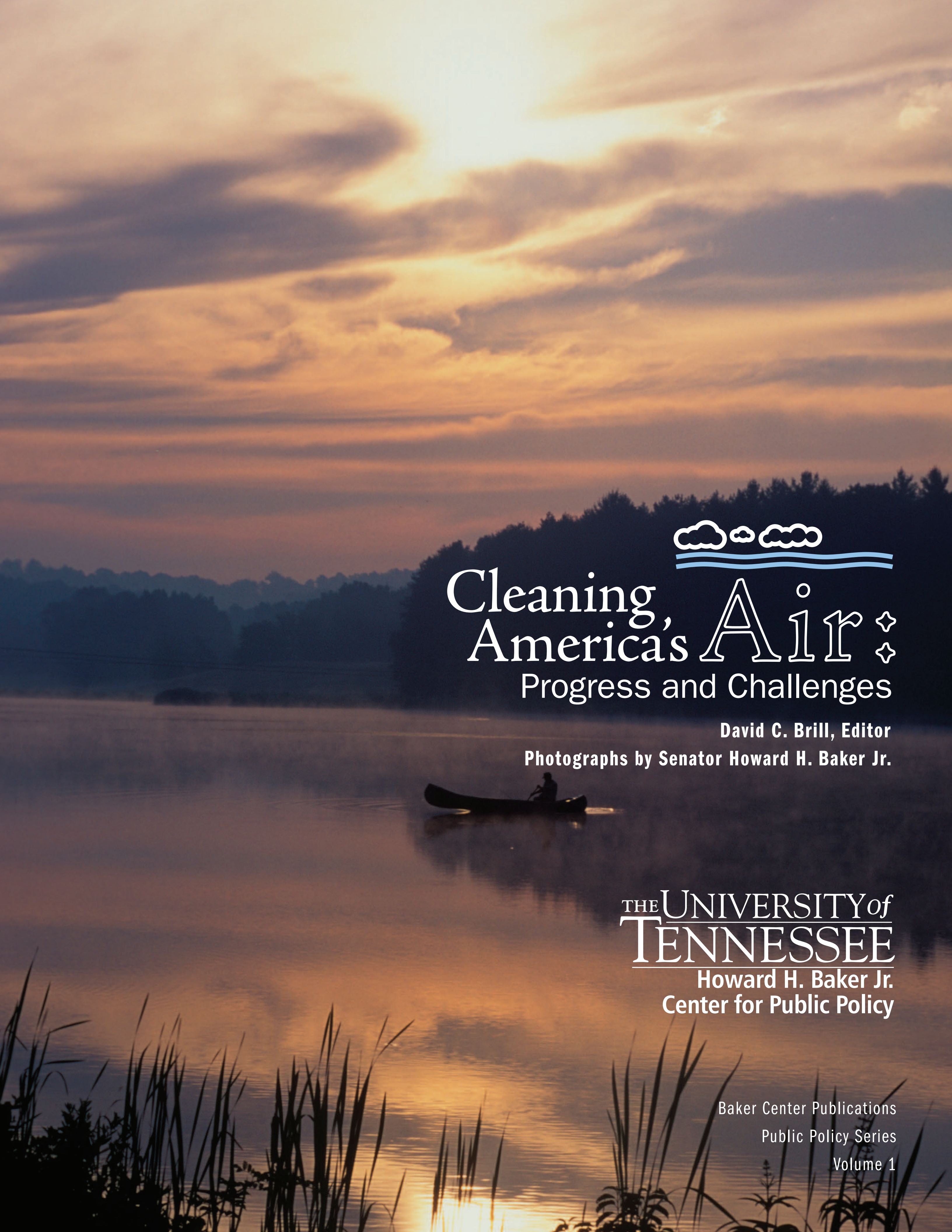

Cleaning America's Air: Progress and Challenges

David C. Brill, Editor

Photographs by Senator Howard H. Baker Jr.

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Cleaning America's Air: Progress and Challenges

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The In 1970, the U.S. Congress passed the Clean Air Act, arguably the most comprehensive environmental legislation ever enacted, and in so doing, launched the modern environmental movement. In the decades since, guided by the act's provisions and amendments, America has achieved significant strides in clearing the nation's air.

The act's creation resulted from remarkable collaboration between two senators who sat on opposite sides of the aisle: Howard Baker, a Republican from Tennessee, and Edmund Muskie, a Democrat from Maine. Drafted in response to a glaring need and facilitated through bipartisan "comity," as Senator Muskie termed it, the act continues to evolve and inspire new efforts to protect the health of all Americans while preserving the nation's environmental resources.

As the directors of three organizations situated at the crossroads of science-based environmental protection, sustainable economic development, and public policy, we had long wanted to collaborate on a program that explored the history and evolution of the Clean Air Act. We also hoped to examine current and future air-quality challenges. Our plans reached fruition on March 9, 2005, at the University of Tennessee, when we hosted the conference "Cleaning America's Air: Progress and Challenges." The conference assembled a panel of esteemed experts and drew an audience of thousands of scientists, policy-makers, students, faculty, media representatives, and interested citizens.

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We open on page 2 with "The Clean Air Act: A Chronology," by Paul Augustine, an environmental policy analyst for the U.S. Environmental Protection Agency. Augustine prepared an extended history of the Clean Air Act for this conference while serving as an intern at the Joint Institute for Energy and the Environment (JIEE) and the Howard H. Baker Jr. Center for Public Policy.

On page 7, in "U.S. Environmentalism, *Comity*, and the Clean Air Act," Senator Howard Baker reflects on the personalities and politics that converged to create the act in 1970. Many of Senator Baker's elegant photographs of the Tennessee landscape are featured in this publication. Senator Baker regards his role in creating the Clean Air Act as one of his proudest accomplishments, and he signified that by making this presentation his first address after returning from his ambassadorship in Japan.

On page 12, "In the Shadow of Greatness," by Leon Billings, Senator Muskie's executive assistant, describes the collaborative brilliance of two Senate powerhouses as they worked to cobble together the act. In "EPA Adapts and Evolves in Protecting America's Air," on page 15, Milton Russell, a former EPA assistant administrator and founding director of JIEE, focuses on the then-fledgling EPA's efforts to implement the act and on the course corrections that ensued a decade later.

In "Science and Clean Air: A National Perspective," on page 27, Paul Gilman, founding director of the Oak Ridge Center for Advanced Studies and a former EPA assistant administrator and chief science advisor, examines the act's targeted pollutants, the progress we've made in controlling them, and the mechanisms by which these pollutants harm the human body.

On page 19, in "Great Smoky Mountains National Park: A Regional Treasure Imperiled," the park's superintendent, Dale Ditmanson, and air-resource specialist Jim Renfro discuss air-quality issues as they affect the country's most-visited national park.

Bill Baxter, a board member of the Tennessee Valley Authority, describes TVA's success in reducing harmful air emissions while spurring economic development in "It's a Question of Balance: Moving Forward on Clean Air," on page 30. In "Working Together to Achieve Cleaner Air for Tennessee," on page 23, Betsy Child, then-commissioner of the Tennessee Department of Environment and Conservation, describes the state's efforts to enforce and administer the act.

And on page 36, in "Riders on the Blue Marble Must Confront Climate Change," Vice President Al Gore presents a compelling case for addressing global warming. Gore established his devotion to and credibility on environmental issues with publication of his best-selling book *Earth in the Balance: Ecology and the Human Spirit*. He has since shared his dynamic and informative conference presentation with audiences around the country.

We hope these presentations arouse in you, as they did in the members of the conference's audience, an abiding appreciation for the Clean Air Act, the individuals who worked so diligently to create it, and the enduring legacy of improved environmental protection and human health the act has achieved.

Alan Lowe, executive director
The Howard H. Baker Jr. Center for Public Policy

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Joint Institute for Energy and Environment

Jack Barkenbus, executive director
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Glimpsing nature through the camera lens of Senator Howard Baker reveals Baker's deep connection with the environment. Senator Baker's photographs provide the perfect context for this conference on the Clean Air Act, and the organizers thank him for permission to present them in this volume.

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The Clean Air Act: A Chronology

By Paul Augustine

The Clean Air Act of 1970 is the most comprehensive environmental legislation ever passed. It affects virtually all facets of human life—from industry and automobiles to human health and preservation of the natural world. It also exemplifies how extensive regulation, remarkably, can bypass political gridlock, given the right circumstances.

At the same time, it exposes the ever-present lag in the political system: it took 13 years for the long-debated Clean Air Act Amendments of 1990 to be passed, revealing that many roadblocks to the passage of controversial, but often necessary, environmental programs remain.

Public-health officials had some concern about the human-health effects of pollution as early as the 1940s.

Public-health officials had some concern about the human-health effects of pollution as early as the 1940s. Then on October 25, 1948, the 14,000 inhabitants of the small town of Donora, Pennsylvania, found themselves amid a deadly cloud of polluted air. Within 6 days, 20 people had died and nearly 6,000 were ill.[1] (The noxious agents in this instance were later determined to be sulfur dioxide, nitrogen oxides, and metal dust from a local steel plant.) In London in December 1952, sulfurous smog killed about 4,000 people in 1 week.[2] This was followed by a similar incident in New York in 1953, which resulted in 200 deaths.[3]

Though the tragic pollution-related deaths in London, New York, and Donora prompted only short-lived interest in the problem of air pollution, they did result in the passage of the 1955 Air Pollution Control Act. This act was limited in scope, however, just providing funding for research to be conducted by the Public Health Service, a bureau within the Department of Health, Education, and Welfare (HEW). Nevertheless, it was a harbinger of changing values in American culture: following World War II, values and preoccupations of this nation began to shift from national security and economic concerns toward quality-of-life issues, including the environment.[4]

The [1955} Air Pollution Control Act proved ineffective at preventing dangerous airborne releases.

The Air Pollution Control Act proved ineffective at preventing dangerous airborne releases. In Congress, an effort to pass federal standards for air quality was championed by Senator Edmund Muskie (D-ME), now heralded as the father of the modern environmental movement; Abraham Ribicoff, former secretary of the Department of Health, Education, and Welfare; Representative Kenneth Roberts (D-AL); and Representative Paul Schenck (R-OH). Their efforts led to the passage of the Clean Air Act of 1963, which increased funding for research and technical-assistance programs, encouraged the development of exhaust-control devices for automobiles, and gave the federal government the authority to regulate against major sources of pollution. But like its predecessor, this act proved weak at effecting significant change.

A 4-day temperature inversion in New York City in 1966 led to the deaths of an estimated 80 people and rekindled national interest in air quality.[5] In November 1967 President Lyndon B. Johnson signed the Air Quality Act, which essentially gave state and local governments the primary responsibility for air-pollution control, suggesting that the federal government study, but not establish, emissions standards for automobiles. This act, the precursor to the Clean Air Act of 1970, tendered federal funds to state governments to plan and implement their pollution-control strategies. But as of 1970, not a single state had activated a complete set of standards for any pollutant.[6] The Air Quality Act of 1967 was widely considered a failure. And not all were pleased with the hands-off approach taken by the national government.

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Senator Muskie, a leading contender for the Democratic presidential nomination in 1972, felt the pressure to produce a new federal bill that would impose tougher air-pollution standards. Based on estimates by the National Air Pollution Control Administration, Muskie and a few cohorts, chief among them Senator Howard Baker Jr. (R-TN), proposed a new policy that included new federal air-quality standards and deadlines for achieving them through state implementation plans. This policy would later be revised and would provide the basis for the Clean Air Act of 1970 (technically an amendment to the Clean Air Act of 1963 but substantially strengthened over the original act).

Two oil spills off the California coast and the infamous incident involving the polluted Cuyahoga River's bursting into flames in Cleveland in 1969 captured the attention of the media and the public. There was clearly concern over the state of the environment by 1970—April 22 of that year marked the first Earth Day celebration. Air pollution was highly publicized during the explosion of environmental awareness that characterized this period. Political pressure then provided the stimulus for comprehensive national air-quality legislation.

There was clearly concern over the state of the environment by 1970—April 22 of that year marked the first Earth Day celebration.

Political leaders sensed the state of the public consciousness and embraced the topic of environmental protection in their campaigns. In his 1970 State of the Union message to Congress, President Richard Nixon declared, "The great question of the seventies is, shall we surrender to our surroundings, or shall we make peace with nature and begin to make reparations for the damage we have done to our air, to our land, and to our water?"[7] Nixon, in part trying to steal the thunder from Senator Muskie, a potential rival in the 1972 presidential election, called for "comprehensive new regulations" to protect the environment.[8]

In December 1970, the Clean Air Act was enacted by Congress. The stated purposes of this major piece of legislation were

- to protect and enhance the quality of the nation's air resources so as to promote the public health and welfare and the productive capacity of its population;
- to initiate and accelerate a national research-and-development program to achieve the prevention and control of air pollution;
- to provide technical and financial assistance to state and local governments in connection with the development and execution of their air-pollution prevention and control programs; and
- to encourage and assist the development and operation of regional air-pollution prevention and control programs.[9]

The 1970 Clean Air Act required the newly formed U.S. Environmental Protection Agency (EPA) to develop national air-quality standards, to establish motor-vehicle emission standards, and to establish emission standards for stationary sources. States were given the responsibility of creating emission-reduction plans. Due to a lack of experience in dealing with emissions standards, the state plans, as well as the EPA's standards and deadlines, were often infeasible. Still, this act committed the nation to a path toward an ambitious set of goals for clean air, and it marked a change in the federal government's role in environmental affairs. (Soon afterward, the federal government would step into other areas of pollution control through the Clean Water Act, the Safe Drinking Water Act, the Resource Conservation and Recovery Act, and the Toxic Substances Control Act, among others.)

The 1970 Clean Air Act required the newly formed U.S. Environmental Protection Agency (EPA) to develop national air-quality standards, to establish motor-vehicle emission standards, and to establish emission standards for stationary sources.

While the Clean Air Act was widely supported, the oil embargo of 1973 and the energy crisis of the 1970s led to conflict over pollution-control programs. Although presidents Nixon, Ford, and Carter had

While the levels of particulates, sulfur dioxide, and carbon monoxide were greatly reduced during the 1970s, ozone and nitrogen-dioxide levels remained very high, compelling environmentalists to question whether EPA had executed the Clean Air Act as forcefully as it should have..

all attempted to create a national energy policy, no consensus could be reached. Facing high inflation and increasing oil prices with inelastic demand in the late 1970s, the Carter administration was forced to ease air-pollution control requirements to some extent.

In 1977 the Clean Air Act was further amended. Once again this was a result of a bipartisan effort led by Muskie, Baker, Robert Stafford (R-VT), Pete Domenici (R-NM), John Chafee (R-RI), and James Buckley (C-NY). The core changes were the introduction of classification of attainment versus non-attainment areas, the creation of new source performance standards, the definition of prevention of significant deterioration, and the implementation of more stringent motor-vehicle emissions standards.

While the levels of particulates, sulfur dioxide, and carbon monoxide were greatly reduced during the 1970s, ozone and nitrogen-dioxide levels remained very high, compelling environmentalists to question whether EPA had executed the Clean Air Act as forcefully as it should have. There was a call for revision in the 1980s, but revision proved an arduous task.

The Reagan administration brought an entirely different point of view to environmental policy. It sought to reduce government regulation, to shift responsibilities to the states, and to rely more on the private sector to achieve its ends. During the Reagan administration, in 1981, the Clean Air Act came up for reauthorization. Efforts were being made on both ends to amend the existing legislation. Industry groups founded the Clean Air Working Group, led by William Fay, to lobby for a relaxation of standards. Environmentalists formed the National Clean Air Coalition under the leadership of Richard Ayres.

Reagan's efforts to deregulate environmental laws and the perceived bureaucratic deadlock of the 1980s actually strengthened public zeal for environmental protection.

Reagan administration officials and the Clean Air Working Group argued that while the benefits of the Clean Air Act in its initial years were manifold, the marginal utility of the act was diminishing; they felt that each additional dollar spent on air-pollution control would be an inefficient use of funds. Many groups, including the American Medical Association, strongly disagreed. But with the position of the executive branch so firm, a legislative stalemate was inevitable. Congress cooperated with the executive branch in the beginning of the Reagan years but soon became protective of environmental policy.

While the early Reagan years were characterized by the administration's less-than-aggressive environmental policy, resonant also in EPA and in the Department of the Interior (DOI), the later Reagan years were wholly different. Following the embarrassing Congressional hearings of many high-ranking EPA and DOI officials and the forced resignations of EPA administrator Anne Gorsuch and several other EPA higher-ups, White House officials realized that they needed to rid themselves of the politically unfavorable anti-environmental label. Though they would never receive environmentalist backing, they could at least make efforts to keep environmentalists quiet.

Bush's election in November 1988 on a platform that promised greater attention to environmental protection—in stark contrast to the Reagan administration—raised hopes for amending the Clean Air Act and enacting more comprehensive environmental legislation. This new environmental focus in the executive branch culminated in the passage of the Clean Air Act Amendments in the fall of 1990.

To reestablish dignity at EPA, Reagan called upon the agency's first administrator, William Ruckelshaus, to serve in that capacity once again. Ruckelshaus was given the directive to restore order to EPA. He was charged to keep EPA out of the headlines—to fix environmental problems quietly. To do this, Ruckelshaus was given free rein to bring in whomever he wanted, regardless of party affiliation. He brought in a bipartisan community that performed its tasks professionally. One of the most important contributions to modern environmental policy occurred during this period, with the banning of leaded gasoline. But notwithstanding the new administration at EPA and congressional persistence, attempts to pass acid-rain legislation and to strengthen the Clean Air Act proved unsuccessful.

