INDEX OF

LEADING ENVIRONMENTAL INDICATORS

2007

TWELFTH EDITION

BY STEVEN F. HAYWARD
AND AMY KALEITA

twelfth edition
Index of Leading Environmental Indicators
2007

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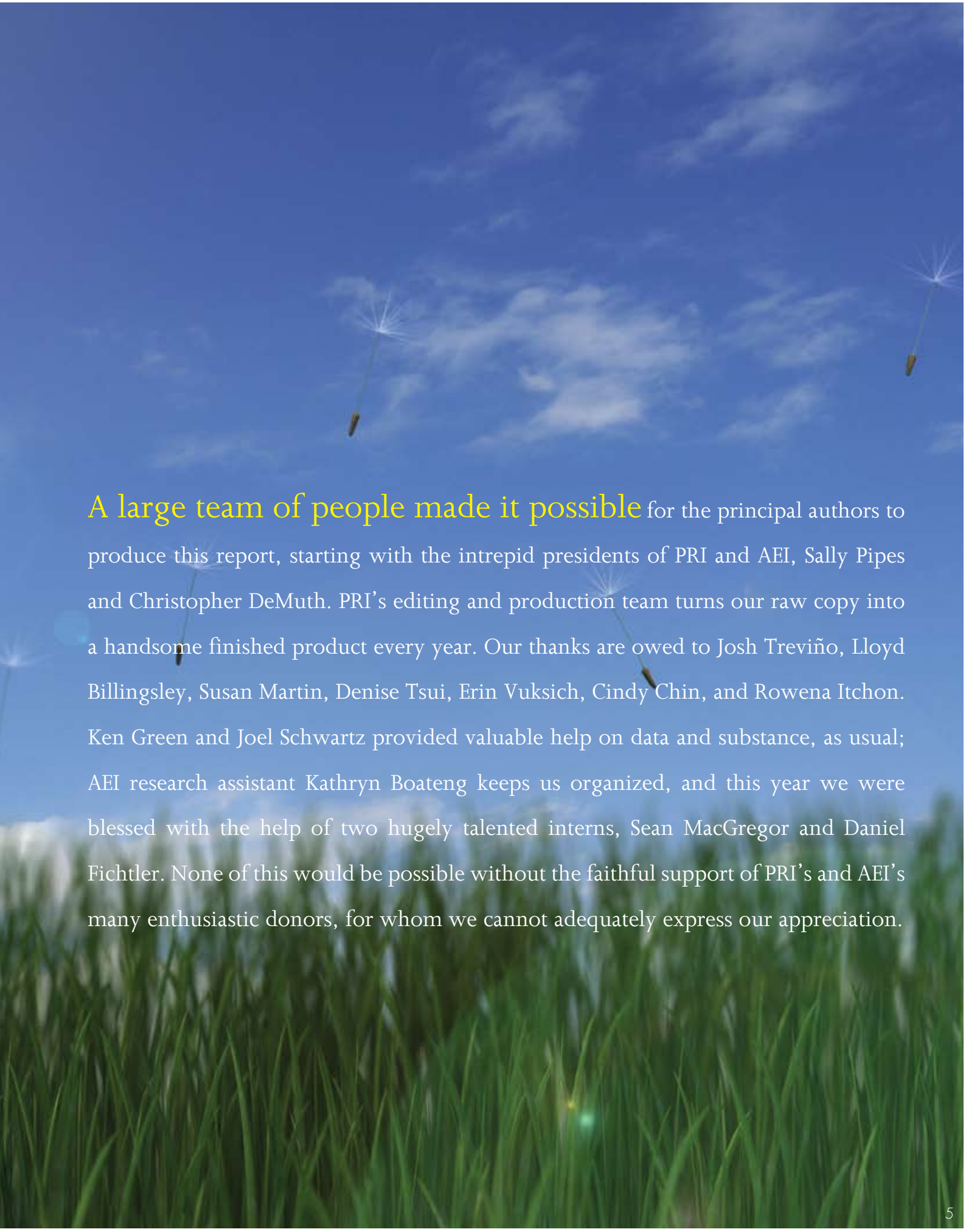


A large team of people made it possible for the principal authors to produce this report, starting with the intrepid presidents of PRI and AEI, Sally Pipes and Christopher DeMuth. PRI's editing and production team turns our raw copy into a handsome finished product every year. Our thanks are owed to Josh Treviño, Lloyd Billingsley, Susan Martin, Denise Tsui, Erin Vuksich, Cindy Chin, and Rowena Itchon. Ken Green and Joel Schwartz provided valuable help on data and substance, as usual; AEI research assistant Kathryn Boateng keeps us organized, and this year we were blessed with the help of two hugely talented interns, Sean MacGregor and Daniel Fichtler. None of this would be possible without the faithful support of PRI's and AEI's many enthusiastic donors, for whom we cannot adequately express our appreciation.

Preface to the 12th Edition

The Paradox of Environmental Indicators

Environmental progress no longer depends on hundreds of bureaucrats at the Environmental Protection Agency mandating what piece of pollution-control equipment will be on each smokestack. Government must continue to set standards. But the burden of innovation and technology development will shift to the private sector.

—Daniel Esty, Yale University[1]

Can it be that there is a simultaneous proliferation of environmental indicators and data along with a regression in our ability to track and assess environmental trends? The surprising—and troubling—answer is Yes.

As this *Index* has reported for more than a decade, there is a veritable explosion in public- and private-sector efforts to develop environmental indicators on the macro and micro scale, such that it has become impossible to keep up. Indeed, it is tempting to change the name of this annual report to the *Survey of Leading Environmental Indicators* (in keeping with our goal of preventing the *Index* from becoming a phone book–sized data dump).

James Boyd of Resources for the Future convened a workshop on environmental indicators in November of last year, at which he presented a number of challenging questions about the status and utility of our present indicator systems.[2] Are we able to answer the famous question from another context: Environmentally, are you

better off than you were four years ago? Can we assess environmental performance—both institutional and in terms of the investments we are making in environmental protection? The answers are not encouraging. As Boyd and others have observed, despite our increasing technical sophistication and measurement tools, we still have not created, in the public sector, a coherent institutional structure for environmental indicators, analogous to the Bureau of Labor Statistics or the Bureau of Education Statistics.

With a few notable exceptions such as air quality, scientists and policy makers are still unable to draw on consistent data over time in many areas of environmental concern. We lack standardized measurements; we even lack a common environmental language. Many of the popular concepts, such as "sustainability" and "ecosystem services," have not been developed beyond a level of vague generality. Above all, we still have substantial data gaps in important areas, and the gaps may be growing larger, as bureaucracies, facing fiscal constraints, cut back on monitoring in order to trim their budgets. The H. John Heinz Center for Science, Economics, and the Environment details the problems in its *Filling the Gaps*[3] report, the most recent update to its important *State of the Nation's Ecosystems* project. The Heinz Center estimates that the 10 most important gaps in our data about U.S. ecosystems could be filled for about $75 million a year—a rounding error for most federal agencies.

Meanwhile, the United States is spending multiple billions a year on climate-change research, which is not surprising since climate change has become *the* environmental issue that dwarfs all others. Attempts to address the issue of climate change are beset by two general problems. First, since much of the research requires predicting conditions decades into the future, constructing objective indicators of climate change in the present has become a contentious pursuit. How much is statistical "noise" or natural variability, and how much is intrinsic to the phenomenon of rising levels of greenhouse gases? Though we will not attempt to wade into this controversy in the short compass of this report, we have expanded the climate-change section in this edition. We attempt to develop a set of *policy-relevant* indicators (i.e., data that do not depend on a particular climate model or theory to be correct) and a set of secondary indicators of variables that are of increasing public concern, such as storm intensity and sea-level rise.

Second, the problem with discussions of climate change from a policy perspective is that the language of "skeptics versus alarmists" has put the issue into a straitjacket, leaving little room for a reasonable middle ground, or for people who believe our reach exceeds our grasp, in science and especially in policy. So for the first time the *Index of Leading Environmental Indicators* comes equipped with a DVD movie—"An Inconvenient Truth—or Convenient Fiction?"—that presents an alternative to the climate extremism that is popular with Hollywood and other pessimistic enclaves. Look for updates on this and other issues on the Web.

Above all, this *Index* is designed to shine a spotlight on, and deepen our understanding of, environmental *progress*—the side of the environmental story that is seldom told. It does not shy away from the bad news or tell only the good news; however, the media and activist obsession with bad news skews our priorities and blinds us to ways of transferring our successes to areas where there has been less progress.

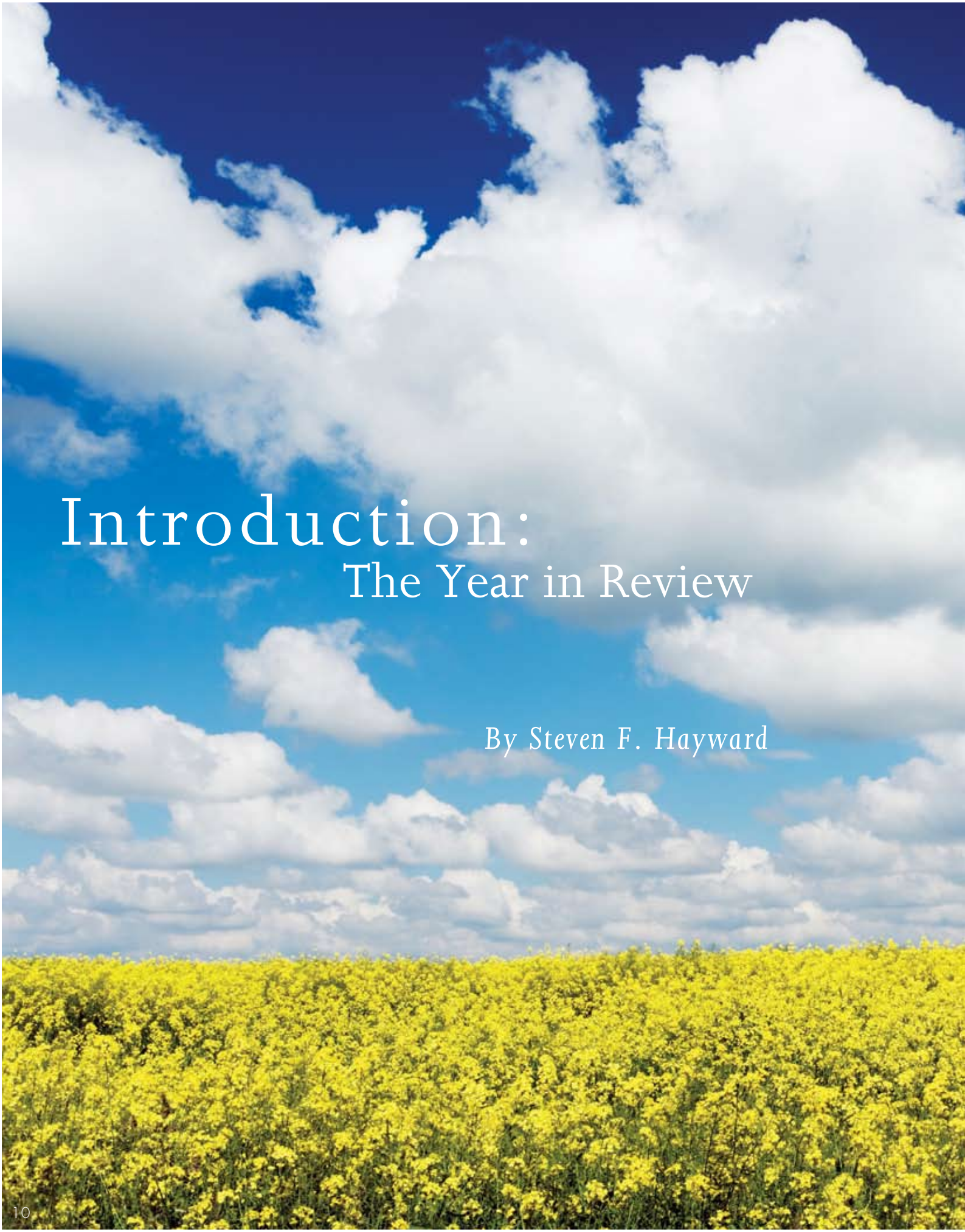
—STEVEN F. HAYWARD

Notes

1 Daniel C. Esty. "Being Green Puts You in the Black," *Washington Post*, March 4, 2007.

2 For video of the event, see: http://www.rff.org/rff/Events/Collaboration-on-Indicators.cfm

3 http://www.heinzctr.org/ecosystems/index.shtml. Following the 2002 release of the Heinz Center's report *The State of the Nation's Ecosystems, USA Today* published an editorial discussing the lack of environmental information available to the public. This editorial emphasized the failure of state and federal agencies to fund the collection of necessary environmental data despite very effective collection of comparable information on the U.S. economy, population, energy usage, human health issues, and crime rate. The editorial concluded that "without such information, the public doesn't know when to celebrate environmental successes, tackle new threats, or end efforts that throw money down a drain" (*USA Today*, September 21, 2002).