Reagan's efforts to deregulate environmental laws and the perceived bureaucratic deadlock of the 1980s actually strengthened public zeal for environmental protection. In subsequent presidencies, the first Bush administration used the American environmental consciousness just as Nixon had done some 20 years earlier, with Bush pledging to be "an environmental president." The Clean Air Act was due to be amended, and George H.W. Bush pledged to take action with celerity. The promise was expedited by the replacement of Senate Majority Leader Robert Byrd (D-WV), a proponent of high-sulfur coal and Midwestern utility companies, with Senator George Mitchell (D-ME), an ardent supporter of acid-rain regulation.[10]

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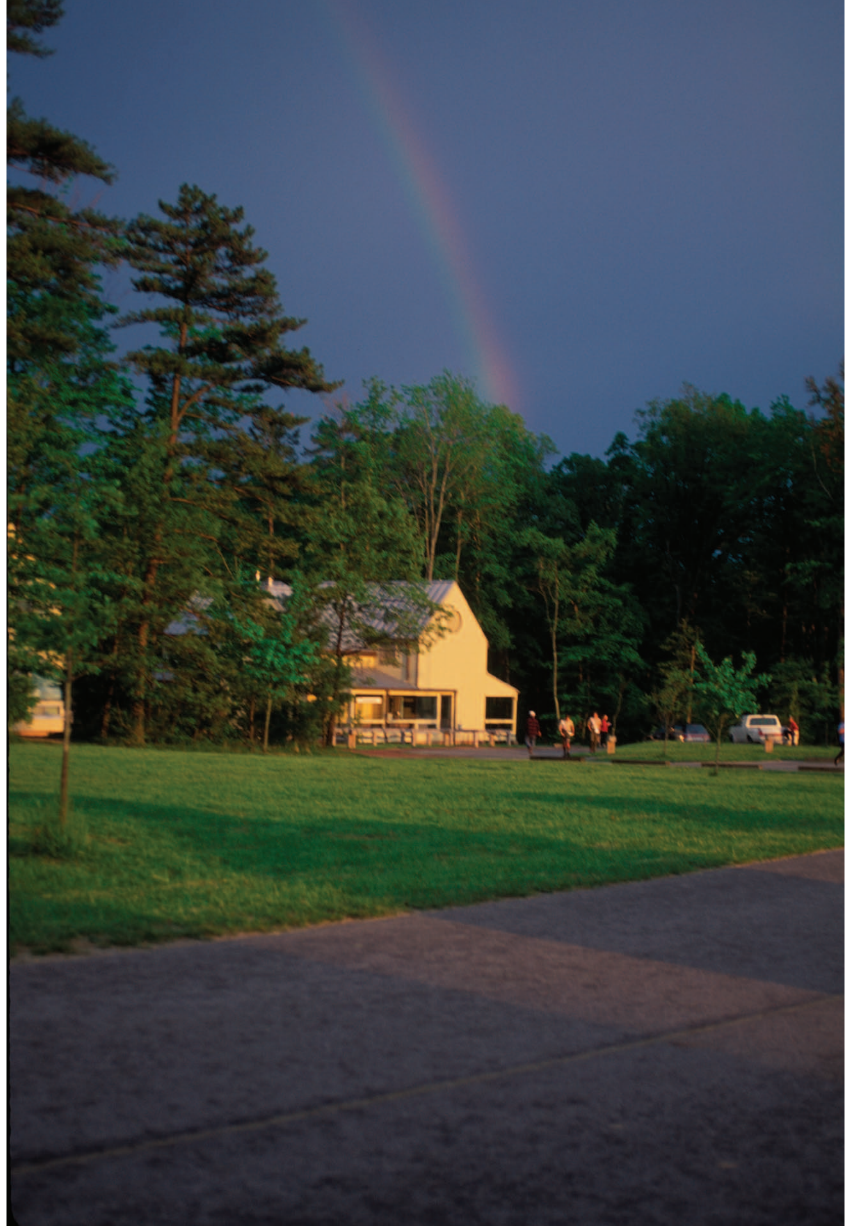
The nearly 800 pages of the Clean Air Act Amendments of 1990 have a few critical aims:

- reducing acid rain through a system of marketable permits (as opposed to the command-and-control techniques, which had been more commonly used) for coal-fired power plants;
- reducing air emissions in urban non-attainment areas; and
- lowering the emissions of 200 airborne toxic chemicals.[11]

The 1990 amendments went on to give the EPA administrator the task of determining the maximum achievable control technology (MACT) for "major industrial facilities that emit one or more of the 189 substances presumed to be toxic" and to issue regulations requiring these sources to install agency-determined control equipment.[12] This may be seen as a technology-forcing power, since it encourages the development of new technologies and forces industrial facilities to use the most advanced control technologies available.



In the 1992 presidential campaign, the environment received considerable attention. Bill Clinton enjoyed much support from environmentalists when he selected as running mate Senator Al Gore (D-TN), who had just published his provocative book, *Earth in the Balance: Ecology and the Human Spirit*. While the Clinton administration was unable to make major gains in pollution control during its terms in office, it was able to establish other environmental protection programs. Clinton also supported the controversial EPA clean-air standards for ozone and fine particulates in 1997.

The Clean Air Act certainly has been one of the most expensive pieces of environmental legislation ever passed. But while the cost of air-pollution damage in 1970 in the United States was estimated to be within the range of $6.1 billion and $18.5 billion (in 1974 U.S. dollars),[13] with a "best estimate" of about $12.3 billion for that year, the benefit of cleaning the air was significantly greater.[14]

In 1979 EPA predicted that the Clean Air Act would cost the public and private sectors about $240 billion between 1977 and 1986.[15] This study was based on engineering estimates rather than industry surveys and was regarded as a low estimate of the actual price, given rising pollution-control costs and a likely progression toward more stringent regulation. The Council on Environmental Quality estimated that air-pollution control had cost the United States $25 billion in 1979 and that the costs would exceed $40 billion by the mid-1980s. Moreover, expenditures on pollution-control equipment also represent lost opportunities to invest in productive ventures, which could improve the standard of living with inputs of new goods and services. It is estimated that the annual economic impact of the Clean Air Act Amendments of 1990 was between $12 billion and $53 billion in 1995 and will be between $25 billion and $90 billion in 2005.[16]

While many industries and their supporters decry this expenditure as wasteful and unnecessary, organizations such as the American Lung Association (ALA) call for further regulation to reduce the health

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impacts of air pollution. ALA estimates the annual health cost alone of air pollution at $50 billion, including days of work lost to illness, as well as cost of care.[17]

Section 812 of the 1990 Clean Air Act Amendments called for EPA to conduct retrospective and prospective studies on air-pollution control. The results of these analyses were compared with the "no control" scenario, the level of emissions that are estimated to have occurred if no such legislation had been enacted, and the net benefits of the Clean Air Act were estimated at $21.7 trillion (in 1990 U.S. dollars).

That report suggests that the benefits of the act exceed the costs by as much as a factor of 40, chiefly due to lower levels of airborne particulates and lead, which reduced the number of deaths significantly. The retrospective cost-benefit analysis showed that the Clean Air Act prevents about 18 million illnesses and 200,000 deaths each year.[18]

The Clean Air Act has achieved—and will continue to achieve—its goal of improving public health. The act also provides a model of policy-making as a continuous dynamic process of identifying problems, formulating government responses, organizing administrative mechanisms for carrying out the policies, and evaluating the effectiveness of those policies.

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During the summer of 2003, Paul Augustine, a student at Yale University, worked as an intern for the University of Tennessee's Joint Institute for Energy and Environment and for the Howard H. Baker Jr. Center for Public Policy. As part of his internship, he drafted "The Clean Air Act: An Archetype for Dynamic and Comprehensive Environmental Policy," which is excerpted here. Augustine recently received a Master of Public Administration degree in environmental science and policy from Columbia University's School of International and Public Affairs. He has accepted an assignment to work as an environmental policy analyst for the U.S. Environmental Protection Agency's Clean Air Markets Division.

Notes

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4 Ronald Inglehart, *Culture Shift in Advanced Industrial Society* (Princeton, NJ: Princeton University Press, 1990).

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6 Pub. L. No. 90-148, 81 Stat. 485.

7 Transcript of the President's State of the Union Message to Joint Session of Congress, *The New York Times*, January 23, 1970, 22.

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U.S. Environmentalism, *Comity*, and the Clean Air Act

By Howard H. Baker Jr.

President Thomas Jefferson insisted that his tombstone reflect only that he had founded the University of Virginia—not that he served as ambassador to France, as secretary of state, and as vice-president and president of the United States, or that he had drafted the Declaration of Independence. In his mind, his most meaningful accomplishment involved founding an institution of higher learning.

In much the same way—though I do not compare my achievements to those of Jefferson—I hope to be best remembered for my role in shaping the Clean Air Act of 1970. Indeed, I count myself fortunate for having had the opportunity to serve the state of Tennessee and the nation in many different capacities. But those personal achievements will be most valuable to my descendents and my biographers, as they measure the level of my participation in public affairs. Yet, 35 years after the Clean Air Act's creation, the act's principles and goals survive and continue to provide this country—and provide me—with an enduring legacy.

Howard H. Baker Jr.

In 1969, I was one of several fortunate American citizens who came together at a propitious moment in history and developed the concepts that, in many respects, have changed the world and altered our attitude toward the environment.

I hope to be best remembered for my role in shaping the Clean Air Act of 1970.

In that year, Senator Ed Muskie (D-ME), a colleague and a good friend, and I shared a vision, and each of us provided critical elements to that vision. In the end, we succeeded in producing a law that demonstrated clearly that the whole is greater than the sum of the parts.

It's worth noting that Senator Muskie was a distinguished and aggressive Democrat. I was less distinguished but certainly no less active as a Republican. But together we produced a legislative work that will endure as the beginning, in many ways, of the environmental movement in the United States.

Unprecedented Process

The Clean Air Act of 1970 passed the United States Senate unanimously. But even more remarkable than the unanimous support the act received was the act's journey itself, from concept to passage, which was unique and unprecedented in several key ways.

- First, the act declared a direct and overarching federal interest in protecting the health of all Americans from air pollution.
- Second, we incorporated into the law the concept of "technology forcing," that is, pushing the pace of technological development to support the act's goals of reducing harmful airborne pollutants.
- Third, we established deadlines for government action.
- Fourth, we made many of those government actions mandatory rather than permissive.
- Fifth, we empowered the public—individual citizens—with the authority to use the federal courts to achieve the objectives we set forth, in the event that the bureaucracy or politicians failed to do so.

To my knowledge, none of those concepts had ever been legislated before. And all were contained in the 38-page public law called the Clean Air Act of 1970. Central to the story of the Clean Air Act are the political and legislative dynamics that facilitated the act's creation and passage. But equally important are the personal dynamics that made it possible and which endured long after the act's approval and after my departure from the U.S. Senate.

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Senator Muskie was a partisan Democrat who never let partisanship interfere with his desire to create good public policy.

Two Parties, One Vision

Senator Muskie was a dear friend. He was a man whose intellect, initiative, and innovative capabilities were remarkable. He was a partisan Democrat who never let partisanship interfere with his desire to create good public policy. In every aspect of his legislative career—which I witnessed personally—on the environment and in the budget process and later, as secretary of state, on foreign policy, Ed Muskie was willing to work as long as it took, with whoever was necessary, without respect to party or point of view.

He believed that we could compromise without surrendering principles; he knew that compromise—he called it, by the way, *comity*—was the essence of a workable legislative process. And he knew that each of us had his own ideas, as well as ideals. All of us had loyalty to our constituencies, which, like his own, had to be accommodated and taken into account.

As unique as the participants who helped shape this landmark law was the political and cultural context in which it was created:

- First, while television had evolved into a powerful medium, it had not yet overshadowed the reach and influence of the printed word.
- Second, political campaigns didn't cost nearly as much then as they do today. Consequently members of Congress spent a lot less time raising money, and I'm sure they felt a lot less obligated to the sources of their campaign funds.
- Third, our constituencies were considerably less organized on specific issues, thus it was easier to be a leader and less essential to be a follower.
- Fourth, members of the House and Senate actually *wrote* legislation. Only on occasion did I have to remind other individuals involved in the process—including my friend Leon Billings, Ed Muskie's chief of staff, and his colleague Jim Range, my former chief counsel—that I was a senator and they were not.
- Fifth, members of the Environment and Public Works Committee actually enjoyed working on tough domestic issues like clean air because they were, at the time, besieged by constituent activists opposed to the Vietnam War, which was at its height during that era. In fact, in those days, the Senate Office Building was in effect being occupied by demonstrators. I've always suspected that my colleagues in the Senate found relief in talking about clean air instead of Vietnam.

Members of the Environment and Public Works Committee actually enjoyed working on tough domestic issues like clean air because they were, at the time, besieged by constituent activists opposed to the Vietnam War.... I've always suspected that my colleagues in the Senate found relief in talking about clean air instead of Vietnam.

Prejudices and Priorities

When we wrote the Clean Air Act and its sister legislation, the Clean Water Act, committee members had frank and open discussions, as each brought his prejudices and priorities to the process. We laid the interests of constituencies on the table, often bluntly, but frequently with humor. Our committee made decisions by consensus if it was possible, and usually it was.

There is no better measure of the dynamics of the committee than when Jim Buckley, who was elected as a conservative Republican senator from New York, came to the committee in 1971. He had initially been assigned to what is now the Senate Energy Committee, and he'd been distressed by the fact that the committee functioned as its chairman's fiefdom, with most votes being decided by the proxies that the late Scoop Jackson (D-WA) had in his pocket.

Later, when Jim joined the Environment and Public Works Committee, he was struck by the fact that not only did his views get heard, they actually mattered. He quickly learned that he could make a difference, and even though, as a Republican, he had deep reservations about expanding the role of the federal government in the area of clean air and water, it was he who pointed out that *conservative* and *conservation* share the same Latin root. Jim was so well incorporated into the dynamics of the committee that in 1972 he served as co–floor manager for the Clean Water Act, even against the veto of the Republican president, Richard Nixon.

When we wrote the Clean Air Act, and its sister legislation, the Clean Water Act...we laid the interests of constituencies on the table, often bluntly, but frequently with humor. Our committee made decisions by consensus if it was possible, and usually it was.

The Act's Fundamentals

There were three fundamental ideas that evolved from the Clean Air Act. Ed Muskie believed that there needed to be a basis on which to require major investment in air-pollution control. Moreover, he believed that there needed to be a firm basis for asserting a federal interest in air-pollution control. He had, in earlier and more rudimentary air-quality legislation, required the development of air-quality criteria. He insisted that air-quality standards be based on science, not on economics or politics. He wanted the public to understand the *science* of air pollution. He contended that we, as elected officials, would deal with the economic issues.

Our colleague Senator Tom Eagleton (D-MO), who had just been through a bruising effort to write occupational safety and health legislation, eloquently and assertively pointed out that the Congress and the executive branch made bold promises to the public—the war on this, the war on that—but often nothing was accomplished in a timely way. He believed that the way to resolve the issue of public confidence was to establish statutory deadlines driving administrative and other actions.

I was concerned that we might be striving to achieve more than our collective capacity could deliver. While I agreed with Ed Muskie that standards should be based on science, and I agreed with Tom Eagleton that there ought to be deadlines for the achievement of those standards, I simply didn't know whether we had the technical capability to accomplish our bold, and some would say *excessive*, objectives.

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Science-Based Standards

So as part of our accommodation, we agreed that there would be science-based air-quality standards and there would be deadlines, but there would also be opportunities to extend those deadlines where the technology didn't exist to achieve the standards we had set. We further agreed that, to force the development of new technologies, the authority to extend those deadlines should be limited—that the administrator of the Environmental Protection Agency would be authorized to make certain limited extensions. But we also agreed that, at some point, the polluters—the manufacturers of automobiles and the owners of power plants, for instance—would have to appeal to Congress if they needed more time to achieve the act's standards.

We believed that the body politic had elected us to make the difficult decisions. We did not believe that we were elected to delegate our responsibilities to administrative agencies. We respected the technical, scientific, and regulatory skills that were available to the federal government and to the states, but ultimately, judgments with respect to the availability of technology, the costs of pollution control, and the ability to meet standards-specific deadlines were political, not bureaucratic, in nature.

In short, the public had the right to demand that their elected officials balance the ability to achieve the required pollution reductions against the risks to the public health if those reductions were not achieved.

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The Amendments

The 1970 Clean Air Act cannot be fully explored or appreciated without a look at the amendments to the act passed in 1977. Between 1970 and 1977, politics in America had changed dramatically. Campaign costs had escalated, corporate political action committees (PACs) had been formed, and unlike in 1970 when there were few advocacy groups for or against clean air, we had created a lobbyist boom.

Meanwhile, congressional committee business was out of the closet and in the bright light of public exposure. In many cases, that meant that the lobbyists were in the room with the legislators when they marked up a bill. As a result, we had to review the successes of our 1970 product—and evaluate prospective amendments to it—in public and under a microscope.

Every day in 1975 and 1976, when we considered Clean Air Act amendments and then conferred with the House on them, our venues were packed with lobbyists in long lines extending out the doors. While our committee continued to have the kind of serious debate that had dominated our earlier deliberations, the existence of an audience changed the tenor, if not the substance, of our deliberations. It was more difficult to have the kind of casual and colloquial conversation that we had had in the back room at the time of the writing and adoption of the 1970 act.

It was more difficult for members to find accommodation for competing views. There was more suspicion. And there was a great deal more participation from the affected communities than had been the case previously. As a result, it became more difficult for members to define and agree upon the objectives and then work out the best means for achieving them.