Introduction:
The Year in Review

By Steven F. Hayward

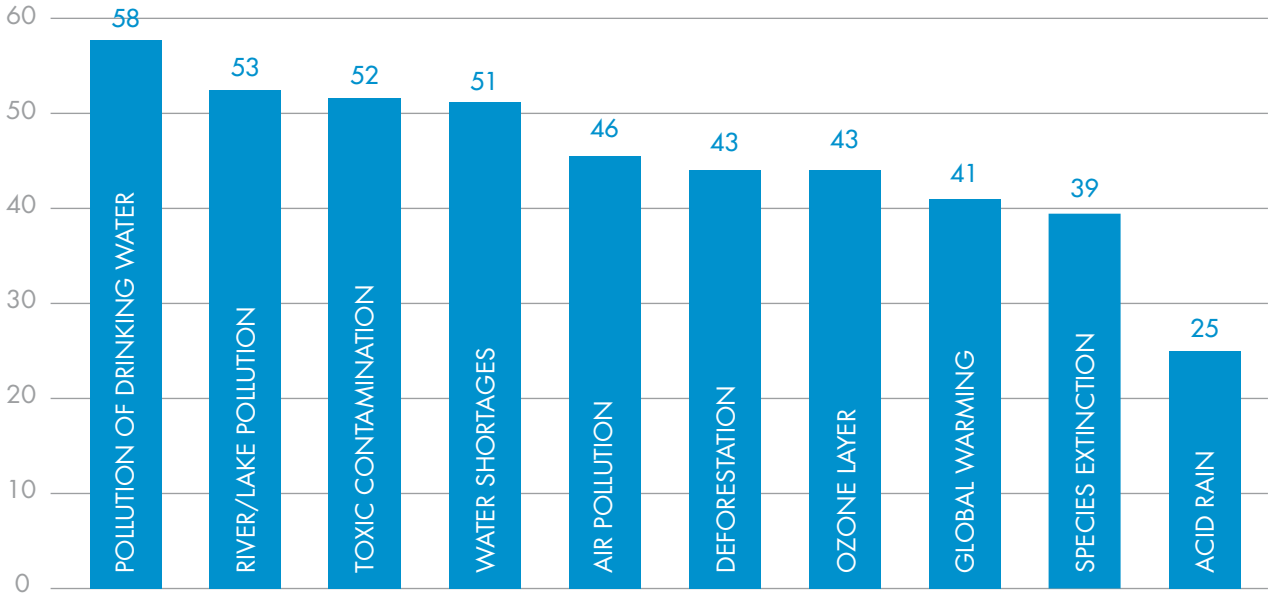
I. Trends in Public Opinion

WHAT WAS THAT NOISE?
Did you hear something about *climate change?*

AFTER YEARS OF PUBLIC INDIFFERENCE ABOUT CLIMATE CHANGE—Gallup's environmental opinion analyst Riley Dunlap in 2005 wrote that climate change "puts people to sleep"—the year 2006 may have seen a turning point—perhaps even a tipping point! (see nearby sidebar)—in public concern about climate change. Gallup's annual spring survey of environmental issues, conducted each year in March, continued to find only subdued public arousal over climate change, with respondents ranking it as the eighth most important environmental issue (out of 10); 41 percent told Gallup they worry a "great deal" about global warming (up from 26 percent in 2005). In fact the long-term trend of public opinion has changed very little over the last decade. (See Figures 1 & 2.)

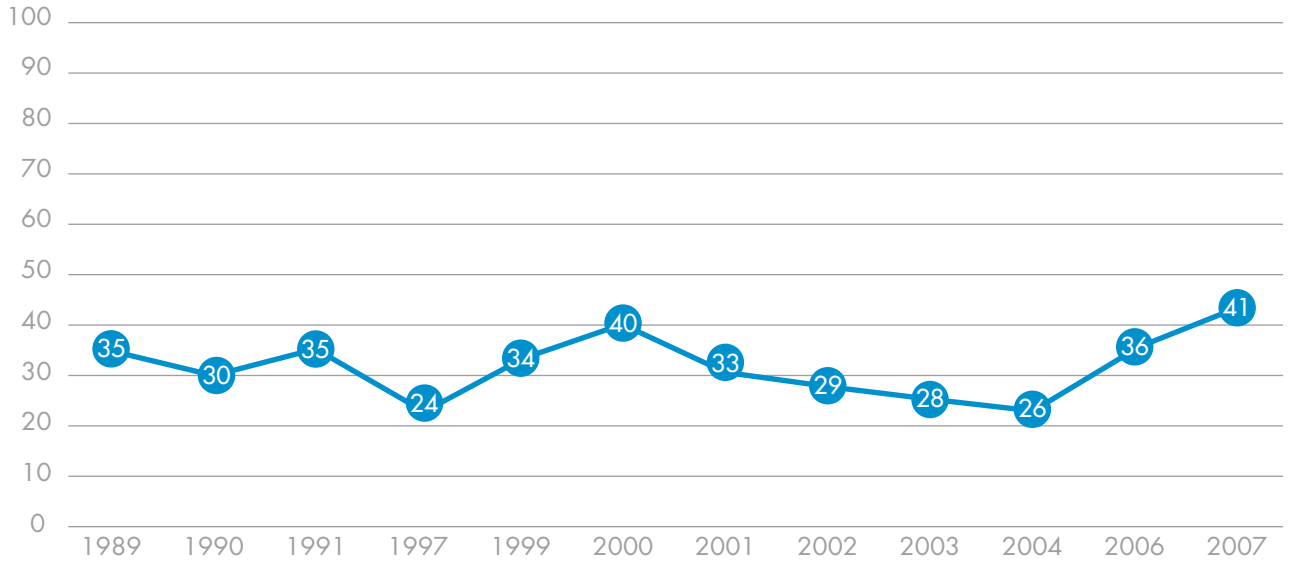
These results closely track findings we reported in last year's *Index* from a 2003 MIT public opinion survey which found that less than 10 percent of respondents chose the environment as one of the top three most important issues facing the United States today (in Gallup's latest surveys, only 2 percent chose the environment as the most important issue in response to an open-ended question), and of those respondents who did select the environment, climate change/global warming was ranked as the sixth (out of 10 choices) most important environmental issues; only 21 percent of respondents chose climate change as one of the top two most important environmental issues.

Figure 1: Gallup Poll: Which of the Following Environmental Issues Do You Worry "a Great Deal" About?



(Source: Gallup March 2007 Survey)

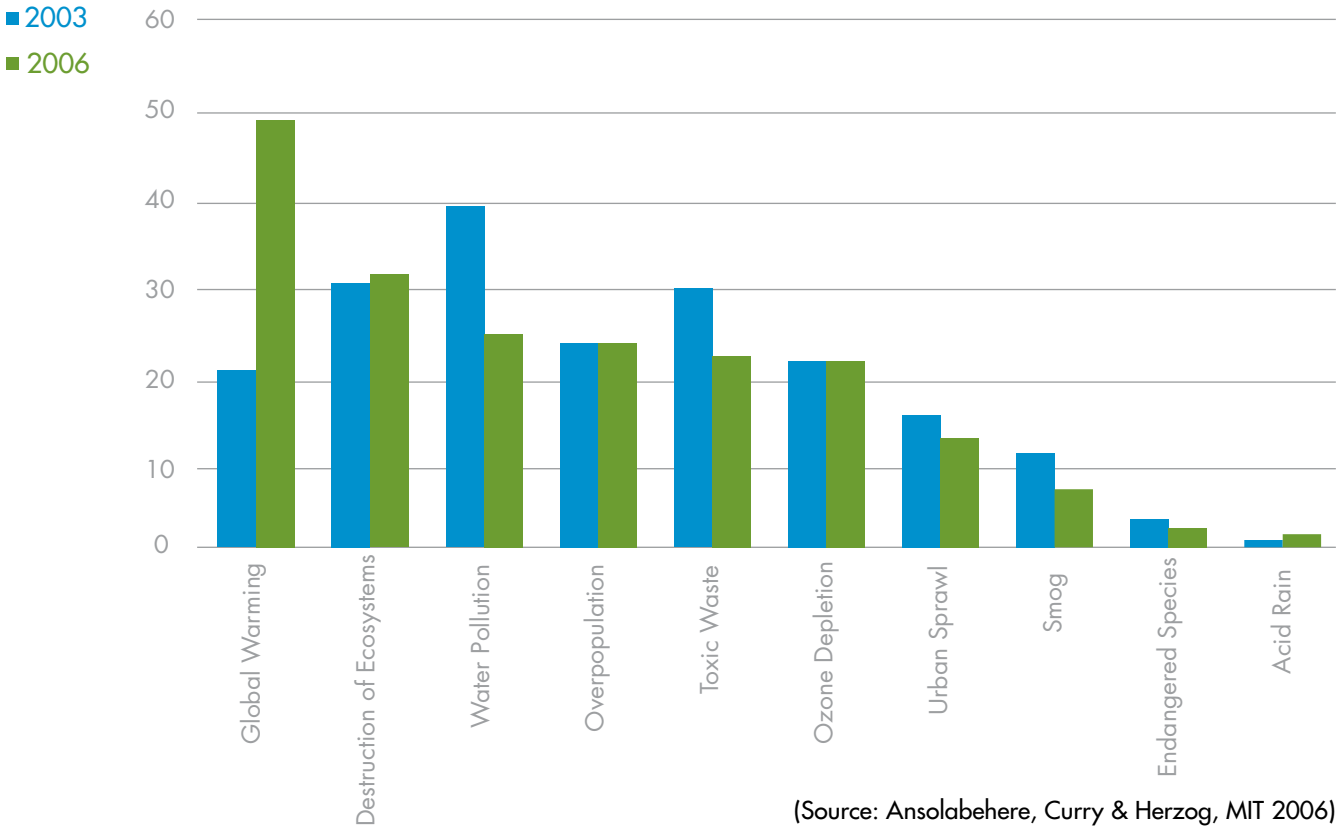
Figure 2: Percent of Americans Who Say They Worry "a Great Deal" About Global Warming



(Source: Gallup Poll, March 2007)

By the end of the year, however, public opinion may have begun to make a significant shift. What a difference a half-year—and an intensive public-awareness campaign—can make. MIT went back into the field with the same survey in September 2006, with notably different findings.[1] While the respondents who named the environment as one of the three most important issues rose only to about 12 percent, climate change now ranked first among those respondents, with nearly half choosing it as the most important environmental issue. As seen in Figure 3, the gain in climate-change concern is due to the shift from water pollution and toxic waste to global warming as the primary concern.

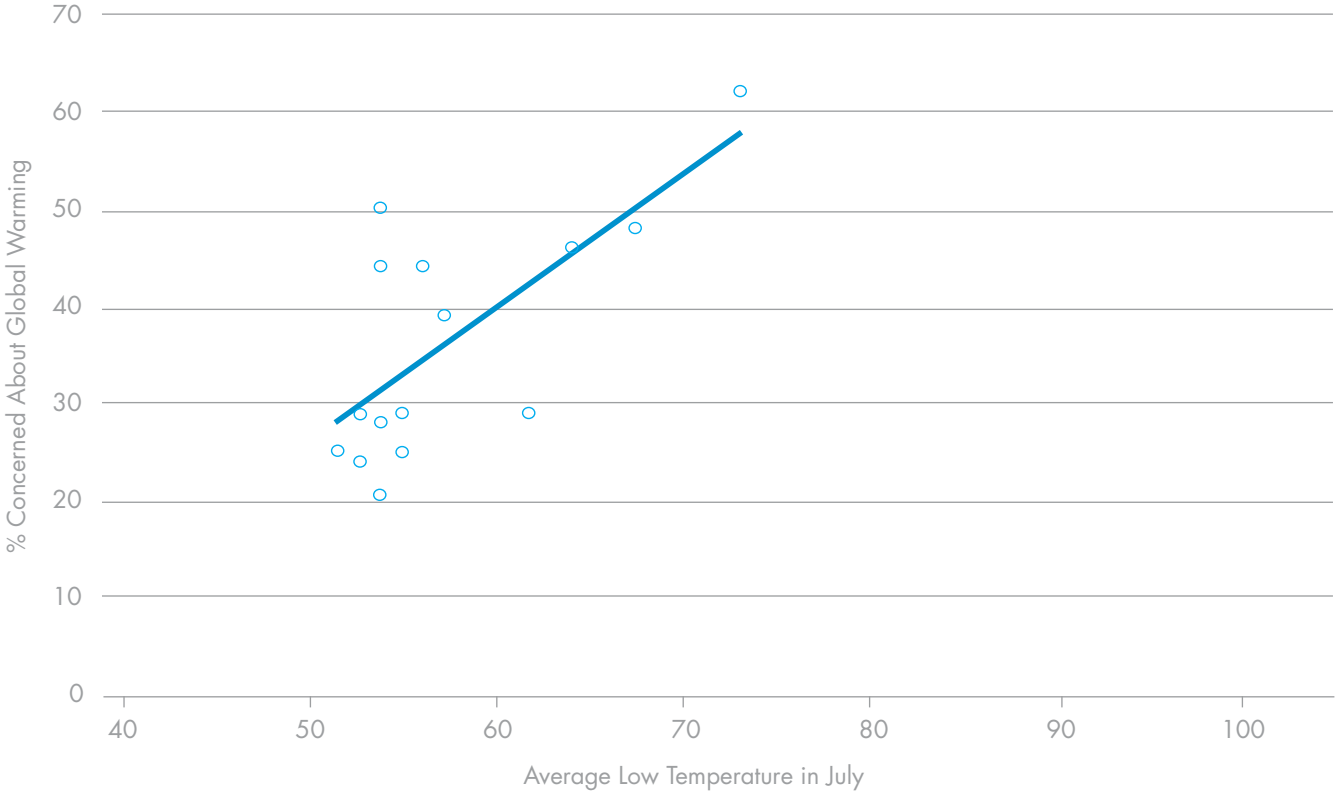
Figure 3: "Which Is the Most Important Environmental Issue Facing the United States Today?"



(Source: Ansolabehere, Curry & Herzog, MIT 2006)

This shift in opinion may have to do with the weather. As we report in the climate-change section of this edition, 2006 ranks among the warmest years on record, and the United States experienced a substantial heat wave in the summer. In the fall of 2006 two British researchers reported an entirely common-sense correlation between high temperatures and public concern for global warming in the European Union, as shown in Figure 4.[2]

Figure 4: Public Concern for Global Warming in the EU-15



(Source: Lorenzoni & Pidgeon)

As mentioned previously, however, the shift in opinion is most likely neither serendipitous nor merely weather-related, but is owing also to a period of purposefully intense public campaigning from environmental advocates. Last year the Yale School of Forestry and Environmental Studies published a plan to elevate climate change to the top tier of its political agenda. The plan grew out of a 2005 summit meeting of environmental leaders held, naturally, in Aspen.

The conference report, *Americans and Climate Change*, lists 39 recommendations for "moving the needle" of public opinion about global warming from the anemic mid-30s to over 50 percent, including everything from influencing public-school curricula to reaching NASCAR's fan base and seizing events like Hurricane Katrina as "teachable moments." The report was forthright in its view that environmentalists need to "wake up the public about the urgent nature of the issue, [and] create a major public demand for action comparable to that which stimulated major environmental legislation in the 1970s." (The book is available online at www.yale.edu/environment/publications.)

The media complied with almost slavish devotion to the advocates' story line, with lavish cover stories in *Time* ("Be Worried, Be *Very* Worried"), *Vanity Fair*, and *Wired*, along with numerous global-warming specials on PBS, HBO, *60 Minutes*, and the network news broadcasts. Even the Weather Channel joined the parade. Whether the climate is approaching a "tipping point" is open to dispute; that the media have tipped is not.