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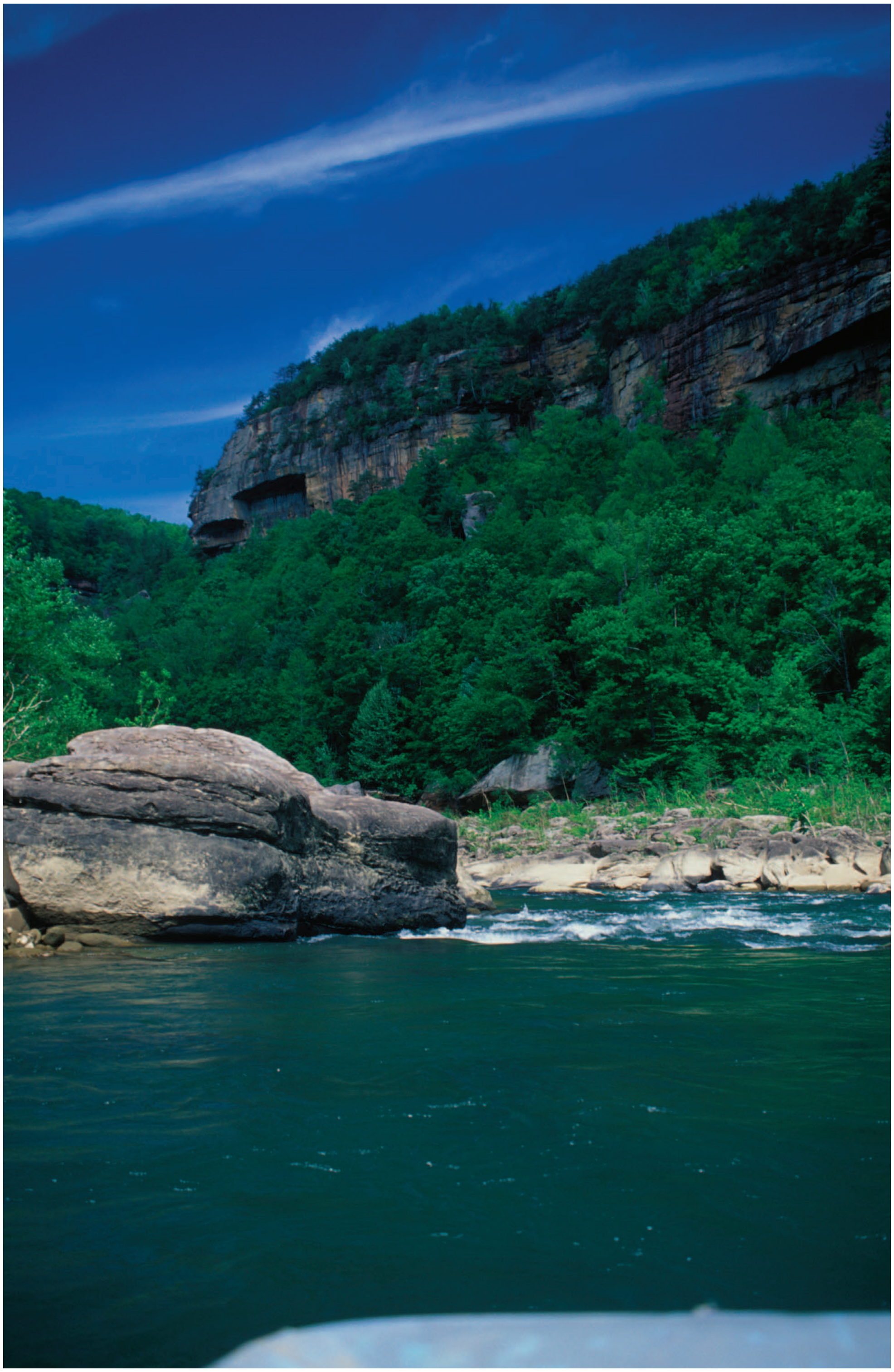

Simultaneous with this opening of the committee's business, there was an explosion of staff. When we wrote the 1970 act, I was supported by the committee's counsels, Tom Jorling and Bailey Guard, and my personal staff consisting of Jim Jordan and Jim Range. The only staff members who participated in the committee's discussions were the minority and majority counsels and one member each of the professional staffs of the majority and of the minority. I am told that it was much more difficult for lobbyists to influence that process because the staff was too busy responding to members' interests to be accessible to the representatives of special interests. But even faced with all that change—open meetings, increased staff, the existence of PACs, myriad lobbyists—we managed to maintain the comity that we had enjoyed at the time of the adoption of the original act.

Mid-Course Corrections

We regarded the 1977 amendments to the Clean Air Act and the Clean Water Act as mid-course corrections, and indeed they were. We all knew at the time we wrote the basic laws that we had made mistakes, that compliance deadlines would be too short, that technology would not keep pace, that many polluters would be so shocked by the magnitude of the imposed burden that they would first try to frustrate the law before they decided to comply with it. Time would be wasted while challenges were exhausted, but in mid-decade I think we all believed that we wanted to improve on our 1970 Clean Air Act product, not to abandon it, and certainly not to weaken it.

Time would be wasted while challenges were exhausted, but in mid-decade I think we all believed that we wanted to improve on our 1970 Clean Air Act product, not to abandon it, and certainly not to weaken it.

Because I was one of the principal advocates of technology-based standards, it was incumbent on me to take the lead on modifying the statutory automobile-emission standards. I told Senator Muskie that we needed to relax the nitrogen-oxide (NO_x) standard. He promised me that it would be done, but asked only that I withhold my amendment until the timing was right.

I talked to him at the time of the subcommittee mark-up in 1977, and he said, "Not yet." We spoke again when the full committee considered the bill, and once again he said, "Not yet." We got to the Senate floor, and I became concerned that my opportunity had come and gone, but once again he promised that I would have my chance and that ultimately I would prevail.

"Howard, I Believe It's Time."

We had a new senator from Michigan that year who had replaced Senator Phillip Hart, who had been Ed Muskie's close friend and ally. Unlike Senator Hart, the new senator, Don Riegle (R-MI), did not take his lead on clean air from Muskie. His interests were those of the automobile manufacturers and auto unions. So when he got to the floor, Senator Riegle quickly stepped forward to offer an amendment to significantly relax the automobile-emission standards. Senator Muskie, Senator Jennings Randolph (D-WV), Senator John Sherman Cooper (R-KY), and I met on the Senate floor, and Muskie said, "Howard, I believe it's time." And Jennings Randolph, who was chairman of the committee, said, "I would like to be a co-sponsor."

Years later, Senator Don Riegle would recall the Baker-Randolph substitute and the fact that his proposal was soundly rejected while ours was overwhelmingly adopted. He would note that this first adventure into Senate politics was a lesson he would remember for a long, long time.

I got my amendment. Ed Muskie accepted and supported my alternative. A weaker option was rejected, and the basic concept we articulated in 1970 had withstood its greatest challenge. For those of you who were not around at that time, I should add as a footnote that we went to conference with the House Conference Committee, which was dominated by automobile-industry advocates and others who had the objective of weakening the Clean Air Act. But because the Senate would not yield any further than it had with my amendment, the auto industry advocates had to accept that outcome or face plant closures. Those ambitious air-quality standards, thought to be impossible to achieve at the time, have since twice been made more stringent as a result, I believe, of the fundamental technology-forcing requirement of the Clean Air Act.

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Prosperity and Environmental Protection

Like many of you here, I have visited many parts of the world that have not enjoyed the full benefits of the environmental revolution, which we all should be proud of having begun. It is difficult to breathe the air in Beijing, and many other Asian and Eastern European cities have unimaginable pollution. We have seen our economy boom, our fleet of automobiles grow, our population increase, and the number of vehicle miles we travel multiply. And yet, in every instance our air is still getting cleaner. We haven't achieved Ed Muskie's public-health standards yet. But we have in place a body of law and a national philosophy that should make that possible in our lifetime.

We triggered a global change as a result of our investment and the collective effort of a few committed men and women who gathered in a small committee room. We charted a change—in my view, no less than a change in the course of history. Special interests today can weaken the law, they can change the law, but ultimately they won't succeed in rolling it back. I did many things in the Senate, most of which I am proud of. But I am never more proud than to be identified as one of the authors of the Clean Air Act of 1970.

Howard H. Baker Jr. served three terms as a U.S. senator from Tennessee (1967–1985). He rose to national prominence during the Watergate hearings as vice-chairman of the Senate Watergate Committee. Baker served as minority leader of the Senate from 1977 to 1981 and as majority leader from 1981 until he retired from the Senate in 1985. From 1987 to 1988, Baker served as White House chief of staff for President Reagan, and from 2001 to 2005, as the U.S. ambassador to Japan. Baker and Senator Ed Muskie (D-ME), the principal authors of the 1970 Clean Air Act, are credited by some as having started the environmental movement in the United States.

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Greatness is defined by how you take advantage of the opportunities that exist when you are in a position to affect the outcome.

In the Shadow of Greatness

By Leon Billings

Leon Billings

I had the good fortune to serve in the United States Senate as a staff person when it was dominated by great men. Not only did I get to work for senators Ed Muskie (D-ME) and Howard Baker (R-TN), but I got to watch other Senate titans like Al Gore Sr. (D-TN), Richard Russell (D-GA), Russell Long (D-LA), Mike Mansfield (D-MT), and the greatest senator I ever met, John Sherman Cooper (R-KY), a man who defined ethical behavior.

Greatness is defined by how you take advantage of the opportunities that exist when you are in a position to affect the outcome. The men I have mentioned were great in that regard, and there were others who deserved that designation, but I'm going to focus on just two of them—Ed Muskie and Howard Baker—because they grasped the moment and they changed the world.

If Ed Muskie was the master of the environmental ship before anyone even thought about the environment in terms of public policy, Howard Baker quickly became his first mate and later his co-captain.

Captain and Co-Captain

If Ed Muskie was the master of the environmental ship before anyone even thought about the environment in terms of public policy, Howard Baker quickly became his first mate and later his co-captain. Muskie had logged 10 years in the Senate before Senator Baker joined him. Within a year of Senator Baker's arrival, they'd worked together to write the Clean Air Act and, within 3 years, the Clean Water Act.

Legislatively, they went where no senator—no member of Congress—had ever gone before. Together they crafted such innovative concepts as "the polluter pays," a principle that Vice President Al Gore successfully defended on the floor of the House in the early 1980s. Among their other innovations were joint and several liability, statutory standards and deadlines, citizen participation and citizen suits, timely judicial review, health- and welfare-based standards, funded mandates, and an enforceable legal mandate that pollution be reduced to the maximum extent possible.

Senators Muskie and Baker weren't alone in this boat. Also on board were creative and innovative colleagues, and they had staff members who knew they were staff members, not senators. They engaged one another from a personal perspective that brought everyone to the table. Each had his biases, but none let his bias close his mind to other ideas. Together they created consensus based on personal experience, philosophy, and expertise. They were guided by the problems they sought to solve and not by the contributors or the lobbyists they might otherwise have attempted to satisfy.

Global Influence

Muskie and Baker created a framework of law that has since inspired the laws of states and other nations. As a result of Senator Baker's vision of technology-based emission standards for cars, countries all over the world now have mandatory automobile emission-control programs.

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Technology forced by Howard Baker's approach to public policy is being exported to our trading partners. By some estimates, 90 percent of the new cars produced in the world today have catalytic converters. And because of the laws written by Ed Muskie and Howard Baker, manufacturers have sought and found ways to produce goods with less waste and greater efficiency.

That is the practical side. But even more significant is the environmental revolution these two men began. In the Senate of the late 1960s, senators accommodated one another. Ed Muskie trusted Howard Baker, and Howard

Baker trusted Ed Muskie. Beyond that, they were friends. In fact, such was the relationship between the two of them that Muskie refused to campaign for a fellow Democrat who was running against Senator Baker in Tennessee.

On another occasion, when the Senate was considering a highway bill, Senator Baker, as he often did, gave his proxy vote to Senator Muskie, with instructions to make sure that if Senator William Scott, a conservative Republican from Virginia, offered a specific amendment and it was certain to fail, Muskie was to vote Baker's proxy for it. The vote came, and Muskie voted Baker's proxy for the Scott amendment. Scott went ballistic. He demanded to know how it had happened that a member of his party had given his proxy vote to a member of the other party.

Power and Credibility

Equally reflective of the power and credibility of the Baker-Muskie relationship was their amendment to the Federal Highway Act of 1972. The two had tried in committee to direct unused interstate highway trust funds to mass transportation. They failed by one vote and decided to take the issue to the floor, even though it meant taking on their own committee chairman and the considerable forces of the highway lobby. Senator Ted Kennedy (D-MA) and Senator Lowell Weicker (R-CT), who had a similar strategy, tried to steal the issue with an amendment that was nearly identical to the proposal that Baker and Muskie had lost in committee. Kennedy and Weicker were defeated by a 2-to-1 vote.

Immediately after that defeat, Baker and Muskie offered their amendment, and it passed, albeit narrowly. Later, a Kennedy aide demanded that I explain why the Muskie-Baker amendment had passed and the nearly identical Kennedy-Weicker amendment had failed. "But they're not nearly identical," I said. He asked me to show him.

"Look at the names on the amendment—*Muskie and Baker* versus *Kennedy and Weicker*," I said. "There's a world of difference." The Muskie-Baker combination was almost impossible to defeat.

It is not just the visionary Clean Air Act for which these two were responsible. Senator Baker is also in many respects the father of the polluter-pays principle, which maintains that a company that causes pollution should pay for the cost of removing it or provide compensation to those who have been affected by it.

During the committee deliberations on the Water Quality Improvement Act of 1970, which in part addressed oil pollution and oil spills, Senator Baker decided to teach the staff a short course on tort law.

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Senator Baker and Senator Muskie had vigorous debates about the limitations of Admiralty Law and how vessel owners avoided paying for the damage caused by oil spills because of something called "comparative negligence," which allowed them to shift at least partial blame onto others.

We learned that negligence was the primary basis on which liability was determined, but in the case of oil pollution, it was complicated by Admiralty Law, the body of law governing navigation and shipping.

Senator Baker and Senator Muskie had vigorous debates about the limitations of Admiralty Law and how vessel owners avoided paying for the damage caused by oil spills because of something called "comparative negligence," which allowed them to shift at least partial blame onto others. The two senators also had extensive discussions about whether liability should be absolute, or whether acts of God should be excluded.

In the end, together, they sired the concept of strict liability and of joint and several liability, which governs the Superfund program today. Loosely defined, strict liability is the assessment of liability for damages without requiring proof of negligence. Joint and several liability is a concept that dictates that parties that contribute to a site's pollution are each liable as if they alone had polluted that site. Under this concept any one party may be held liable for all clean-up costs. In such a case, this one party may be responsible for identifying others to share the liability.

Continuing Careers

Ed Muskie's and Howard Baker's relationship didn't end with their Senate careers. I suspect Senator Baker, acting as White House chief-of-staff during the Reagan administration, may have had something to do with Ed Muskie's being invited to serve as vice-chairman of the Tower Commission, which investigated the Iran-Contra arms deal. And I know it was Howard Baker who asked Ed Muskie to meet Muskie's political nemesis, Richard Nixon, to persuade the former president to urge President Reagan to tone down his rhetoric on the Soviet Union.

And yet, with all this history between the two men [Nixon and Muskie], when Howard Baker asked Ed Muskie to meet with Nixon, Muskie traveled to New Jersey, met with the former president, and contributed to Senator Baker's effort to avert a crisis with the Soviet Union.

When I learned of this, I was flabbergasted. Had I been consulted, I would have let Senator Muskie know just how I felt about him having anything to do with Richard Nixon. We had believed that Ed Muskie was going to defeat Richard Nixon in the 1972 presidential election. During that election, Nixon's people pulled all manner of dirty tricks on the Muskie campaign to derail the senator's candidacy.

And yet, with all this history between the two men, when Howard Baker asked Ed Muskie to meet with Nixon, Muskie traveled to New Jersey, met with the former president, and contributed to Senator Baker's effort to avert a crisis with the Soviet Union. And Senator Muskie did this because his friend and former colleague Howard Baker had asked him to.

Muskie and Baker accomplished all this, but even more important, they launched the U.S. environmental revolution, which has since spread throughout the world. Together, they made a hell of a team and left a remarkable legacy.

Leon Billings is a consultant specializing in environmental, energy, safety, and health legislation. Billings has had a long and successful career in the federal legislative arena. From the late 1960s through the early 1980s, he served as the executive assistant to the late Senator and former Secretary of State Edmund Muskie (D-ME). In this capacity, he played a leading role in the development of existing federal clean-air and -water statutes. He also served 12 years as an elected member of the Maryland legislature.

Muskie and Baker… launched the U.S. environmental revolution, which has since spread throughout the world. Together, they made a hell of a team and left a remarkable legacy.

EPA Adapts and Evolves in Protecting America's Air

By Milton Russell

Implementation is never easy, but it is doubly hard when, as in the case of the Clean Air Act, benefits for all sometimes come at the cost of economic pain to some.

Milton Russell

In 1970 Senator Edmund Muskie (D-ME) and Senator Howard Baker (R-TN) forged the consensus that produced the Clean Air Act legislation with its innovative tools for progress in cleaning America's air. They understood well, however, that success in achieving their goals depended on how effectively those tools would be used.

Implementation is never easy, but it is doubly hard when, as in the case of the Clean Air Act, benefits for all sometimes come at the cost of economic pain to some. At the time, the senators were rightly concerned that the executive branch might not be willing to face down opposition to the expensive changes in the way goods and services had to be produced and consumed if air quality were to be improved. Senator Muskie expressed that concern at the confirmation of the first administrator of the U.S. Environmental Protection Agency (EPA) when he noted his hope that William D. Ruckelshaus would become known as "Mr. Clean."[1]

Considerable progress has been made in cleaning America's air, and much of that progress came about during two critical periods—in EPA's early days following its creation in 1970 and in mid-course, when Ruckelshaus returned to EPA as administrator in 1983. In what follows, I will focus on implementation of the Clean Air Act during these two periods, not only to highlight how progress has been made but also to suggest the implementation challenges that remain.

EPA efforts were then analogous to those of urban firefighters who have to tear down houses to keep the flames from spreading to other structures.

Environmental Commons

It is hard to realize today how bad things were in 1970 when the Clean Air Act Amendments were passed to provide overarching federal authority over the environment and EPA was formed.

Within days and weeks, Ruckelshaus and his then-tiny staff issued a series of far-reaching orders and regulations that transformed the way our environmental commons was to be treated. In short, the infant EPA challenged the view that our health and natural environment were to be held hostage to economic growth and prosperity.

In essence, the situation was seen as so dire that crude tools—policy and regulatory "bulldozers"—were employed sometimes with excessive zeal to forestall disaster, with the full knowledge that some damage would be done but that the damage would be worth the cost. EPA efforts were then analogous to those of urban firefighters who have to tear down houses to keep the flames from spreading to other structures.

As a result of these policy measures, progress in cleaning the air and the water, as well as in reducing the harm from pesticides and chemicals and in protecting wetlands and other ecological resources, did occur in the succeeding decade, first under Ruckelshaus and then under his successors, Republican Russ Train and Democrat Doug Costle. The bipartisan vision of a national effort for environmental quality formulated by senators Baker and Muskie remained largely intact.

This remarkable trio of leaders was able to infuse the political appointees who served under them with that vision, which then enabled them to recruit and maintain an exemplary civil-service staff that was not only skilled and resourceful but also imbued with the mission of the agency. The combination of a shared vision, of strong leadership, and of skilled and dedicated professionals on the front lines carried implementation forward despite the inherent difficulty of the task and the strains of adjusting the American economy to accommodate a new set of constraints and obligations designed to provide the public with cleaner air.

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With the full support of President Reagan, Ruckelshaus replaced virtually every political appointee at the agency with handpicked managers and leaders committed to the mission of EPA—with little reference to their political affiliations—restoring the vision of environmental quality as an American goal to be pursued across all divisions of party, economic class, and region.

Economy vs. Environment

That shared vision was shattered, however, in the first years of the Reagan administration. It came into office convinced that EPA had become too intrusive in private economic decisions and that a rollback in regulation was required. The political leadership of EPA reflected this view and sought to make it a reality, alienating the staff that remained true to the EPA heritage it had helped form. Resistance to the administration's views and actions was reflected both in public outrage and in environmental policy's becoming an intensely partisan issue.

EPA was mired in high-level controversy and scandal, leading to the forced resignation of its administrator. The president, reassessing the situation, called on Ruckelshaus to return. He did return, to be greeted by perhaps the greatest outpouring of affection and relief from staff members in the history of government. The second great phase of policy reformation and implementation in EPA's history then followed.

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From Bulldozers to Scalpels

Yet, it was time for a new approach to sustaining progress in cleaning the air. By this time, the bulldozers of brute force regulation had done their work in ameliorating the environmental crisis the nation faced in 1970. For the most part it was now time for shovels and even scalpels to sustain progress—while avoiding or minimizing ancillary harm. This meant balanced, efficient, and carefully considered additional actions. To move forward, EPA had to transform the way it did its work and the goals it sought to achieve.

As for how EPA did its work, the first change followed from the post-Vietnam mood in the nation, which came to be called "participatory democracy." If the public was to be involved, the basis for every decision and how it was made had to be manifest.

As for how EPA did its work, the first change followed from the post-Vietnam mood in the nation, which came to be called "participatory democracy." If the public was to be involved, the basis for every decision and how it was made had to be manifest. The time of "we decide and announce; you just trust us" was past. *Transparency* became the watchword.

In the post-bulldozer era, action required more nuance and care. This meant that bureaucratic stovepipes inside the agency had to be dismantled, conflicting views had to be heard, and action options—with pros and cons—had to be raised and considered. In particular, the agency needed to take into account the secondary impacts that exercising one option might have on achieving other environmental, social, and economic goals. Ruckelshaus and his deputy, Al Alm, established a formal broad-based decision support system to ensure that all relevant research and analysis was done and taken into account.

Furthermore, meetings for making final decisions were designed to include every agency expert who had something to offer—especially those who held diverging opinions. Near the end of each of those sometimes long and rancorous meetings, Ruckelshaus would quietly say, "I am thinking about doing X. This is your last chance to convince me that this would be wrong." And even the lowest-level staffer in the room was expected to speak up if he or she had something else to contribute that might sway the decision.

Participatory decision-making also meant that those outside the agency—those affected by agency decisions—had to be given full opportunity to make their cases and share in seeking better solutions. Yet it remained clear that the final responsibility for decisions rested with the appointed officials who were sworn to uphold the law.

The second change in the way EPA did its business was to put science and values in their proper places. Science had to be protected from external influence, but at the same time, final decisions based on that science had to reflect the law, economic and social consequences, and public opinion.

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Turning from process to the goals of action, a third change shifted the agency away from a focus on the potential causes of harm—for example, the existence of a hazardous chemical—to the endpoint that might bear that harm, for example, human health or an ecological system. That is, action had to be focused on the risk, the

harm that a chemical would pose if it were found in the environment at predicted concentrations. The simple fact was that science had achieved the ability to identify an almost unlimited number of hazards, but as a society we could not "zap every molecule." Hence, once the risk was identified, values had to come into play in deciding what to do about it—given the law, the social and economic consequences, and public opinion—while also considering the other environmental and health risks that might result from taking a particular action.

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The paradigm for achieving this end was known as "risk assessment/risk management." Good independent science and analysis were used to identify and, if possible, to quantify the potential harm, and then—and only then—would values come into play in deciding which action to take to reach a balanced solution in the public interest. Ruckelshaus brought this paradigm to EPA and based it on the conclusions of a seminal National Research Council report[2] that to this day provides the intellectual basis for modern environmental protection, not only in this country but also in much of the world. This is one of the enduring implementation legacies of this era at EPA.

Implementation Outcomes

So how did all this play out with respect to clean air? Consider some of the key decisions of that era.

EPA concluded that acid rain was a serious but geographically limited problem that harmed forests and lakes and the fish and other biota within them. It further concluded, however, that effective action was beyond its capability and legislative mandate and hence required congressional action—in part because the economic consequences were significant. That action finally occurred in 1990 when Congress passed that year's amendments to the Clean Air Act. Those amendments incorporated the efficient emissions-market approach used previously by EPA in the early stages of eliminating lead in gasoline.

As to lead in gasoline, once additional health-effects data came to light, I pulled a tiny group of scientists and economists into my office, put them into emergency mode, and offered them an unlimited budget. Within a few months, this talented and dedicated group produced the compelling analysis that showed lead in gasoline caused serious, long-term, widespread harm. Most important, millions of American children were suffering IQ losses and learning disabilities because of it.

Further, we found that eliminating lead would actually save billions of dollars per year in the long run. To accomplish the removal of lead, we fashioned the first major emissions cap–banking program for the transition, which eliminated lead faster and saved the country from the economic trauma of a short-term massive disruption in gasoline supplies. That analysis led to one of the fastest-acting major regulations in EPA history, and lead was removed. I am proud to say that, following the EPA model and using our analysis, most of the countries of the world soon followed suit, with global consequences for children's health.

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On another air issue, using the risk-assessment/risk-management paradigm, EPA identified the most harmful toxic emissions from industrial processes. The problem was that often the sources were ubiquitous—some tiny, others large, some cheap to control, and others incalculably expensive. To make the air safe, EPA developed the

Finally, on global climate change, EPA issued the first official government report cautioning about its effects on sea-level rise. This report, produced by my staff, galvanized attention when it hit the front page of *The New York Times*.

"bubble" policy that allowed firms whose emissions could not be controlled (except perhaps at ruinous expense) to pay part of the tab for additional controls at other firms where control was cheaper. This approach resulted in bringing the air in an airshed to safe levels at minimum cost. Not only did this approach achieve environmental results and save money, it also allowed the environment to be cleaned up faster because it lessened the political and legal resistance of industry—no longer were companies faced with intolerably expensive and disruptive regulations.

Finally, on global climate change, EPA issued the first official government report cautioning about its effects on sea-level rise. This report, produced by my staff, galvanized attention when it hit the front page of *The New York Times*. And by the way, it earned me a midnight phone call from a hostile senior administration official who was tipped off about the story before it appeared.

As these actions attest, EPA under Ruckelshaus and his worthy successor, Lee M. Thomas, followed where the science, the analysis, and the law led, often in the face of strong opposition from within the administration, from sectoral interests in Congress, and from outside groups. The agency's mission in implementing the law was to protect health and the environment, do it as efficiently and cheaply as possible, and, in everything, speak frankly to and consult widely with the public whose environment it is and whose money would be used to make it better. This approach and the actions that implemented it did much to restore both the public confidence in EPA and the bipartisan consensus on the environment that marked its beginnings.

In this way, the vision of Senator Baker and Senator Muskie was implemented at two defining moments in environmental protection—at EPA's chaotic, "bulldozer" beginning and at the critical transition to the "shovels and scalpels" stage at the middle of its history, which now spans more than three decades. Their broader hope that there would be progress in cleaning America's air was achieved.

Now there are new challenges facing those charged with providing this nation with "the safest, healthiest, most ecologically secure environment that the American people are willing to pay for." And there is work enough for those who would follow in these footsteps.

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Milton Russell is a senior fellow of the Joint Institute for Energy and Environment, a consortium comprising the University of Tennessee (UT), the Tennessee Valley Authority, and Oak Ridge National Laboratory. He is also a professor emeritus of UT Knoxville's economics department. Before coming to Tennessee in 1987, Russell served as an assistant administrator of the U.S. Environmental Protection Agency, directing its policy, planning, regulatory development, and evaluation functions. At EPA, Russell was charged with helping to develop systems and procedures for implementing the risk-based approach to environmental management.

Notes

[1]Ruckelshaus fulfilled that hope, both in terms of the environmental results he achieved at EPA and in terms of the absolute integrity that he brought to public service. He exemplified the latter when, as deputy attorney general, he resigned on the spot when ordered by President Nixon to fire the Watergate special counsel—part of a series of events known forever as the "Midnight Massacre." Ruckelshaus's adherence to his principles marked a critical turning part in that sad affair.

[2]Committee on the Institutional Means for Assessment of Risks to Public Health, National Research Council, *Risk Assessment in the Federal Government: Managing the Process* (Washington, D.C.: National Academy Press, 1983).

Great Smoky Mountains National Park: A Regional Treasure Imperiled

By Dale Ditmanson and Jim Renfro

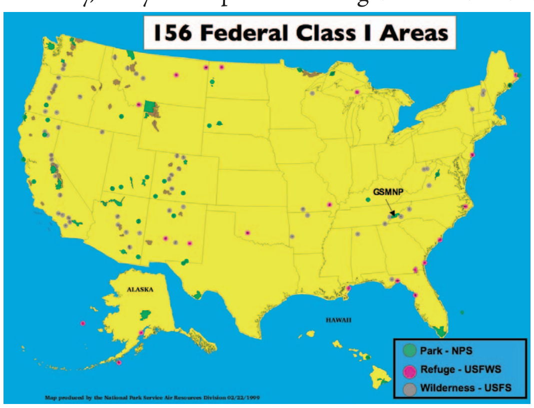
Dale Ditmanson

Jim Renfro

Great Smoky Mountains National Park (GSMNP) comprises a half-million acres straddling the border between Tennessee and North Carolina and provides protection for one of the largest natural areas in the East.

The park is an area of 16 mountain peaks more than 6,000 feet high. It is a place with lush forests and cool hemlock groves. It is a place of broad diversity of plant and animal life. The park contains 1,570 flowering plants—more than any other national park. It has more species of trees, 135, than in all of Northern Europe and contains half of the old-growth forests in the eastern United States.

Many, many more species are being discovered and identified as part of the first All-Taxa Biodiversity Inventory (ATBI) in the National Park system. So far, the ATBI has identified more than 3,000 species new to the park and over 500 species new to science.



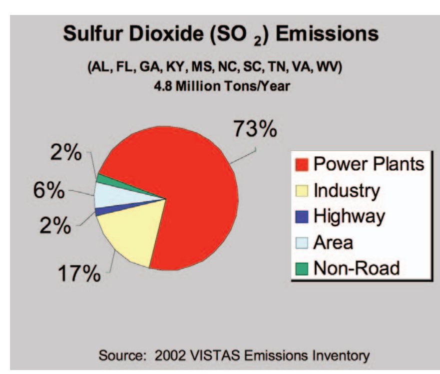
GSMNP is also a place of rich heritage. In fact, the park has the largest collection of log structures in the national park system and provides an abundance of recreational opportunities.

Our mission at Great Smoky Mountains National Park is overlaid by the Clean Air Act, which ties in very closely with the park's protection and preservation missions.

The Clean Air Act references "Class I" areas, which include Great Smoky Mountains National Park. The Class I designation provides us with the highest level of protection, it requires us to ensure that we are looking at all the resource values, and it reflects the idea that national parks should be among the cleanest areas in the United States. Nationwide, some 48 national park areas are among the 1,136 Class I areas.

The Value of Monitoring

Before we can be effective at protecting the park's resources, we must understand the condition of the park's natural systems, and we do that through monitoring. Indeed, monitoring remains the most important aspect of the air program at the park. We take 10 million measurements a year and try to make sense of those measurements, to translate them, to examine status and trends. We provide this information to people who can make decisions to further protect these resources. All negative environmental impacts associated with air pollution start with emissions. Thousands of substances are emitted, including sulfur dioxide (SO_2), when we burn things. The 10 Southeastern states emit about 5 million tons of SO_2 per ye ar. About 90 percent of that is from coal-fired power plants and industrial boilers. The Smokies have experienced a 50-percent reduction in sulfates over the last 25 years. This is great news, and it is directly related to the large reductions in emissions our utilities have achieved.



We have not done nearly as well at reducing another harmful primary emission, nitrogen oxides (NO_X). About 40 percent of the total nitrogen in the Smokies is from dripping cloud water. In proper amounts, nitrogen is good for a forest. In fact, we fertilize our gardens with it. But too much nitrogen can change the fertility of the soil and affect how things grow. A protective target load of nitrogen may be about 5 pounds per acre. Currently, the nitrogen load in the park is about seven

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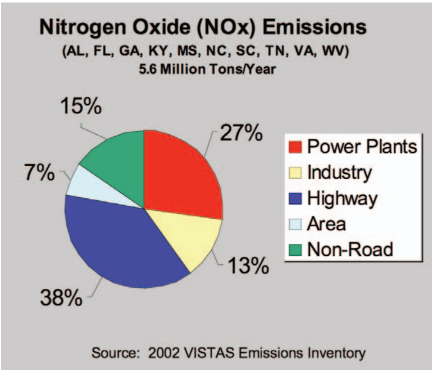

times greater than the optimum target load for preserving and protecting the high-elevation spruce-fir ecosystem.

The 10 Southern states emit about 5.5 million tons of NO_X. Power plants emit part of that amount, but the mobile sources, the on- and off-road sectors, contribute more than half. In fact, those sources account for about 60 percent of regional NO_X emissions.

The Effects of Deposition

The park's streams and soils are naturally acidic and thus unable to buffer acidic pollutants like SO_2 and NO_X in the air. Nitrogen is like a mineral magnet that pulls the calcium, magnesium, and potassium—essential nutrients for living things—out of the soil. GSMNP has the highest acid-rain levels in the country, and nitrogen transported by rain can lower a stream's pH very quickly. In fact, heavy rainfall can make a stream10 times more acidic in just a couple of hours.

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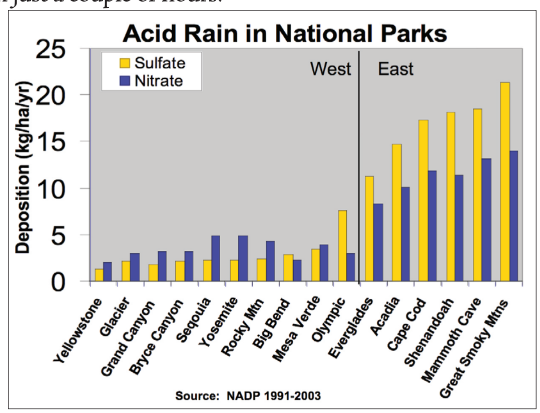
While nitrogen alters the soil chemistry and makes necessary soil nutrients unavailable to plants, it also frees up aluminum, which is already present and available in the soil. Excess nitrogen and the attendant aluminum leak out of the soil into the streams, damaging aquatic life. Aluminum ends up on brook trout's gills, for example, harming the fish. As the nitrogen saturation moves down the elevations, our brook trout habitat is shrinking.



From Primary to Secondary Pollutants

In many cases, the primary emissions don't directly cause the problem—the problem is what the primary emissions turn into. They condense to form particles, and they transform in the atmosphere into secondary pollutants that cause impacts to resources and public health. Among these secondary pollutants is ozone, which we know affects public health and plant life.

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In this region, we have a lot of sunlight, which frequently brings high-pressure sunny days. But these same conditions can cause the air to stagnate, which can increase the concentration of pollutants. Furthermore, sunlight and heat increase the chemical reactivity of these pollutants.

On the other hand, the winds and clouds associated with the park's elevated topography are mechanisms that actually deliver more NO_X pollution to the park, where organic emissions from trees then react with not-so-natural emissions of NO_X to create ground-level ozone.

"Bad-Air Days"

Ground-level ozone pollution is the invisible, poisonous form of oxygen. The ozone molecule has three atoms of oxygen instead of two, and it affects the health of plants and animals. That same pollutant that gets into our lungs can also get into plant leaves and disrupt photosynthesis. It can stress the plant and hamper healthy growth. Ozone can actually cause visible injury to plants, and some 30 plant species in the park are showing visible effects of ozone exposure.

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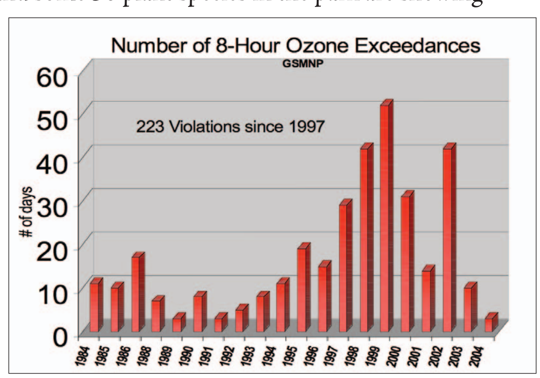
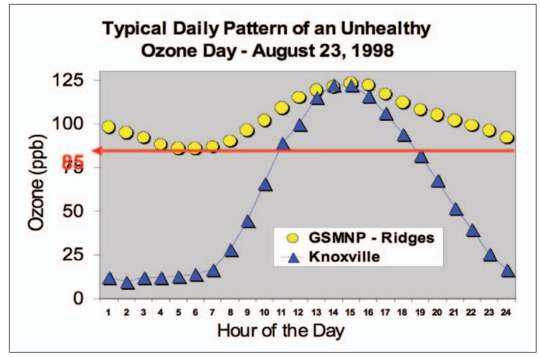
If you look at the number of bad-air days, or the number of times ozone measurements exceeded the 8-hour standard in the Great Smokies, you see a wide range. Some years we have more than 50 bad-air days, but we've averaged about 30 per year for the past 10 years. Last year was the cleanest year on record since the early 1980s, with just 3 bad-air days.



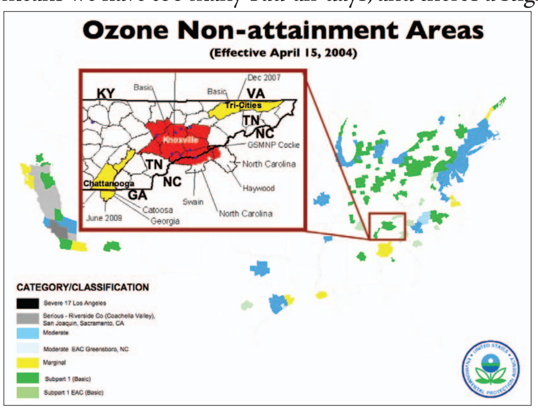
Because emissions are the number-one factor in creating these days, as emissions decline, air quality improves and the number of bad-air days decreases. Since the 1990s, ozone levels have come down overall, but ozone affects some areas more than others. We see a different pattern of ozone on our ridge tops throughout the eastern United States, for instance, as compared with most low-elevation areas. The ozone pattern typical of ridges in the park measures an average exposure two times higher than that in a nearby city like Knoxville, largely because of the way ozone cycles at different elevations.