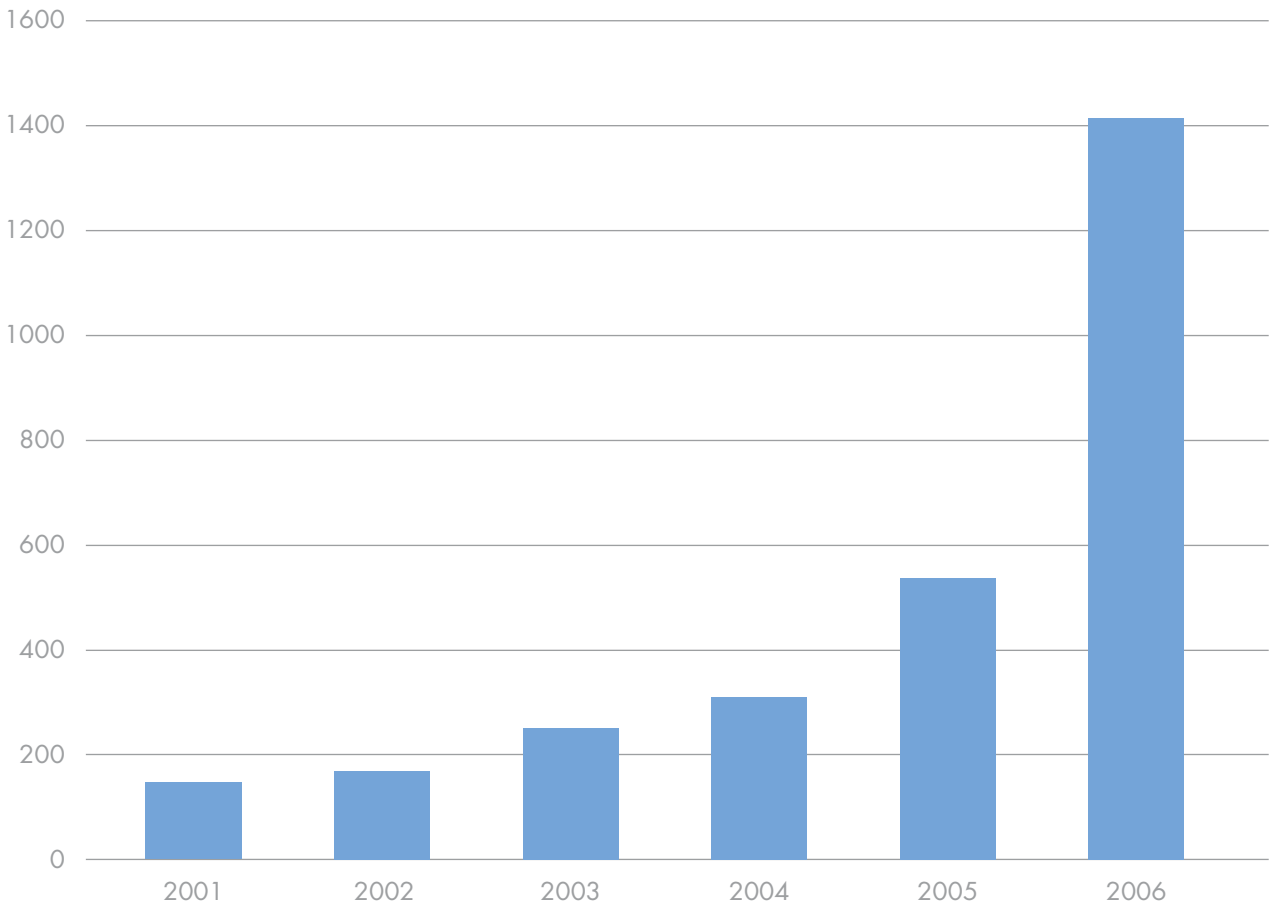
Perhaps the most notable new development was the launching of the Evangelical Climate Initiative, in which conservative evangelical Christians embraced the issue and called for urgent political action. The entire spectacle was capped by former Vice President Al Gore's *An Inconvenient Truth* receiving the Academy Award for Best Documentary Feature. Gore's movie, and his relentless promotion of the issue, is remarkable for its audacity. Not since Abraham Lincoln in 1858 and 1859 has a potential president staked so much on trying to move public opinion on a single issue. However, as George Will caustically commented, "Dismayed by the Kansas–Nebraska Act and then the Dred Scott decision, Lincoln did not exclaim: 'That does it! Instead of running for president, I am going to prepare a PowerPoint presentation.' "

TIPPING POINT FOR "TIPPING POINTS"?

Ever since Malcolm Gladwell elaborated the idea of the "tipping point" in his 2001 book of that title, we have been at risk of allowing a cliché to do our thinking for us. We have seen tipping points in Iraq, in federal budget "earmarking," in the election cycle just passed, and especially in the environment. This is nowhere more evident than in climate change, where the "tipping point" meme, and its close relatives, have come to dominate media discussion of the issue. "This 'tipping point' scenario has begun to consume many prominent researchers in the United States and abroad," the *Washington Post*'s Juliet Eilperin reported on the front page in January.[3] *New York Times* columnist Thomas Friedman wrote: "We reached a tipping point this year" on environmentalism generally. Gore himself says we may have only 10 years left "before we cross a point of no return."[4] CBS News correspondent Scott Pelley narrated a *60 Minutes* segment on NASA's chief climate scientist, James Hansen, saying, "Hansen says his research shows that man has just 10 years to reduce greenhouse gases before global warming reaches what he calls a *tipping point* and becomes unstoppable."[5] Hansen told *Time* magazine directly, "We are getting close to a *tipping point*," and *Time* announced in a headline: "Earth at the Tipping Point."[6] Hansen has company from Professor Michael Mann, co-author of the famous "hockey stick" reconstruction of the earth's temperature history, who told *Seed* magazine that "we may be starting to breach some *tipping points*."[7] "WORLD FACING TIPPING POINT ON WARMING," the *Wichita Eagle* announced. And so it goes.

The theme is not limited to American media outlets; the BBC is also fond of it, and the British newspaper *The Independent* wrote that "a crucial global warming *'tipping point'* for the Earth has already been passed."[8] (Emphasis added in all cases.) If the media say so in harmony, then it must be true. As a retired clergyman told the *Atlanta Journal-Constitution*, "Man, when those big publications spend that much time with it, then things have tipped!"[9] Figure 5 displays the trend in the incidence of the term "tipping point" in stories discussing climate change from 2001 through 2006 as revealed in a search of the Nexis database of newspaper and magazine articles.

Figure 5: Incidence of "Tipping Point" in Climate-Change News Articles



(Source: Author query of Nexis news database)

This trend caught the jaundiced eye of *Nature* magazine, which normally aligns itself with the climate pessimists. Noting in an editorial that the notion of a "tipping point" "is now being ever more frequently deployed in the debate about the world's climate," *Nature* cautioned: "It is reasonable to worry about such things, but there are three dangers attendant on focusing humanity's response to the climate crisis too much on tipping points. The first is the uncertainty of the science; the second is the tendency of such an emphasis to distort our responses; the third is the danger of fatalism.... Anyone claiming to know for sure when a particular tipping point will be reached should be treated with suspicion."[10]

Concern about climate change turns out to be the anomaly of public opinion about the environment. Gallup's spring 2006 environmental survey concluded that "the environment barely registers as a top-of-mind concern for the public when Americans are asked to name the country's top problem….The American public does not have a sense of urgency about the environmental issue at this time." Delving into the internals of Gallup's survey reveals some interesting paradoxes.

The number of respondents who believe environmental quality in the United States is getting worse has increased nearly 18 percent over the last half-decade (see Figure 6). However, when the questions focus on individual environmental issues, Gallup's data reveal mostly declining trends: fewer respondents answer that they worry "a great deal" about air pollution, water pollution, toxic contamination, and so forth. With the exception of global warming, the number of people who say they worry "a great deal" about individual environmental problems has declined between 15 and 25 percent since 1989 (see Figure 7). This would also track with Harris Poll findings, which indicate a long-term uptrend in the number of people who report satisfaction with the quality of their local environment over the last decade (see Figure 8). Unfortunately Harris has not updated this question since 2004.

How do we explain the apparent paradox of increasing general pessimism about the environment alongside decreasing concern for individual environmental problems, not to mention the low salience of the whole issue? Perhaps the public's declining concern over individual environmental problems reflects perception of the positive trends in actual conditions as reported here and elsewhere for the last decade. The general pessimism may reflect the fine distinction historian John Lukacs offers between public *sentiment* and public *opinion*: "Opinion and sentiment are not always the same." Public opinion, Lukacs offers, is what people really believe, while public sentiment is what people think they are *supposed* to believe.

Lukacs reminds us of the observation James Fenimore Cooper made in *The American Democrat* in 1838: "Men actually yield their own sentiments to that which *they believe to be* the sentiment of the majority."[11] [Emphasis added.] The general pessimism found in Gallup's polls probably reflects the default sentimental pessimism of the conventional environmental movement as well as the crisis-mode coverage of most environmental issues in the media. This subtle distinction might also explain the durability of the long-term narrowing of the gap between the proportion of respondents who say environmental protection should take precedence and those who favor economic growth, as displayed in Figure 9.

For the last few years the gap has been much smaller than the historic average seen in the 1980s and 1990s. Two other findings of Gallup's annual survey are worth mentioning.

First, as Gallup puts it, "Attitudes on the environment are highly partisan; a plurality of Republicans (47 percent) are positive about environmental conditions, contrasted with only nine percent of Democrats." This tracks some other survey data that show Republicans tend to be more optimistic across the board, such as the Pew poll on election day 2006, which found Republicans markedly more optimistic than victorious Democratic voters.[12]

Second, the combination of higher energy prices and the ferment over global warming appears to have contributed to a significant shift in public attitudes toward nuclear power. After several years in which a slim majority of poll respondents expressed opposition to nuclear power, in 2006 a majority responded favorably to the idea (see Figure 10).

Figure 6: Gallup Poll: Do You Think the Quality of the Environment in the Country Is Getting Better or Getting Worse?