When ozone concentrations exceed the standards for good health, whether we're on a ridge top or in the city, we're breathing the same bad air in the middle of the day. But at night, when ozone levels come back down in the city, they remain high at higher elevations in the park.



The ozone pattern typical of ridges in the park measures an average exposure two times higher than that in a nearby city like Knoxville, largely because of the way ozone cycles at different elevations.

A "non-attainment" designation means that we're exceeding the ozone standards established by the EPA. It means we have too many bad-air days, and there's a stigma associated with that. People may not want to visit or live here, which will have significant negative economic impacts. Failure to reach the EPA standards has other negative economic impacts, as well: it is more difficult to permit a new industry in the region, and it can restrict access to federal highway funds. We have three non-attainment areas in East Tennessee; in fact, Great Smoky Mountains National Park is itself a non-attainment area.



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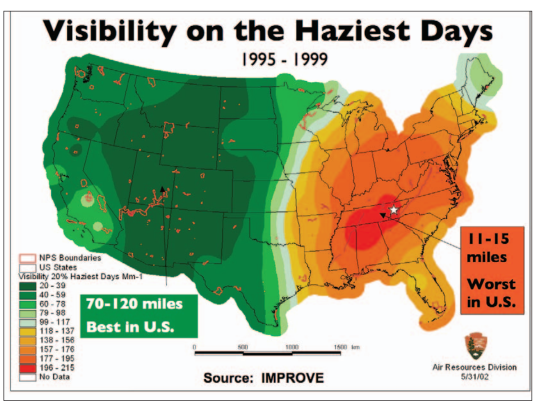
What can individuals do to help reduce ozone pollution when forecasters predict a bad-air day? For one thing, we can drive less, we can conserve electricity, we can walk rather than drive to a restaurant for lunch, and we can set our thermostats 1 degree higher in the summer. All those things will help reduce emissions.

The Effects of Visible Haze



Another important area of concern is impaired visibility and the haze that causes it. Essentially, haze is composed of small airborne particles and gases that scatter or absorb light. The same particles that cause the acid rain cause the regional haze, though some natural factors—water and humidity—also contribute.

The nation's haziest areas are in the Southeast, where visibility can be limited to 11 to 15 miles. Natural summer visibility for the park is about 77 miles, but our current average is about 15 miles.

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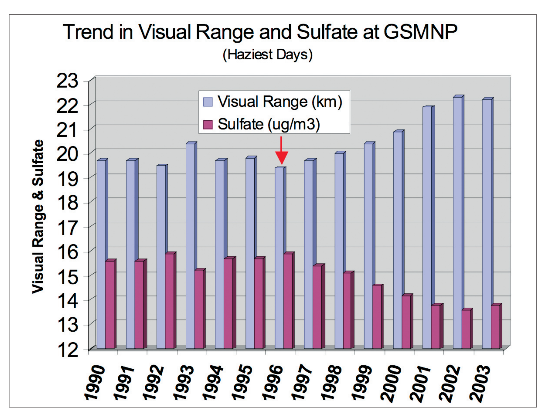
In addition to taking photos that indicate visibility, we use pumps and filters to vacuum the air. By weighing and examining the filters before and after use, we can find out the quantity and composition of the particles in the air. From there, we calculate how this mixture affects visibility. Sulfates account for more than three-fourths of the haze on our haziest days. Organic carbon represents another big piece of the haze-producing pie. Wind-blown soil and dust and nitrates are much smaller components of the haze.



Reducing SO_2 is one of the most effective things we can do to improve visibility and reduce acid rain. Over a 10-year period, a group called the Southern Appalachian Mountains Initiative (SAMI) conducted an assessment that determined that 82 percent of the sulfate measured at the park comes from the Southeast region. We

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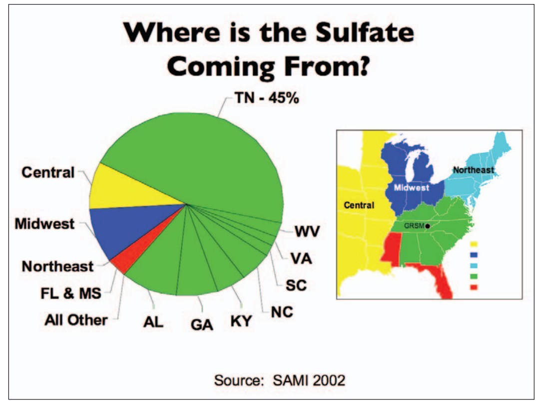
also get sulfate from the central states—from the Midwest—so pollution does travel hundreds of miles to reach our region.

Fine particulate matter 2.5 ($PM_{2.5}$) is about the size of a grain of flour. $PM_{2.5}$ causes health impacts and contributes to visible haze. Nationally, $PM_{2.5}$ levels are down 10 percent. In the Southeast, they're down 25 percent, and they're down about 40 percent in the Smokies, so that means air that is clearer and more healthful.



Concerted Effort

We at GSMNP, with the help of such partners as the Friends of Great Smoky Mountains National Park and the Tennessee Valley Authority, are doing our utmost to understand and address air-quality problems that affect the park and the region. We have ongoing research and education projects that involve college students, as well as K-through-12 pupils. We're continuing to build strong relationships with our surrounding counties and the region as a whole. We're using electric and hybrid vehicles, and we're working with neighboring communities.

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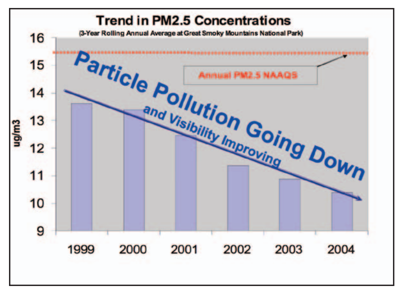

The Organic Act of the National Park Service talks about our responsibility in protecting the park's natural and cultural resources, leaving them unimpaired for future generations. That is the overall mission of the National Park Service, and bolstered by the provisions of the Clean Air Act, we will do our utmost to fulfill that mission.

Great Smoky Mountains National Park is perhaps this region's most valuable natural, cultural, and recreational resource, and the millions of visitors who arrive here each year deserve our assurance that it will remain so for generations to come.

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Dale Ditmanson became superintendent of Great Smoky Mountains National Park in 2004. Ditmanson's first National Park Service assignment was at Fort Sumter National Monument in Charleston, South Carolina. Ditmanson later served as superintendent of Florissant Fossil Beds National Monument in Colorado and as assistant superintendent of Glen Canyon National Recreation Area and Rainbow Bridge National Monument in Arizona and Utah. As the associate regional director, he was in charge of all park operations in the northeastern United States.

James R. (Jim) Renfro is an air-resource specialist and the chief of the Air Quality Branch at Great Smoky Mountains National Park. Renfro joined the Smokies staff in 1984 and is currently responsible for managing the largest air program in the national park system and one of the most intensely studied areas in the United States. Renfro's duties include coordinating air-resources management operations and activities at seven air-quality monitoring and research stations, which take more than 10 million measurements annually.

Working Together to Achieve Cleaner Air for Tennessee

By Betsy Child

Tennessee's Department of Environment and Conservation (TDEC) is responsible for all of the state's environmental programs, including those resulting from passage of the Clean Air Act.

EPA is responsible for setting the air-quality standards and making the designations on attainment or non-attainment of environmental goals. The state's role is to develop and implement a plan to meet those federal standards. It's also our role to monitor air quality within the state. Tennessee's Department of Environment and Conservation (TDEC) is responsible for all of the state's environmental programs, including those resulting from passage of the Clean Air Act.

The Governor's Priorities

In late January 2005, Governor Bredesen outlined his investments in fundamentals for the future: education—including pre-K, K-through-12, and higher education; job creation; and the environment. Protecting the natural resources of the most bio-diverse of the nation's non-coastal states presents considerable responsibility.

As a reflection of his commitment to the state's environment, the governor included in our budget a $10-million initial investment in the Tennessee Heritage Conservation Trust Fund that we hope will leverage considerable public and private donations to approach conservation in a strategic way across Tennessee.

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Under land conservation, the Cumberland Plateau, whose beautifully rugged topography lies between Nashville and Knoxville, is the top priority for the state because of its unique assets and the short time that remains to protect its natural features from imminent threats.

A Case for Environmental Education

Early in 2005, I presented a budget of $323 million for TDEC to the ways and means committee of the state's House of Representatives. We currently spend less than one-tenth of 1 percent of our budget on environmental outreach and education, but that's an allocation we're hoping to change. We now realize that we have to place more emphasis on front-end education in order to prevent damage to the environment, and that effort is going to require many partners.

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We don't want to duplicate any efforts being made at the University of Tennessee or by a number of environmental advocacy groups, among them Keep America Beautiful. But we do recognize that our office needs to play a leading role in educating consumers on how their actions can affect the health of the state's environment. As part of this effort, last year we funded a full-time position in the Department of Education to develop and support a statewide environmental curriculum for K-through-12 students.

This educational effort, like all efforts aimed at improving environmental conditions, including air quality, must be based on sound science. TDEC contributes to that battery of both sound science and reliable evidence by the range of monitoring and evaluation it conducts for water-, air-, and land-related activities.

There are areas within the state that are not meeting the new, stricter 8-hour ozone standards put in place by EPA on April 15, 2004. Areas facing potential non-attainment drafted Early Action Compact agreements that outline control measures and actions they would take to achieve cleaner air.

Just in the area of air quality, TDEC's monitoring provides essential ambient air-quality data on both current and historical conditions. These monitors measure our progress in controlling the target emissions established by the Clean Air Act.

In executing its mandate to assess air quality throughout the state, TDEC has 23 monitors in place. Those monitors provide information to the media on forecasts for ozone and particulate matter. We also provide this information to EPA.

Critical air issues—ozone, small particulate matter ($PM_{2.5}$), and regional haze—present serious health consequences, even with the improvements we've made. ($PM_{2.5}$ refers to airborne particles measuring 2.5 microns in diameter or less.)

There are areas within the state that are not meeting the new, stricter 8-hour ozone standards put in place by EPA on April 15, 2004. Areas facing potential non-attainment drafted Early Action Compact agreements that outline control measures and actions they would take to achieve cleaner air. Some areas in Tennessee had action plans approved by EPA. These areas were given deferrals against the potential burden of restrictions on economic development and loss of control over their federal highway funds.

The areas whose action plans were not approved by EPA face potential restrictions on certain road projects and possible limits regarding the location of new industries or expansion of existing ones.

NO_X and VOCs

You've heard a good bit about nitrogen oxides (NO_X) and volatile organic compounds (VOCs)—the key precursor chemicals that form ground-level ozone. On-road vehicles (diesel trucks, cars, etc.) and off-road vehicles (heavy equipment) are our biggest troublemakers when it comes to the production of NO_X, accounting for 36.8 percent and 24.2 percent, respectively, of NO_X emissions statewide.

We also have tracked the cost and the amount of time it takes for a vehicle to undergo an [emissions] inspection. Inspection costs $10 and takes 10 minutes, but the program removes an average of 3,700 tons of ozone-forming pollutants and 40,000 tons of carbon monoxide from the air per year.

To address these pollutants, Middle Tennessee has had a car inspection and maintenance program in place for almost 10 years. We have been carefully monitoring this program over the past 8 years, and we can give you the scientific model that estimates the amount of reduced pollutants in these counties due to vehicle emission testing. We also have tracked the cost and the amount of time it takes for a vehicle to undergo an inspection. Inspection costs $10 and takes 10 minutes, but the program removes an average of 3,700 tons of ozone-forming pollutants and 40,000 tons of carbon monoxide from the air per year.

Vehicle inspection and maintenance testing is one of the reasons the Middle Tennessee area and Chattanooga were able to get an Early Action Compact deferral from EPA and not face immediate restrictions on transportation projects and industrial development.

Had it not been for the aggressive local control measures in its Early Action Compact plan, the Hamilton County–Chattanooga area might have faced EPA non-attainment restrictions. The city and county prohibited open burning, instituted a vehicle inspection and maintenance program, and reduced speed limits to 55 miles per hour. With this aggressive action plan in hand, the city and county mayors appealed directly to EPA. With the implementation of these local air-quality initiatives, EPA approved Hamilton County–Chattanooga's appeal and granted a deferral.

Private-Sector Initiatives

Several private-sector companies are also making an important contribution to improved air quality in Tennessee.

Several private-sector companies are also making an important contribution to improved air quality in Tennessee. Delta Faucet in Jackson is replacing some of the solvents used in its degreasing processes with less-harmful substitutes. Knoxville-based Brunswick Boats, one of the world's largest producers of pleasure boats, has adopted a closed-mold process that is reducing VOC emissions by almost 90 percent. Alcoa Aluminum and Eastman Chemical have begun to use biodiesel fuel in some of their fleets.

In East Tennessee, IdleAire has created technological facilities that provide air-conditioning and heating, Internet access, and other services to parked trucks so the drivers don't have the idle their diesel engines for prolonged periods. The wonderful interstates we have in Tennessee are both a blessing and a curse. Indeed, the roads facilitate efficient transportation and make Tennessee a natural logistical hub. But the heavy-duty diesel engines of 18-wheelers rolling

The wonderful interstates we have in Tennessee are both a blessing and a curse. Indeed, the roads facilitate efficient transportation and make Tennessee a natural logistical hub. But the heavy-duty diesel engines of 18-wheelers rolling into and through our communities contribute significantly to the ozone problem. Knox County has spent $2 million of its federal congestion-mitigation funds to help locate IdleAire facilities in East Tennessee.

Individuals across the state are also doing their part. Many of the state's residents are practicing trip reduction, that is, consolidating several errands into one trip, and buying green power where it's available. Meanwhile, more and more of the state's residents are driving hybrid vehicles.

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Individuals across the state are also doing their part. Many of the state's residents are practicing trip reduction, that is, consolidating several errands into one trip, and buying green power where it's available. Meanwhile, more and more of the state's residents are driving hybrid vehicles. For the Toyota Prius to be named car of the year in 2004—and not by some tree-hugger organization but by *Motor Trend* magazine—is very encouraging. The fact that all the major auto manufacturers are integrating at least one hybrid model into their portfolios is a sign that we are moving the right direction. The state is considering more hybrid vehicles for its fleet.

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We are also making great strides in public transportation. All vehicles in Knoxville Area Transit's (KAT) fleet now operate on some form of alternative fuel. Eighteen KAT buses operate on propane, four trolleys are powered by hybrid electric/propane engines, and the rest of the fleet is using biodiesel fuel. Four of KAT's staff cars are hybrid electric/gasoline.

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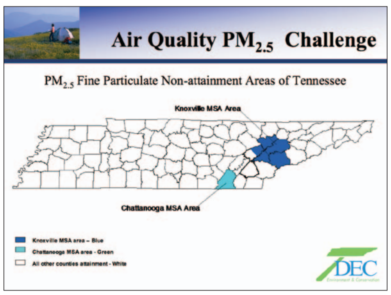
The East Tennessee Clean Fuels Coalition is doing a terrific job of making alternative fuels available in the East Tennessee area. The City of Chattanooga is the first metropolitan area to completely transition its fleet to biodiesel. At the state level, we will soon be purchasing green power for parks in areas where it is available.

Particulate Matter ($PM_{2.5}$)

Though we're making measurable strides in controlling air pollution, $PM_{2.5}$ remains a challenge for the state. Hamilton County–Chattanooga and Knox County were the only two counties in the state measuring non-attainment for $PM_{2.5}$ target goals, but several surrounding counties were included by EPA in the non-attainment designation as well because the agency felt that these counties were contributing to the metro areas' non-attainment status. EPA identified Anderson, Blount, Hamilton, Knox, and Loudon counties as $PM_{2.5}$ non-attainment areas in their final designations.



Tennessee, like the rest of the nation, has made significant strides in reducing harmful air pollution as a direct result of the passage of the Clean Air Act. But the state's efforts can succeed only if they're integrated into a larger comprehensive plan that engages all Americans. Indeed, the bottom line for all entities—local, state, federal, and personal—is that we all have to take an aggressive stand in addressing air-quality issues.

Moving forward, TDEC is determined to take the lead in ensuring the health and prosperity of the Tennessee's residents while protecting the state's wealth of natural resources.

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Betsy Child served as commissioner of the Tennessee Department of Environment and Conservation (TDEC) from January 2003 to April 2005. Child has held senior executive positions in the healthcare industry, the electric utility industry, in public policy formulation, and in local government. She also spent 14 years in teaching and administrative positions in higher education.

Science and Clean Air: A National Perspective

By Paul Gilman

Paul Gilman

We in the United States have made significant progress in reducing harmful airborne pollutants since passage of the Clean Air Act, even as we have experienced sector growth that might once have significantly compromised air quality.

Since 1970 we have achieved a 25-percent reduction of the six major pollutants that are regulated by the Clean Air Act. And it's worth noting that emissions of air toxics were reduced between 1990 and 1996 by about 24 percent, so clearly the pace of progress has accelerated over time. During the same period, gross domestic product has increased 161 percent, while vehicle-miles traveled has risen 149 percent. Energy consumption has increased 42 percent, while the population of the United States has grown by 39 percent.