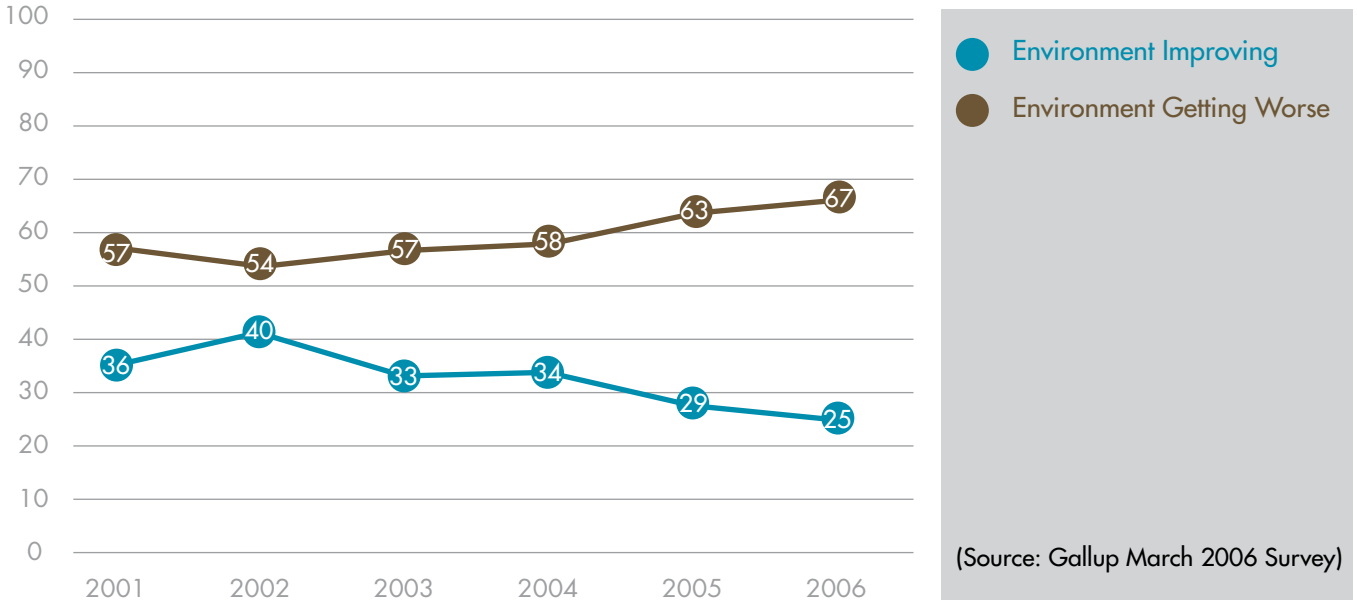


Figure 7: Percent of Respondents Who Say They Worry "A Great Deal" About…

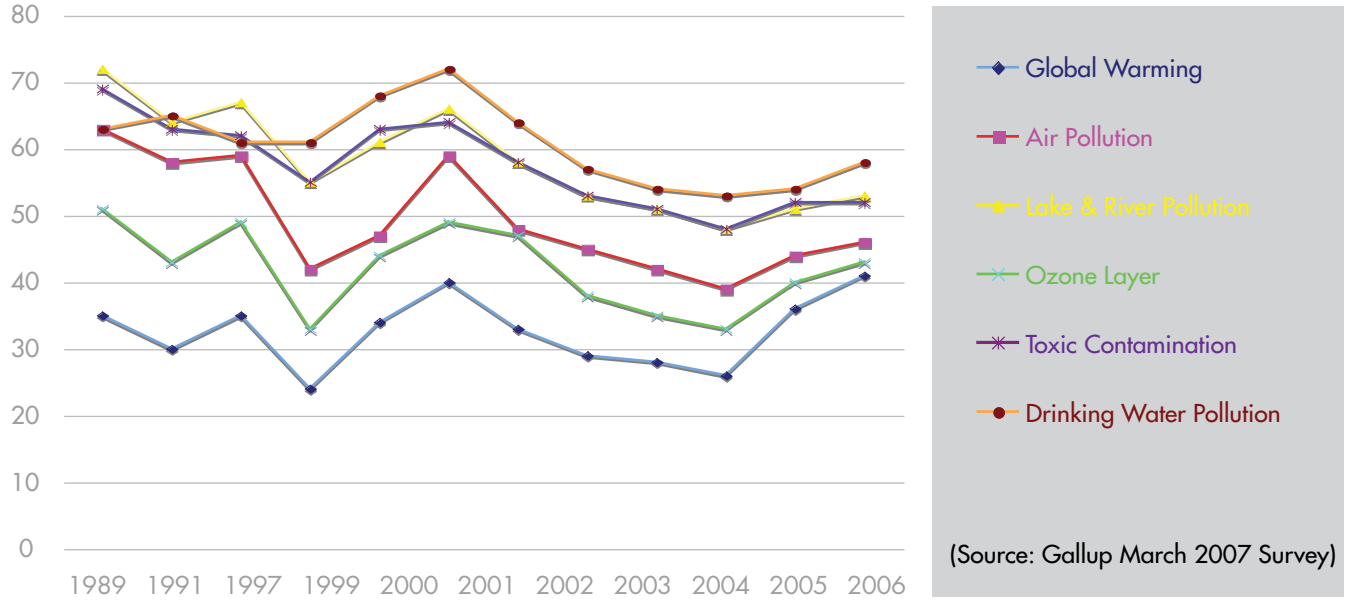
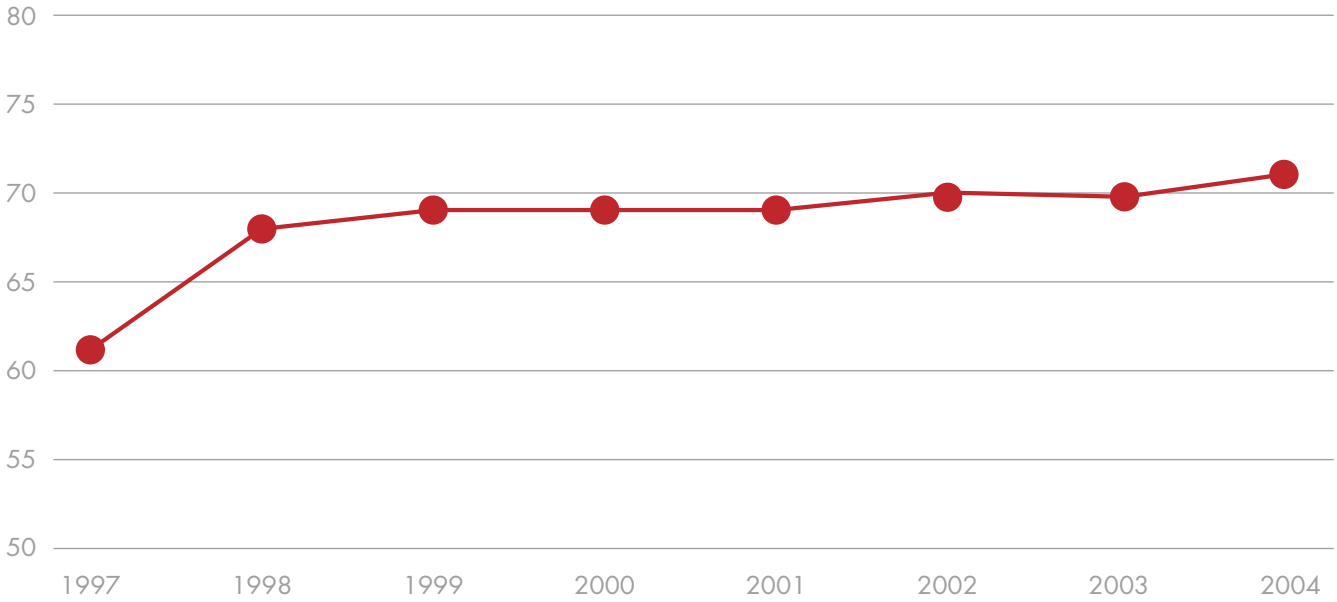
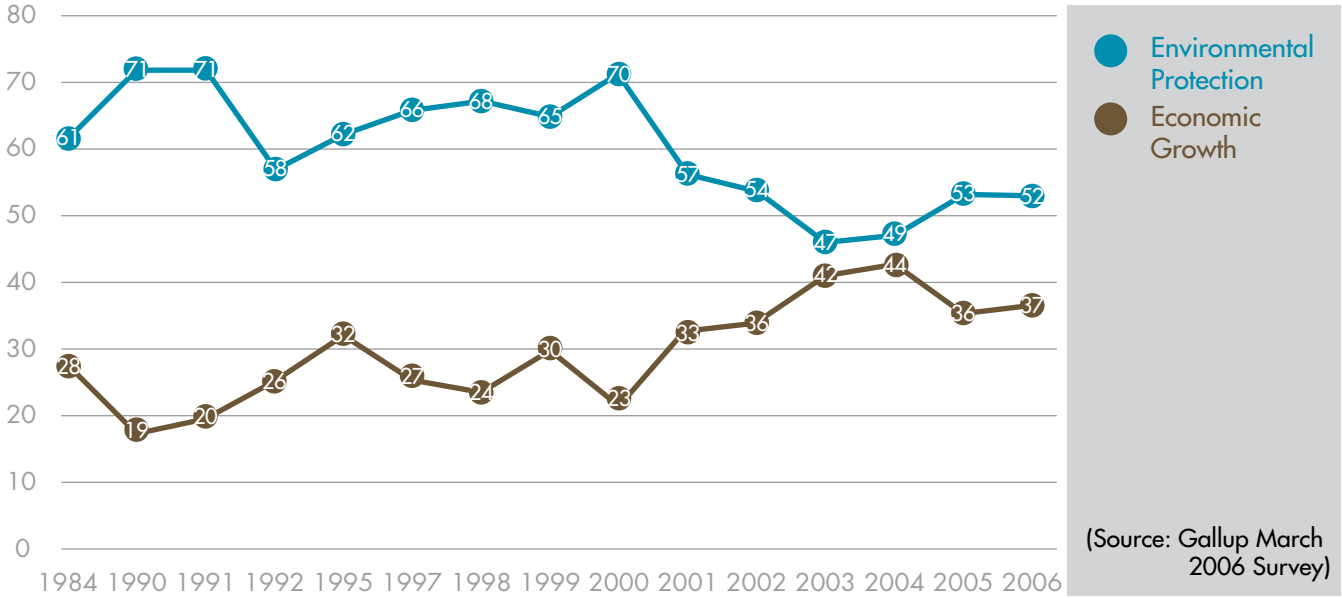


Figure 8: Harris Poll: Do You Feel Good About the Quality of the Air, Water, and Environment Where You Work and Live?



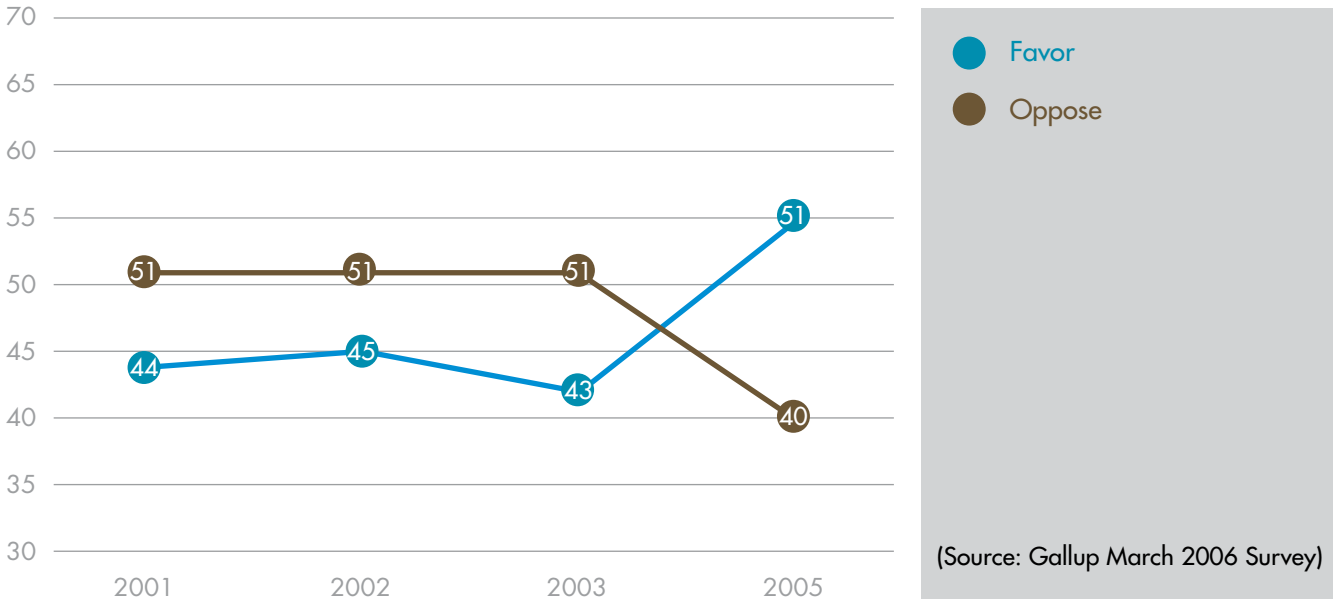
(Source: Harris Poll)

Figure 9: Gallup Poll: Should Environmental Protection or Economic Growth Have Priority?



(Source: Gallup March 2006 Survey)

Figure 10: Gallup Poll: Do You Generally Favor or Oppose Expanding the Use of Nuclear Energy?