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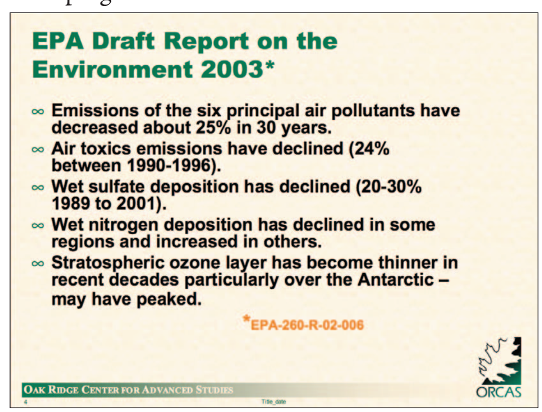
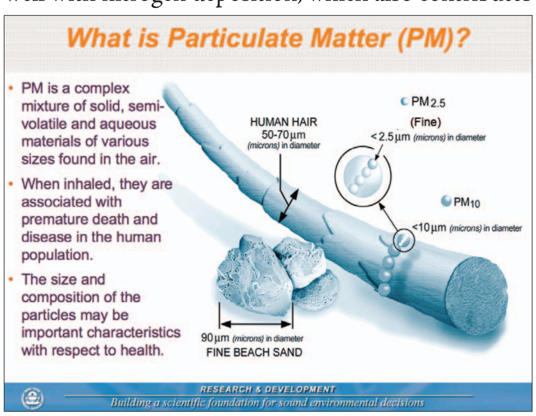


In terms of specific pollutants, wet sulfate deposition, one of the pollutants that contribute to acid rain, has declined by about 30 percent since 1989, though the precise level of decline varies from the Northeast to the mid-Atlantic regions.

While we've made strides in controlling sulfate deposition, we haven't done as well with nitrogen deposition, which also contributes to acid rain. In some places nitrogen levels have stayed constant, in some places they have declined, but, notably, in other places they have increased. Meanwhile, stratospheric ozone levels appear to have leveled off rather than continuing to decline.



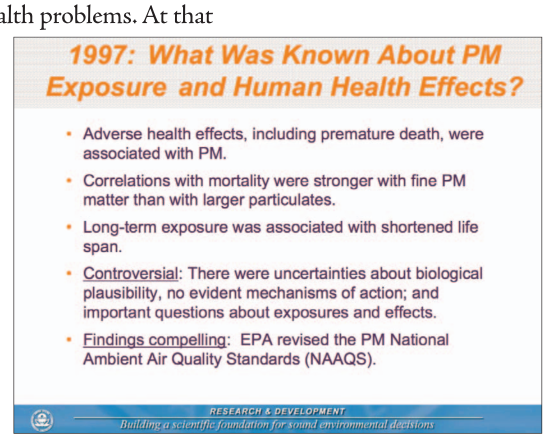
Particulate Matter

In 1997 there was a substantial debate over whether or not particulate matter in general posed a serious health concern and, if so, what specific types of particulate matter were associated with health problems. At that time, the focus turned to even finer particles than we had previously regulated under the Clean Air Act—the so-called $PM_{2.5}$, which refers to particulates measuring 2.5 microns or less in diameter.

In 1997 epidemiologists could tease out some apparent links between exposure to particulate matter and health consequences, and some of these patterns were striking.

Particulate matter is derived from natural sources (for example, dust and forest fires) but also from human activities and devices (internal-combustion engines and power plants, for instance).

In 1997 epidemiologists could tease out some apparent links between exposure to particulate matter and health consequences, and some of these patterns were striking. Premature deaths were associated with exposure to high levels of particulate matter, and in some cases, the deaths followed only days after exposure. There were longer-term correlations, as well, between particulate matter exposure and decreased life span.

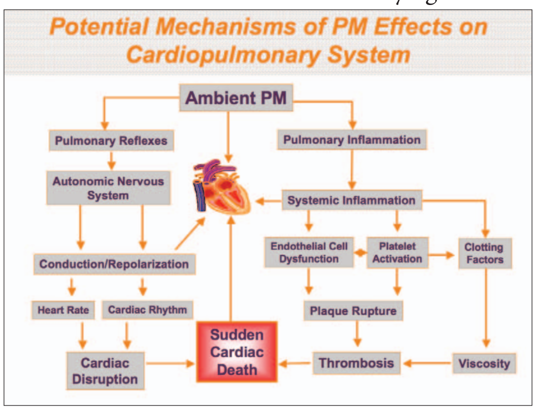


At the time, we thought that seniors were the most vulnerable population, but we've since learned that people with compromised pulmonary systems are also susceptible to the effects of particulate matter.

Though the data showed a statistical relationship between exposure to particulate matter and health effects, biologists were not sure how the components of particulate matter were affecting both short-term mortality and long-term declines in longevity. Furthermore, there were real questions about whether or not the measurements at air monitors had any real relevance to us in our daily lives, since so much of our lives are spent indoors.

Mechanism of Harm

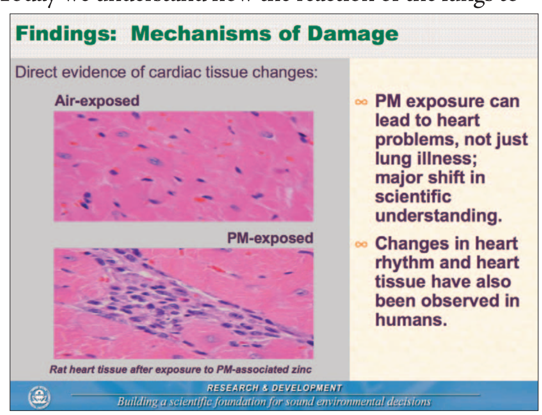
Faced with these issues, the U.S. Environmental Protection Agency, universities, and private organizations set out on a 5-year research program with advice on research strategy from the National Academy of Sciences. Now, 5 years later, we have identified plausible biological mechanisms. But some questions remain regarding the underlying mechanism of harm, among them, who is most susceptible to this particulate matter and why?



At the time, we thought that seniors were the most vulnerable population, but we've since learned that people with compromised pulmonary systems are also susceptible to the effects of particulate matter. The restricted breathing spaces in unhealthy lungs actually concentrate the particulate matter at higher dose levels than in the healthy lung.

We've also learned that ambient-air-quality monitors provide very good measures of our exposure to particulate matter in our daily lives and that we can rely on the health patterns that we've established based on data from those monitors.

In 1997 we knew that, after exposure to elevated levels of particulate matter, people were dying of coronary-related disease within days of exposure, but we had no clear grasp of plausible mechanisms. Today we understand how the reaction of the lungs to particulate matter affects the nervous system in a way that leads to cardiac disruption.



We also understand how lung inflammation affects the plaque that builds up in one's coronary system. This buildup leads to changes in the viscosity of blood, which contributes to thrombosis and sudden cardiac death. From this research, another important question arose: Can we begin to attribute these health effects to a specific source of particulate matter? Is it internal-combustion engines? Is it power plants? We have made progress in answering these questions.

In 1997 we knew that, after exposure to elevated levels of particulate matter, people were dying of coronary-related disease within days of exposure, but we had no clear grasp of plausible mechanisms. Today we understand how the reaction of the lungs to particulate matter affects the nervous system in a way that leads to cardiac disruption.

Several monitoring sites around the country equipped with sophisticated instruments are beginning to produce some promising information. And this information may help guide our efforts to identify and regulate the most significant sources of particulate matter.

Focus on Mercury

One of the benefits of using technologies to reduce sulfur-nitrogen compounds is that the same technologies achieve a concomitant reduction in mercury. To achieve further reductions, however, we need to look for technologies that specifically target mercury.

Municipal incinerators and medical-waste incinerators were the major contributors [of mercury] in the past, but we've reduced emissions from these sources by more than 90 percent.

Today power plants are the major emitters of mercury compounds to the air, but this wasn't always the case. Municipal incinerators and medical-waste incinerators were the major contributors in the past, but we've reduced emissions from these sources by more than 90 percent. Many would argue that the same technologies that achieved those reductions could be applied to power plants, but there are obvious issues of scale that might make adapting these technologies difficult.

The good news regarding mercury is that we are making substantial progress in the development of control technologies. The Department of Energy has launched a demonstration program that offers much promise in developing those technologies, but we're not sure how soon they can be commercialized and deployed.

Substantial questions remain with regard to the regulation of mercury.

Substantial questions remain with regard to the regulation of mercury. One of them is the rate at which mercury in the environment is reduced as we reduce emissions from power plants. EPA modelers use an assumption that every 1 percent of mercury reduction achieved at the stack results in a 1-percent reduction in fish tissues in the environment over a 5-year period. Do we know that's the case? No. Could the response period be longer? Yes. It could be 10 years or 50 years, depending on the particular freshwater environment we're talking about. It could be a shorter period, as well.

Among the unknowns we face is the consumed amount of fish from affected waters. Indeed, can we, as we model the benefits of mercury reduction, say this level of reduction will have this specific consequence for this fish population, which is consumed by this group of people at this rate? No.

Probably half of the mercury exposure affecting people in the United States comes from consumption of tuna. This reality should prompt us to ask ourselves how well we understand how mercury cycles out of our power plants into the deep sea and ultimately into wild tuna.

If we have a poor understanding of the freshwater environments of the continental United States, we have a far poorer understanding of how mercury cycles into the ocean-caught tuna fish we consume. At the Oak Ridge Center for Advanced Studies, our hope for the future is to bring policy-makers and researchers together, shoulder to shoulder, to provide the answers that will allow us regulate in this arena in a smart and efficient way.

There is no doubt that Americans are breathing much cleaner air today than they were in the years before passage of the Clean Air Act of 1970. To a large extent, science has guided our efforts to identify the sources of the major pollutants and to understand how, precisely, these pollutants affect health and longevity.

Our rapid progress in addressing air-quality issues and our increasing knowledge base should in no way incline us to slacken the pace of investigation. As long as there are measurable negative effects—to humans as well as to myriad natural systems—associated with exposure to airborne pollutants, the important work of scientists and policy-makers must continue apace.

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Paul Gilman assumed the position of founding director of the Oak Ridge Center for Advanced Studies (ORCAS) in 2004. ORCAS is a consortium comprising research universities and government, industry, and non-governmental organizations. In 2001 Gilman was nominated by President Bush to serve as the assistant administrator for the Environmental Protection Agency's Office of Research and Development. Before joining EPA, Gilman served as director of policy planning for Celera Genomics in Rockville, Maryland, a bioinformation and drug-discovery company known for having decoded the human genome. Gilman has also held posts with the National Academy of Sciences and the National Academy of Engineering, as well as with the Office of Management and Budget for Natural Resources, Energy, and Science.

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It's a Question of Balance: Moving Forward on Clean Air

By Bill Baxter

Attempting to make environmental policy without appreciating these larger perspectives is likely to lead to wrong conclusions and to undue expense for taxpayers and ratepayers, and such policy would yield only partially effective remedies.


Bill Baxter

The Clean Air Act, which has been the law now for 35 years, is a success. To accurately assess and fully appreciate where we are regarding environmental progress, we must see our situation in the context of a longer time span, as well as in the context of other major trends that influence our environmental progress. Attempting to make environmental policy without appreciating these larger perspectives is likely to lead to wrong conclusions and to undue expense for taxpayers and ratepayers, and such policy would yield only partially effective remedies.

My goal is to help us appreciate where we have come from, where we are today, and where we are headed—to see the long view, both retrospectively and prospectively. I also want to put our environmental progress in the larger context of our progress in energy and our economy.

Because our energy sources, our environmental conditions, and our economic opportunities are inextricably linked and mutually dependent, we must examine our environmental progress in the context of these three elements. In short, energy, environment, and economy are like the three legs of a stool: if you take one of those legs away, the stool falls over. And I'd like us to keep that stool analogy in mind as we go forward in talking about interrelated policies.

In short, energy, environment, and economy are like the three legs of a stool: if you take one of those legs away, the stool falls over.

Since the 1970s the air in our country, including the Tennessee Valley, has gotten significantly cleaner. At the same time, and perhaps even more important, during these same 35 years, our country has developed new sources of low-cost, more environmentally benign energy.

In 1975, we were more dependent on fossil fuels being burned at power plants that lacked environmental controls. Back then, zero-emissions sources of energy were less understood and used less than they are today. Nuclear energy now represents about 20 percent of our nation's electric power, and at TVA that number is 30 percent and growing. In 2007 TVA will start the first new nuclear generator of the 21st century in America at Brown's Ferry Unit 1 in northern Alabama, bringing on an additional 1,250 megawatts of zero-emission low-cost electricity for the valley—enough energy to power another Chattanooga.

Growth of Zero-Emission Sources

Our nuclear power together with our hydroelectric, wind, solar, and other renewable energy technologies now compose 40 percent of all of TVA's power. So 40 percent of all TVA's power is produced with zero air emissions. And this is 40 percent of a much larger overall amount of supplied power. Today in the valley, for example, we are using 56 percent more power than we used in the '70s. Our economy in this region has paced the nation in growth. And cleaner, more affordable electric power has helped make that economic growth possible. We're now also seeing full-scale pilot commercial plants for clean-coal technologies.

Our nuclear power together with our hydroelectric, wind, solar, and other renewable energy technologies now compose 40 percent of all of TVA's power. So 40 percent of all TVA's power is produced with zero air emissions.

So while our energy sources today are cleaner than they were in the 1970s, our mix of energy sources is far superior. But there's even better news: While we've been making great progress in the quality of the air and positively diversifying our energy sources, we've done so in a fashion that has also continued the growth of our economy.

One of the most important things TVA can do is to continue to provide dependable, affordable electric power. The power produced by TVA today is actually less expensive, adjusted for inflation, than it was in the 1970s.

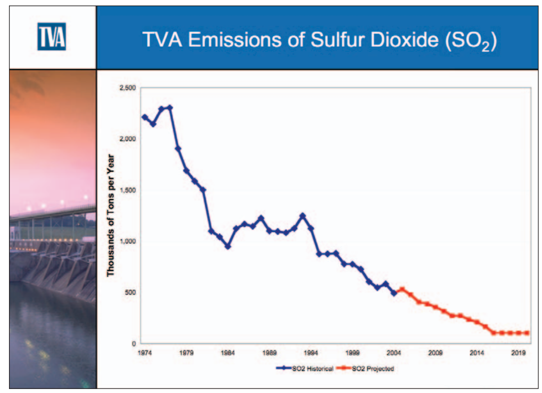
We cannot have true economic prosperity for long if we're fouling our nest. And we cannot constrict the ample supply of low-cost energy that is necessary to drive our economy. Conversely, we cannot continue to make progress on cleaning our environment if we cripple our economic strength or ignore our energy security.

A brief survey of the countries of the world teaches us that nothing promotes pollution like poverty. The essential wherewithal for improving the environment is economic strength. For that reason, it is an essential part of our environmental strategy that America remain competitive in the global market.

Since passage of the Clean Air Act, total emissions of the six principal pollutants identified in the bill have dropped by more than half.

Gains in Principal Pollutants

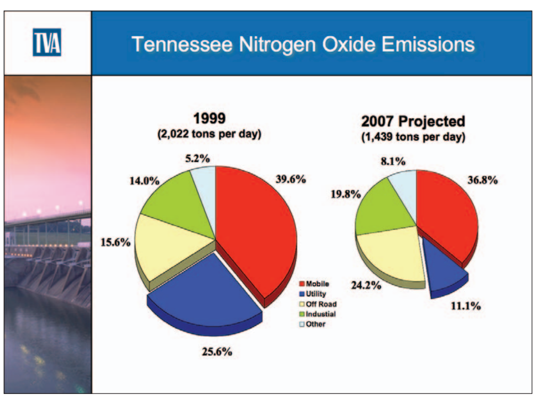
Since passage of the Clean Air Act, total emissions of the six principal pollutants identified in the bill have dropped by more than half. And during this same period, gross domestic product is up dramatically, as are vehicle-miles traveled and energy consumed. The U.S. population has grown by 39 percent, average family incomes have increased by 50 percent, and we're living longer. TVA's emissions are at the lowest level in 30 years, and the air in the valley has never been cleaner in our lifetimes.



Sulfur dioxide (SO_2) was identified very early as a contributor to acid rain. This pollutant is emitted from all coal-fired power plants, and it's got to be reduced. TVA has reduced SO_2 emissions at its coal-fired plants by 78 percent since the 1970s. To achieve these dramatic improvements, TVA has spent $1.5 billion of the ratepayers' money. We've installed six flue-gas desulphurization systems, commonly referred to as scrubbers. We've switched to low-sulfur coal at many plants, and we're not yet finished. Between now and the end of this decade, TVA will spend another $1.2 billion of the ratepayers' money to install four more scrubbers and achieve an 85-percent reduction in SO_2 emissions.

In 1980 there were seven SO_2 non-attainment areas in the Tennessee Valley. Today, there are none.

Ozone is caused by the combination of nitrogen oxide—which comes from coal plants, vehicles, and other sources—volatile organic compounds (VOCs), and sunlight. All three must be present to create ozone. As we move forward with our program at TVA, the utilities' portion of the sources of nitrogen oxide will be 11 percent. In fact, we're already at the level that we set as a goal for 2005.



TVA has reduced nitrogen oxide emissions by 78 percent since passage of the Clean Air Act. To achieve these improvements, we've spent $1.4 billion on what are called selective catalytic reduction units (SCRs). We use low-NO_X burners and other technologies, and when we complete the program at the end of this decade, we will have spent another billion dollars on reducing nitrogen oxide by 85 percent.

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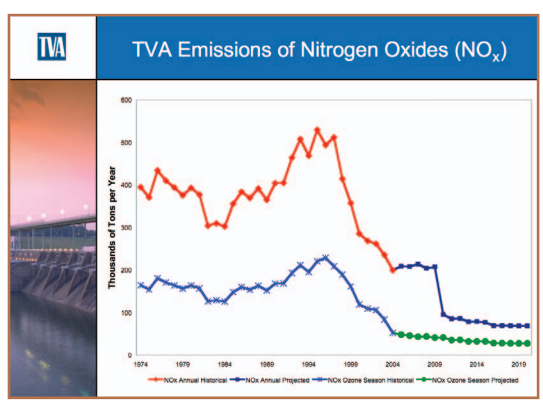
Tougher Ozone Standards

On April 15, 2004, EPA changed the rules on allowable ozone levels. Before that, all counties in the TVA region were in full compliance with EPA's ozone standards. With the implementation of the new standards, several counties in the region were reclassified as not attaining targeted ozone levels. Does this mean that the air became dirtier at the stroke of midnight on April 15? Of course not.



There are more than 3,000 counties in the United States, and as a result of the new tighter standard promulgated by EPA in April 2004, all or portions of 474—or about 15 percent—of the nation's 3,000-plus counties were in non-attainment status. Those counties are now examining what they need to do to achieve attainment of these new tougher standards.

During 2004, under the stricter standards, the state of Tennessee had 360 green (good) or yellow (moderate) days, according to EPA terminology. Four days were orange (unhealthy for sensitive groups) and one day was red (unhealthy).

Here in Tennessee, 18 out of 95 counties have been reclassified as non-attainment areas, and they have work to do in resolving that issue. For the most part, the counties that are in non-attainment status contend with a combination of emissions from coal-fired power plants and vehicles. During 2004, under the stricter standards, the state of Tennessee had 360 green (good) or yellow (moderate) days, according to EPA terminology. Four days were orange (unhealthy for sensitive groups) and one day was red (unhealthy). For Great Smoky Mountains National Park, 362 days were green or yellow; three days were orange. The Knoxville metropolitan statistical area experienced 364 good or moderate days, and one orange day.

It's important to note that we were lucky with the weather in 2004, but if air quality were a function of only the weather, I would feel bad about spending $5 billion of the ratepayers' money to reduce emissions. The 2004 ozone season was the only season in the last quarter-century during which no Tennessee monitoring stations exceeded the new ozone standard.

According to National Park Service data for 2004, Cades Cove did not exceed the ozone standard for a single day, nor did Clingman's Dome. There was only one day on which ozone standards were exceeded at Cove Mountain and two at Look Rock, and those measurements were only 1 part per billion above the standard at that time.

This is tremendous progress. To articulate these statistics another way, during 2004, 99 percent of the days in our area had good-to-moderate air quality.

Not only have we made dramatic progress in reducing SO_2, nitrogen oxide, and particulate matter, we've also improved our energy position and our economic prosperity during the same 35-year period, and all of the future trends project continued prosperity.

Targeting Particulate Matter

Particulate matter is a secondary pollutant, and TVA contributes to this through its emissions of nitrogen oxide and SO_2. Therefore, our efforts to reduce particulate matter have targeted reducing those two emissions, and we've achieved dramatic reductions as a result.

In 2004 every county in the Tennessee Valley was in full compliance with particulate matter regulations before December 18. On December 18, EPA—the Bush EPA—toughened the rules pertaining to *fine* particulate matter. The size of the particles we are talking about is about 1⁄30 of the diameter of the human hair. This is the third tightening of particulate-matter standards, and in my view, this offers proof that the Clean Air Act is working. It is a living document that adjusts over time and prods us to continue progress.

Because of the new rule, 225 of the 3,000-plus counties in America, a little less than 10 percent, will now need to adopt measures to bring themselves back into attainment status. If you retroactively apply the new particulate-matter standards back through all of 2004, 94 percent of the days in Tennessee were green or yellow, and 6 percent were orange. In Great Smoky Mountains National Park 97 percent of the days were green or yellow. And for Knoxville, 93 percent of the days were green or yellow.

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Misinformation and Mistaken Beliefs

So why, in spite of these facts demonstrating our progress, did two-thirds of surveyed Americans say they believe their air is dirtier today than it was in the past? I would suggest that this widely held—but erroneous—belief is rooted in the type of information that the public receives and how it receives it.

So why, in spite of these facts demonstrating our progress, did two-thirds of surveyed Americans say they believe their air is dirtier today than it was in the past?

Consider, for instance, that the air in the Smokies and in the Knox County area was monitored every single day in 2004. And for the first four months of 2004, there were no readings of unhealthy levels of ozone at any of the monitoring stations, but there was no mention of this in the media. Clean air is not big news. But then on April 15, EPA issued tougher standards for ozone.

Three weeks after those new standards were issued, a state meteorologist doing her job and relying on the computer models she had to use, predicted that the following day would show the first ozone exceedance in East Tennessee under the new standards. As soon as the prediction was issued, it became legitimate news, and the

Knoxville News Sentinel carried a front-page headline that read First Alert Issued on Air Quality. The sub-headline was Region on orange alert. Residents told to take precautions the next two days.

As it turned out, we didn't reach the predicted ozone level, and on the following two days, levels of ozone did not reach the unhealthy range. Despite this fact, there was no story to correct the previous day's front-page headline, and the public was left to believe that the air quality was so bad that they needed to take precautions to avoid being harmed. This was unfortunate, because it affected the way people think about the quality of their air.

In reality, had the orange-alert day actually materialized, it would have been potentially harmful only to sensitive individuals—those with asthma or an existing respiratory-health problem. These individuals should not exercise strenuously on an orange-alert day.

I use this local example to emphasize once again that it is critically important for us to be operating with all the facts, in a fair and accurate perspective, and not just with isolated events or facts selected out of context. Public policy based on misinformation or fear is not likely to achieve good results for the public. In fact, it usually leads to new government rules with huge costs and only partial effectiveness.

Public policy based on misinformation or fear is not likely to achieve good results for the public. In fact, it usually leads to new government rules with huge costs and only partial effectiveness.

Our air quality continues to get better, and EPA keeps tightening the standards periodically to increase health protection for sensitive individuals. Although some Tennessee counties now slightly exceed the new ozone standard and/or the new fine-particle standard on a few days, this does not mean every time we leave our homes to go to work, go boating on our lakes, or hike in our mountains that we are breathing unhealthful air. In fact, there are only a few days each year on which pollution levels are higher than the levels EPA has now identified as important to protect the most sensitive individuals, with an adequate margin of safety.

The Matter of Mercury

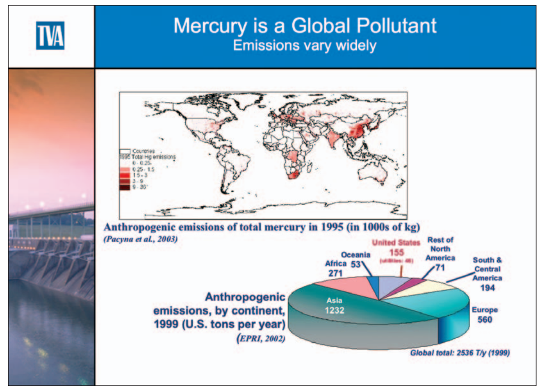
Currently the Clean Air Act does not regulate mercury emissions from coal-fired power plants, but there is discussion in Washington about changing that. If we want to solve the mercury problem, we first need to understand the causes and sources of the problem, and our assessment must be based on scientific fact. Specifically, EPA is about to issue new rules on mercury, and the U.S. Congress is currently discussing possible legislation to address mercury from U.S. coal-fired plants. But according to the Electric Power Research

If we want to solve the mercury problem, we must understand the causes and sources of the problem, and our assessment must be based on scientific fact.

Very few members of the American public are even aware that roughly 55 percent of all the mercury emitted into our environment is from natural sources. Roughly 45 percent of the mercury emitted into our environment does come from human activity, and the largest emitters are Asia, China, India, Europe, Africa, South America, and Central America.

Institute, U.S. coal-fired plants account for less than 1 percent of the annual worldwide emissions of mercury, and these emissions are continuing to decline to even smaller levels as we reduce sulfur dioxide and nitrogen oxide.

If we're serious about reducing mercury emissions, the sources of the other 99 percent of the world's mercury emissions need to be addressed, as well. Very few members of the American public are even aware that roughly 55 percent of all the mercury emitted into our environment is from natural sources. Roughly 45 percent of the mercury emitted into our environment does come from human activity, and the largest emitters are Asia, China, India, Europe, Africa, South America, and Central America.



Unless mercury emissions from these areas are effectively regulated, U.S. regulations will not have any measurable impact on total mercury in our environment and will serve only to increase the cost of energy in this country. That, in turn, will make American industries less competitive in the global economy, which means fewer jobs for us.

Passing legislation to further reduce the 1 percent of mercury emitted into the air from U.S. coal-fired power plants may very well have no effect on mercury levels in fish.

It's known that concentrations of mercury in the air are usually very low and are of little health concern, but mercury in our water supply does concern us, and it's methyl mercury in fish that might get into our food chain that concerns us most. Passing legislation to further reduce the 1 percent of mercury emitted into the air from U.S. coal-fired power plants may very well have no effect on mercury levels in fish.

Mercury emissions from the typical coal plant are about 1 part per billion. Removing that mercury from those plant emissions is like filling Neyland Stadium to the brim with ping-pong balls, all white except for 30 orange balls representing all the mercury that a coal-fired plant emits. Now imagine that all of those ping-pong balls are shooting out of Neyland Stadium at 200 miles per hour—the speed of emissions. Our job would be to find and remove the 30 orange balls.

For Congress or for this administration to rush forward and place additional costly regulations on this nation's electric power would harm our economy without improving the health of our citizens.

Conflicting Data on CO_2

Carbon dioxide (CO_2) is not considered a pollutant under the current Clean Air Act and represents another major area where solid science cries out to be heard—the area of climate change. Before we begin unilaterally passing costly restrictions on the emissions of a gas not yet considered a pollutant under the Clean Air Act, we ought to have accurate scientific information about the sources of climate change and the extent to which man's activities are contributing. At the very least, I would suggest that an objective observer would say there is vigorous scientific debate on the issue of climate change.

Recent scientific studies indicate that humankind's impact on global temperatures is very small and is a constant, predictable component, not an accelerating trend.

There are a number of reputable scientists who, based on good, objective, current data, argue both sides of this issue. Some indicate that our globe is warming. Others reject predictions of catastrophic global warming and classify them as baseless. They argue that the balance of the evidence demonstrates that the natural variability in the earth's climate over hundreds of thousands of years is the overwhelming factor influencing global temperatures, not human activity.

Most of the public-policy debate concerning climate change revolves around the wisdom or the lack of wisdom represented by the Kyoto Protocol to the United Nations Framework Convention on Climate Change. This protocol was negotiated by the Clinton administration but was never ratified by the United States Senate. In fact, the Senate voted unanimously not to consider the Kyoto Protocol so long as the world's largest emitters of CO_2—China, India, and others—were not included in the mandatory reductions that would have been imposed on the United States and others. According to preliminary estimates, if the United States had signed the Kyoto Protocol, it would cost the American economy anywhere from $30 billion to $100 billion a year for perhaps only a tiny difference in the hypothesized global climate trends.

Recent scientific studies indicate that humankind's impact on global temperatures is very small and is a constant, predictable component, not an accelerating trend. A report called "Arctic Climate Impact Assessment" was released in fall 2004 and has been used to support the proposition that global warming is occurring. And the Arctic is said to be the first region to feel these effects. However, upon closer examination, Oregon State University climatologists have demonstrated that Arctic temperatures today are in fact cooler than they were 70 years ago.

We're told that the Arctic shelves will continue to melt, causing the oceans to rise. A United Nations' study indicates that the sea level will rise 1.8 millimeters, or about $^{1}/_{14}$ of an inch, annually. However, other scientists argue that there is a total absence of any recent acceleration in sea-level rise as claimed by the United Nations. In fact, sea level has been several inches higher in the past 100 years than it is today.

Meanwhile, scientists in Australia have recently discovered a phenomenon they term "global dimming." If this phenomenon is proven correct, indications are that global dimming would offset any global warming effect by about half. According to NASA's Goddard Institute for Space Studies, global dimming demonstrates the self-correcting capability of our ecosphere. Theoretically, as so-called greenhouse gases increase in the atmosphere, they block solar radiation, which then cools the earth back down.

It's worth noting that in the early 1970s, scientists were not arguing about global warming; they were arguing about global cooling and a coming ice age. Temperatures around the world had fallen steadily for 30 years. Pack ice was increasing, and the growing season had been shortened by 2 weeks in only a few years. In 1975 *Newsweek* noted, "Ominous signs [indicate] that weather patterns have begun to change with serious political implications for just about every nation. The resulting famines could be catastrophic."

My point is not to take sides in this debate. I contend that we will be shaping poor public policy if we begin passing laws and regulations before we fully understand the science. Such laws and regulations will most definitely cost the taxpayers, the electric ratepayers, and consumers whose products and services come from an energy base.

Science's Critical Role

While scientists study these complex issues and policy-makers work in good faith to base regulation on sound science, we should take concrete steps to continue to reduce emissions that are known to be harmful wherever we understand their sources and have the technology to mitigate them effectively and economically. In pursuing our environmental policies, we must continue to develop a diverse energy portfolio that will provide for our nation's security and independence. And we have to keep in mind the critical need to control the cost of energy, as it is a core component of our prosperity.

In these regards, I believe TVA is doing as well as anyone. We have one of the most aggressive emission-reduction programs in the nation. I contend that we *can* have a healthy environment, a diverse and sound energy portfolio, and a prosperous economy. It's a question of balance.

As solutions to our current environmental challenges are found, TVA will remain involved on all three fronts—energy, the environment, and economy. TVA will continue its rich tradition, as it has for more than 70 years, serving as a living laboratory for America, helping us to answer the critical questions of balance as we continue to move forward on clean air.

Bill Baxter was appointed to the board of the Tennessee Valley Authority by President George W. Bush. Before his TVA appointment, Baxter served as chairman and CEO of his family's business, Holston Gases Inc., headquartered in Knoxville. From 1997 to 2000, Baxter was the commissioner of the Tennessee Department of Economic and Community Development. Baxter graduated cum laude from Duke University in 1975 and earned a degree from the University of Tennessee School of Law in 1978.

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The creation of the Clean Air Act of 1970 marked an important turning point in our nation's history, but it also revealed what is possible when two men from opposing parties work together to effect positive change.

Riders on the Blue Marble Must Confront Climate Change

By Al Gore

"To see the earth as it truly is, small and blue in that eternal silence where it floats, is to see riders on the earth together, brothers on that bright loveliness in the eternal cold—brothers who know now they are truly brothers."
—*Archibald McLeish*

Al Gore

The creation of the Clean Air Act of 1970 marked an important turning point in our nation's history, but it also revealed what is possible when two men from opposing parties work together to effect positive change. There is stark contrast between what goes on now in the relationship between the two parties and the kind of relationship that Senator Howard Baker (R-TN) and Senator Ed Muskie (D-ME) enjoyed. This reality should cause all of us as Americans to pause and ask ourselves how we can rebuild that comity, that bipartisanship that senators Muskie and Baker were known for.

I am going to try to relate the global perspective of what is happening to our environment and the challenge of making further progress in cleaning up our air. I'd like to begin by referencing the first photograph ever taken of Earth from space, and it's one we've all seen. It's called "Earth Rise," and it depicts the partly illuminated planet hovering in the black of space with the surface of the moon in the foreground. It was taken by a rookie astronaut on an important mission. The mission commander was Frank Borman.

Many historians believe that the worldwide modern environmental movement began the moment this picture exploded into the consciousness of people around the world.

NASA's Apollo missions culminated in the moon landing of Apollo 11. But before that landing, three missions went around the moon before returning to the earth, and Apollo 8 was the first of those missions. The crew had lost radio contact with Earth when they passed around the dark side of the moon. And when they came back into radio contact, they looked up at Earth and took the picture. And I want you to make note of the date: December 24, 1968. Many historians believe that the worldwide modern environmental movement began the moment this picture exploded into the consciousness of people around the world. At that moment, if people could have put their feeling into words, they likely would have said, *Oh, I get it*. This picture began a new way of thinking about our relationship to one another on this planet.

NASA

In the next session, Senator Howard Baker and Senator Ed Muskie led Congress to pass the Clean Air Act of 1970 unanimously. The Clean Water Act, the National Environmental Policy Act, and a raft of others soon followed.

Another striking photo of Earth was taken during the last Apollo mission, on December 11, 1972, halfway between

NASA

Called "The Blue Marble," this photo, taken from the last Apollo mission, is the most widely published photograph in history.

My teacher was merely expressing the prevailing view; he held an assumption that he didn't question. Continents are so big that they obviously can't move, and that illustrates the old saying from Mark Twain about what gets us into trouble: it's not what we don't know; it's what we know for sure that just ain't so.

Earth and the moon. It's a unique picture because the sun was directly behind the spacecraft, so the disk of planet Earth is fully lit up. It's called "The Blue Marble," and it's the most widely published photograph in history.

Faulty Assumption

I'm going to relate two stories about teachers I had—one I liked and the other one I didn't. This one is about my 6th-grade teacher, the one I didn't like. When we studied geography, he'd pull a map of the world down over the blackboard. I had a classmate who pointed to the outline of South America and pointed to the outline of Africa and asked, "Did they ever fit together?"

The teacher said, "Of course not; that's the most ridiculous thing I've ever heard." That student went on to become a drug addict and a ne'er-do-well. As we know now, they did fit together. Alfred Wegner discovered that in the 1930s, but his science was ridiculed for 35 years until it was at last accepted. My teacher was merely expressing the prevailing view; he held an assumption that he didn't question. Continents are so big that they obviously can't move, and that illustrates the old saying from Mark Twain about what gets us into trouble: it's not what we don't know; it's what we know for sure that just ain't so.

There is another prevalent assumption, and it goes like this: The earth is so big that we humans can't possibly have any impact on it. Maybe that used to be true, but not anymore. The most vulnerable part of the earth's environment is its atmosphere. From here to the top of the atmosphere is not as far as it is from here out to the airport. If you were driving in a car, you'd get to the airport in a few minutes. And that space is being

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filled up with a lot of pollution, and that pollution is causing local air problems. For example, pollution is causing problems with lung diseases, and Knoxville has the highest asthma rate of any city in America.

These increasing pollution levels are important also because they contribute to global warming. Global warming is a fairly simple concept: Solar radiation comes in the form of light waves that are absorbed by the earth. Some of it is re-radiated into space as infrared (heat) energy, and the atmosphere traps some of that outgoing infrared radiation. That warms the earth, and that's a good thing. It keeps our temperature relatively constant.

Global warming is a fairly simple concept: Solar radiation comes in the form of light waves that are absorbed by the earth. Some of it is re-radiated into space as infrared (heat) energy, and the atmosphere traps some of that outgoing infrared radiation.

However, when air pollution from all of the earth's residents enters the atmosphere, it thickens the layer closest to the ground so that it acts like a blanket, capturing more of the outgoing infrared energy. In brief, that's what causes global warming.

Charting CO_2

Now for the story about the second teacher, a college professor I had as an undergraduate. Roger Revelle was the first man to measure carbon dioxide in the earth's atmosphere. In the middle 1960s, Revelle showed his class of undergraduates—some 20-odd of us—a graph depicting the first results from the measurement of atmospheric CO_2 over time. Right away it was clear that the concentrations were increasing. Revelle started making these CO_2 measurements in 1958, and every year since then, without fail, they have gone up. At first it was an increase of about 1.5 parts per million, but over the last few years it's been 2.5 parts per million.

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I was elected to Congress in 1976, and I helped to organize the first hearings on this issue. I got my old professor to come and be the lead witness, and I thought if those members of Congress heard what he had to say, that'd solve the problem. But it didn't work that way. When I ran in for president in 1988, I tried to make this an issue. Then in 1992, as vice-president, I put a carbon tax into the economic plan. It was whittled down and didn't survive.

My point is that here we are in 2005, and somewhere along these last decades global warming has become not just a potentially significant problem—now it's showing up in the real world. Glaciers all over the world are melting. Within 15 years there will be no snows of Kilimanjaro. My friend Lonny Thompson from Ohio State University studies glaciers and brought me several pictures taken from the top of Kilimanjaro, showing the pitiful remnants of the once-mighty glaciers on the top of that mountain.

The same thing is happening in our own Glacier National Park. Within 15 years, it will be "the park formerly known as Glacier." And it's happening all over the world. In Alaska, what was once a glacier is now a lake.

Over the past 25 years, the Columbia glacier, located along the southern coast of Alaska near Valdez, has receded very rapidly. Glaciers that existed 100 years ago in Switzerland, China, Argentina, and Peru are now completely gone.

On a glacier in Austria, hikers found the body of a 5,000-year-old man because the ice had retreated—ice that hadn't melted in 5,300 years.

Core Science

Scientists dig ice cores from glaciers and can read the layers as they might read the rings of a tree, counting back year by year. Several years ago, while I was in Antarctica, scientists brought up some core drillings, and one of the scientists counted back and, pointing, said, "Right here is when the U.S. Congress passed the Clean Air Act." I could see the layer with the unaided eye.

These ice-core samples can indicate warming and cooling of the planet over the centuries. The skeptics of global warming insist that the current warming is part of a cyclical phenomenon. They cite the fact that there was a medieval warming period, and they're right. But there's a big difference between what happened then and what's happening now. The fact is, glaciers don't care about politics, and they don't care about ideology. They just melt or freeze, and in that way they are very faithful witnesses. They reveal a thousand years of CO_2 and a thousand years of temperature.

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A thousand years of CO_2 sounds like a measure that stretches a long way back, but the core samples they're drilling in Antarctica go back 400,000 years. At no time in this long 400,000-year period has the amount of CO_2 in the atmosphere risen above 280 parts per million.

The fact is, CO_2 levels are now way, way above where they've been as far back as we can measure, and they're continuing to increase. This is not in dispute by anyone, but people interpret the data differently. There are people who say, *Oh, this is perfectly all right. No problem*. But if the cold periods revealed by the ice core samples indicate ice depths a mile deeper than they are now, what, then, does continued warming mean? We are engaged in an experiment to find out.

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Fatal Heat

Two summers ago in Europe we saw the effects of the big heat wave. Thousands of people died. It didn't get as much notice in India, where temperatures went up to 122 degrees Fahrenheit. But this creates stronger storms, because when you put more energy into a system, the system gets more energetic. And when the oceans are warm, that energy creates stronger storms.

Florida learned this lesson firsthand—and at a considerable cost to life and property—during the hurricane season of the summer and fall of 2004. In that same year, we set a record for tornadoes. Scientists have not established a clear connection between tornadoes and global warming, but we did have more tornadoes than ever before, most likely as a result of the hurricanes. Also in 2004, Japan had an all-time record number of typhoons. The previous record was seven; in 2004, it was ten.

The textbooks say you can't have hurricanes in the South Atlantic, but this past year we had the first hurricane ever in the South Atlantic, and it hit Brazil. A lot of people are asking why these hurricanes seem more deadly now. The scientific community says that warming produces an increase in rainfall that takes the average hurricane an extra half-step up the 5-step intensity scale.

As water temperature goes up, wind velocity and moisture increase. There's been a 20-percent increase in moisture—in the form of rain and snow in the United States—in the last century. Just last year we had a lot of moisture here in Tennessee, and many of the Eastern states had near-all-time-record amounts of moisture.

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The biggest negative consequence of global warming in monetary terms is drought, because the warming increases evaporation off of the oceans, so more moisture falls in single intense storms, which doesn't replenish the aquifers in the same way that more frequent but less dramatic storms do. The same warming that causes evaporation off the oceans also causes soil moisture to evaporate, and soil dries out very quickly.

Global precipitation is not evenly distributed. While there has been more precipitation in North America, parts of Africa have experienced extreme drought. Lake Chad is 1/10 the size it was just 35 years ago.

According to the scientists, if CO_2 levels double in the next 45 years, we will lose as much as 35 percent of our soil moisture. If we don't act soon and thus experience a quadrupling of CO_2, then huge swaths of the United States will lose as much as 65 percent of their soil moisture. And you think farming is difficult now.

Shrinking Ice Shelves

Two areas of the world serve as canaries in the coal mine in terms of CO_2 levels: the Arctic and the Antarctic.

The Ward Hunt Ice Shelf, the largest land-based ice shelf in the Arctic, just cracked in half. In Alaska, trees that sank their roots into the frozen tundra a long time ago are beginning to totter drunkenly because the tundra is melting. The warming and thawing is also causing structural damage to buildings in Alaska and is damaging this country's oil pipeline there.

Starting around 1970, the amount of ice in the Arctic Ocean started dropping off rapidly. We've lost 40 percent of it in the last 40 years. The melting is accelerating because of what's known as a "phase change" where water is present in both its solid phase (ice) and its liquid phase. When the sun's rays strike ice, 95 percent of the solar energy bounces back into space. But when the sun's rays hit liquid water, more than 90 percent of the energy is *absorbed*. When the ice begins to melt into liquid water, there is more water around the ice to absorb much more solar energy, thus warming the water, which melts more ice, and so on in an accelerating process. So where the

If we want to solve the mercury problem, we must understand the causes and sources of the problem, and our assessment must be based on scientific fact.

ice is concerned, the difference between 32 degrees and 33 degrees is not just 1 degree. Ice all over the Arctic is melting rapidly and with big consequences. In fact, polar bears may be threatened with extinction within 20 years.

Within 50 or 60 years, the Arctic ice cap may be completely gone. With 90 percent of the sun's rays being absorbed by the open ocean, the heat sink there is far greater than anywhere else on the planet, and so the temperature increases are also greater there.

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That's important for several reasons. First, global climate is what's called a "nonlinear system." That is, it doesn't just change gradually; it can sometimes change in surprising jumps.

If you look at the global climate, it's really an engine for redistributing heat from the equator to the poles. And it does that by means of ocean currents and wind currents. But the warming isn't evenly distributed. If you take into account that the average global temperature is a little more than 58 degrees Fahrenheit, an increase in the average temperature of 5 degrees—which is now on the low side of the projection—means an increase of only 1 degree at the equator and more than 12 degrees at the North Pole.

Many people are particularly concerned about the effects of all this on the Gulf Stream. The Gulf Stream extends from the Gulf of Mexico up to the area just south of Greenland and Iceland, where it hits the cold wind from the Arctic coming off Greenland. As the warm water of the Gulf Stream evaporates, the steam moves on the prevailing winds to Europe and carries with it heat that's equal to $1/3$ of the heat Europe gets from the sun. That's why cities like Madrid and Rome, which are on the same latitude as New York, are much warmer than New York. In the same way, though Fargo is farther south than Paris and London, it is much colder with no Gulf Stream to warm it.

When the Gulf Stream waters evaporate, what's left in the ocean is dense, cold, salty water—the salt doesn't evaporate. As more evaporation occurs, the water gets denser and heavier, and it sinks toward the bottom at the rate of 5 billion gallons a second, setting up an enormous hydraulic pumping effect that powers the ocean currents. But there is a danger that a lot of lighter-weight fresh water from ice-melt flooding into that dense salty water could short-circuit this hydraulic pump. This actually happened about 11,000 years ago.

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From Fire to Ice

Eleven millennia ago, as the glaciers of North America melted, a huge freshwater lake formed (Lake Agassiz); the Great Lakes are its remnants. One day, an ice dam on its eastern boundary broke suddenly, and a huge amount of fresh water flooded out into the North Atlantic. It ripped open the mouth of the St. Lawrence River, diluted the seawater, and shut off the pump. As a result, the Gulf Stream relocated down around Africa, and Europe entered a thousand-year ice age. And this shift from one state to the other occurred in as little as 2 years' time. It was like a switch had been flipped. It happened once, and, some scientists say, it might happen again.

Seasons are fluctuating, which can cause myriad disruptions in natural systems. In the Netherlands, for instance, for the past 25 years, April 25 has been the peak arrival date for migrating birds. Their chicks hatched June 3, to coincide with the caterpillar season. Twenty years of warming later, the birds still arrive at the same time, but the caterpillars have moved their season up because it's that much warmer. As a result, the chicks hatch a little bit earlier, but they can't adapt to these changes as fast as the caterpillars did.

In Switzerland over the past 100 years, the number of days with frost on the ground has decreased dramatically, and the number of exotic or invasive species now growing there is a direct function of the reduction in frost days. In the past, Alaska's millions of acres of spruce had never had much of a problem with bark beetles. But now with warmer winters, more of the bark beetles survive, and they're destroying the trees.

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Global warming is also allowing mosquitoes to live at higher altitudes, and that presents increased disease threats. According to research from the Harvard Medical School Center, the impact of increasing global temperatures on disease vectors is dramatic. Consider, for instance, that 30 so-called "new" diseases have broken out of small enclaves over the last 30 years or so. West Nile virus hit the U.S. East Coast in 1999, and 2 years later it arrived in Tennessee. Two years after that, it had covered the whole country.

Equally dramatic events are occurring on the Antarctic Peninsula—which juts northward toward Patagonia in South America. Every once in a while you hear about ice shelves the size of Rhode Island breaking off the peninsula, and this has been occurring with increasing frequency. The peninsula's massive Larsen B Ice Shelf is about 35 or 40 miles across and about 100 miles long. It is 700 feet thick. Scientists figured this ice shelf would last at least a hundred years, even with the warming. They were wrong. Starting on January 31, 2002, within a period of 35 days, it was gone. Scientists were truly astonished.

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Once the sea-based ice shelf was gone, the land-based ice wasn't stopped up any more, and it began to slide off the land into the water. Keep in mind that sea-based ice is already floating in the ocean: like the ice cubes in a cold drink on a hot day, when sea-based ice melts, it doesn't raise sea level. When land-based ice plops into the water, however, it does raise sea level.

Rising Waters

On the Thames, the tidal river that flows through London, engineers have now built barriers to control tidal storm surges, because sea level has been rising dramatically in this century.

The lowest-case projection for sea-level rise for the rest of this century is 1 meter, and most believe now that it's going to be much more than that. Some 17 million people live in an area of Bangladesh that is threatened by the 1-meter rise. Likewise, part of Florida will be submerged by a 1-meter rise.

The lowest-case projection for sea-level rise for the rest of this century is 1 meter, and most believe now that it's going to be much more than that. Some 17 million people live in an area of Bangladesh that is threatened by the 1-meter rise. Likewise, part of Florida will be submerged by a 1-meter rise.

The western Antarctic ice shelf is different from the rest of Antarctica because it is propped up by undersea mountains. So, in effect, the ice shelf sits on stilts, and its mass does not displace any ocean water. Were this shelf to melt or settle directly into the ocean, it would result in a sea-level rise of about 20 feet. Greenland has another area of ice roughly the same size as West Antarctica's, where changes are occurring even more rapidly than in Antarctica. The decline in the ice mass on Greenland is so dramatic that world maps may have to be redrawn. If the Greenland ice mass were to melt completely, the World Trade Center memorial in New York will be under water.

Collision Course

We are witnessing a collision between our civilization and the earth's environment, and there are three main factors causing the collision.

The first is population growth. Scientists believe that modern humans emerged about 160,000 years ago. And for the sake of argument, let's say that they are right. Let's call them "Adam" and "Eve." By the time Jesus walked the earth, there were 250 million people on the planet. By the time Christopher Columbus sailed, there were a half-billion of us. By the time of our Declaration of Independence, there were 1 billion people on the planet. And when my generation was born, at the end of World War II, we'd reached a little more than 2 billion people. I'm 55, and in my lifetime we've gone from a little over 2 billion to 6.4 billion. Within 45 years, the United Nations recently announced, we will reach 9 billion.

It took us 10,000 generations to reach 2 billion; it will take us less than a century to jump from 2 billion to 9 billion. And most of the change is occurring in the developing countries, the poor countries.

It took us 10,000 generations to reach 2 billion; it will take us less than a century to jump from 2 billion to 9 billion. And most of the change is occurring in the developing countries, the poor countries.

The second factor is the toll of technology. We are now able to do things we couldn't do earlier in our history. The recent growth in population has been paralleled by a growth in the number of cars, air conditioners, and refrigerators, and that has an impact. Technology is a good thing, particularly as it contributes to the advancement of medicine and communications, for instance. But here's something to think about: Old habits plus old technology produce predictable consequences. By contrast, old habits plus new technology can produce spectacular unforeseen consequences.

Take the habit of warfare as an example. Warfare with the technology of swords and spears and bows and arrows and muskets was one thing, but the new technology of nuclear weapons radically altered the consequences of the old habit of warfare.

Now apply that rule to our even more basic behavior of exploiting the earth for sustenance through technologies like plowing and irrigation. Even these simple technologies applied on a massive scale can produce disasters like the fate of the Aral Sea. The former Soviet Union irrigated cotton fields in the desert using water from the Aral, and as a consequence, the world's fourth-largest inland sea disappeared. Ships that once floated on the waters of that sea are now marooned in the middle of the desert. Clearly, technology can overwhelm the human scale.

In terms of the gases that contribute to global warming, our country's use of technology is responsible for more than that of South America, Central America, Africa, the Middle East, China, India, Japan, and Indonesia put together.

In terms of the gases that contribute to global warming, our country's use of technology is responsible for more than South America, Central America, Africa, the Middle East, China, India, Japan, and Indonesia put together.

The third factor is muddled thinking. Consider that a frog that's dropped into a pot of boiling water will jump right out. But put the same frog put in a pot of lukewarm water that's slowly heated, and he'll just sit there until he's rescued or he dies.

We are very much like that frog in terms of our collective nervous system. It takes a tsunami—a sudden disaster—to get our attention and mobilize us to change our perspective and our behavior. If, however, the changes are gradual and incremental—but ultimately equally as destructive—we opt to sit in the water until we're boiled. There are three misconceptions in our thinking:

First: Isn't there disagreement among scientists about whether problem of global climate change is real or not? No, not really. The so-called misconception regarding the science of global climate change has been well organized and financed, and this has happened before.

At the beginning of the century, Upton Sinclair wrote that "it is difficult to get a man to understand something when his salary depends upon his not understanding it." Last December, *Science* magazine studied 10 years' worth of all of the articles on climate change that have been published in peer-reviewed, refereed scientific journals, and the editors found 928 such articles. Not a single one of them expressed disagreement with the central thesis of the global scientific consensus. The Kyoto Protocol to the United Nations Framework Convention on Climate Change has been ratified by 141 countries now. Only two developed countries have failed to ratify it, and we're one of them.

It's as if people picture a scale with a gold bar on one side and the entire planet on the other. That's a false choice. We have technologies now—like hybrid cars and renewable energy sources—that we are not fully exploiting.

The second misconception: Don't we have to choose between the economy and the environment? It's as if people picture a scale with a gold bar on one side and the entire planet on the other. That's a false choice. We have technologies now—like hybrid cars and renewable energy sources—that we are not fully exploiting.

The third misconception: There are people who say, *OK, if we accept that this problem is real and it's this big and we're causing it—can we really do anything about it?* Some people go straight from denial to despair, without ever pausing at the intermediate step of taking action to correct the problem.

We could significantly reduce the projected carbon emissions from the United States over the next 45 years if we simply implemented end-use efficiency measures, increased the fuel efficiency of passenger vehicles, relied more on renewable energy, and increased carbon sequestration. And we have the technology to do all of these things, but adopting these changes means making political choices.

Consider, for instance, the fuel efficiency of automobiles. Japan requires fuel efficiency of 45 miles to a gallon, and that efficiency continues to increase. China has tougher fuel-economy standards than we do, which is why we can't sell our cars in China. Some U.S. states are taking action on their own. In 11 years, for instance, cars in California must be as fuel-efficient as cars in China are right now. That's bold, isn't it? But the entire automobile industry is suing California to try to eliminate that law.

U.S. as Problem-Solver

At other points in history, the United States has solved problems that many thought were intractable. Many contended that we couldn't stop polio, but we did. Others insisted that we couldn't end segregation or land on the moon. After 50 years we brought Communism down in a bipartisan way. We ended apartheid. We've even solved a global environmental problem—the hole in the ozone layer.

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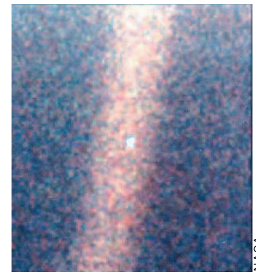
Destruction of the ozone layer was a serious problem, and there were plenty of skeptics who maintained that we couldn't do anything to fix it. But on a bipartisan basis, the United States of America led the way to the enactment of a global treaty that phased out the chemicals that damage the ozone layer. We took the lead, and the rest of the world followed. It's up to us to use our democratic processes and our God-given democratic rights of self-expression and self-governance to make the tough choices—to do what Senator Howard Baker and Senator Ed Muskie did on behalf of our country in 1970. We need to force the technology, raise the standards, and take responsibility for the future consequences of our present behavior. And we need to bring people together to do it.

I'd like to end by referencing another image from space. When the *Voyager I* spacecraft got about 4 billion miles away from Earth, way beyond the edge of our solar system, technicians used the probe to take a photograph of planet Earth. From that perspective, our planet appeared as a tiny pale-blue dot suspended in a sunbeam. Everything that has ever happened on this earth has happened on that pixel. All of the history, all of the triumphs and tragedies, everything. It's our only home, it is now jeopardized, and it is up to us to act to save it.

Al Gore began his political career in 1976, when he was elected to the U.S. House of Representatives, here he served 8 years, representing Tennessee's 4th District. He was elected to the Senate in 1984, reelected in 1990, and inaugurated as the 45th vice-president of the United States on January 20, 1993. Gore received a degree in government with honors from Harvard University in 1969. After graduation, he volunteered for enlistment in the U.S. Army and served in the Vietnam War. Upon returning from Vietnam, Gore became an investigative reporter with the Tennessean *in Nashville, where he also attended Vanderbilt University's divinity school and then law school.*



NASA

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