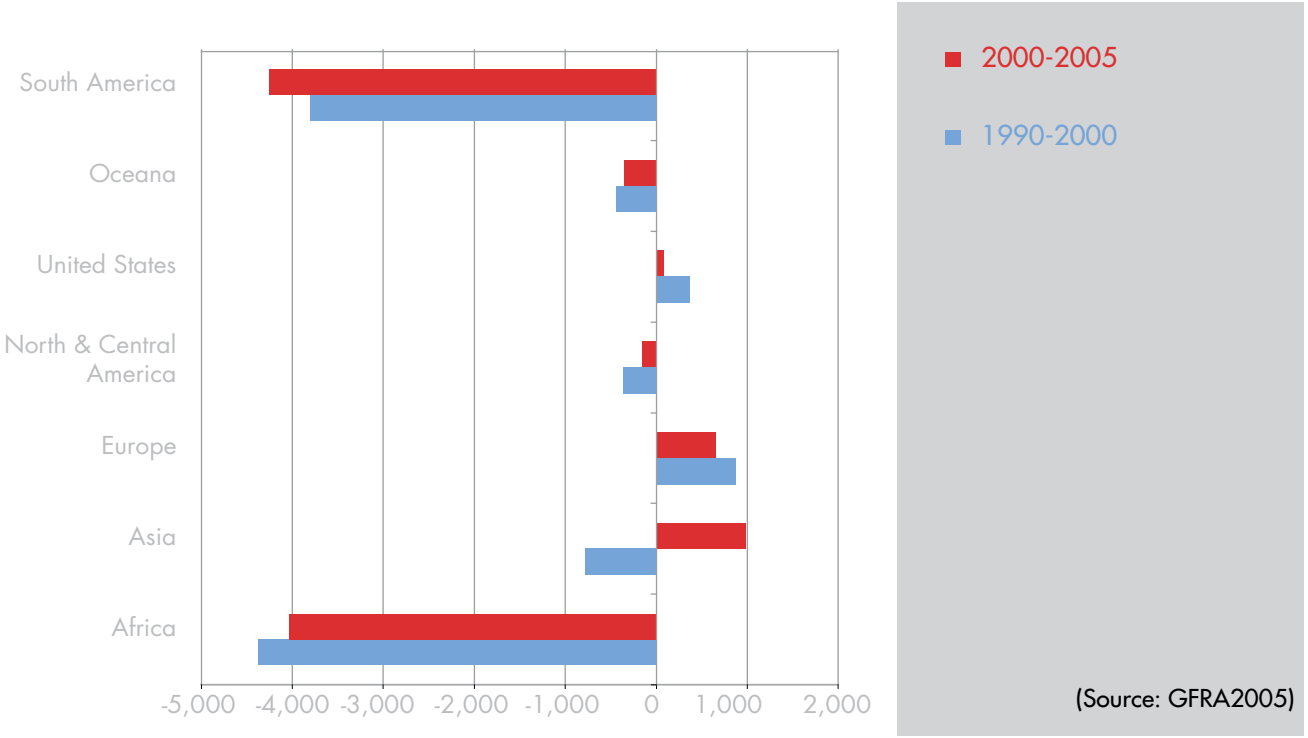
Elsewhere in this edition we review in more detail the highlights of climate-change issues and data indicators from the past year, but here we must wonder whether climate change should eclipse other environmental issues to the extent that it currently does. A number of significant developments and milestones in 2006 deserved notice and attention but were largely drowned out.

II. Global and National Forest Trends

Two important studies of global forest trends appeared in 2006: the 2005 *Global Forests Resources Assessment* (GFRA2005[13]) of the United Nations Food and Agriculture Organization, and a study in the *Proceedings of the National Academy of Sciences* (PNAS) on the idea of "Forest Identity." Both reports provide findings about world forest trends that fundamentally revise current perceptions of global deforestation and offer additional confirmation of one of the central observations we have been making from the inception of this annual report: environmental improvement correlates with economic growth.[14]

The GFRA2005 found that while global deforestation (mainly through conversion to crop and grazing land) continues at a rate of about 13 million hectares (50,000 square miles) per year, the annual net loss of forests has fallen from about 8.9 million hectares per year over the period 1990–2000 to 7.3 million hectares per year over the last five years. Reforestation efforts are mitigating some of the overall forest loss, and appear to be accelerating. Nearly all the net loss of forest land is occurring in Africa (losing 4 million hectares a year) and South America (losing 4.3 million hectares a year).

Figure 11: Annual Net Change in Forest Area by Region, 1990–2000; 2000–2005



One of the more significant findings of the GFRA2005 is that Asia has reversed its net deforestation trend, as shown in Figure 11. Asia lost 792,000 hectares of forest between 1990 and 2000, but gained slightly more than one million hectares from 2000 to 2005. Most of this gain comes from massive reforestation in China, which has added an average of more than four million hectares of forest per year over the last five years (see Table 1). Unfortunately, Indonesia and Brazil are still losing forest land at a high rate, as are most African nations. Overall the global rate of deforestation declined by 18 percent over the last half-decade.

Working with data from the GFRA2005, a multinational team of researchers created the concept of "Forest Identity," published in the PNAS in November.[15] With "Forest Identity" the authors go beyond mere surface area of tree growth; they examine specific attributes and variables of forests such as the density and total biomass of forest growth. Most important, from a climate-change perspective, they examine the amount of carbon sequestered in forest growth.

What is notable from Figure 11 and Table 1 is that the worst deforestation is occurring predominantly in poorer areas. It will not be surprising to regular readers of the *Index of Leading Environmental Indicators* that the authors of the PNAS study found a high correlation between income levels and reforestation. The PNAS study concludes, "[N]o nation where annual per-capita gross domestic product exceeded $4,600 had a

Table 1: Countries with Largest Net Loss and Net Gain in Forest Area, 2000–2005

Country	Annual Change (1,000 ha/yr)	Country	Annual Change (1,000 ha/yr)
Brazil	–3,103	China	4,058
Indonesia	–1,871	Spain	296
Sudan	–589	Vietnam	241
Myanmar	–466	United States	159
Zambia	–445	Italy	106
Tanzania	–412	Chile	57
Nigeria	–410	Cuba	56
Congo	–319	Bulgaria	50
Zimbabwe	–313	France	41
Venezuela	–288	Portugal	40
Total	–8,216		5,104

(Source: GFRA2005)

negative rate of growing stock change." This led the authors to develop the working idea of "forest transition," i.e., the point at which a nation reverses deforestation and begins to add forest land. In Europe and the United States, the forest transition point was reached in many areas in the mid- to late-19th century. The study observes: "In Connecticut, where the first U.S. transition occurred, forests expanded from 29 percent of the state in 1860 to 60 percent in 2002. Subsequent reports of forest areas in states show a diffusion of forest transition generally west and south." The trends seen in the 19th and early 20th centuries in Europe and North America are now appearing in the developing world:

> In tropical developing El Salvador, a survey that encompassed secondary growth, pasture successions, living fences, tenure demarcations, urban forests, and orchards revealed that land with 25 percent tree cover expanded from 72 percent to 93 percent between 1992 and 2001. Forests are recovering in Puerto Rico and the Dominican Republic, next to deforested Haiti….A forest transition has taken place in Japan since World War II.[16]

Forest trends—especially reforestation—are significant for many reasons, the two most important being the effect on biodiversity and on carbon sequestration, a subset of the natural carbon cycle. Although there are significant gaps in the data and discrepancies between different data sets, the GFRA2005 reports some significant positive findings. Though the rate of deforestation of primary forests is "alarmingly high," there has also been a 32-percent increase in the amount of primary forest land set aside for biodiversity conservation since 1990. The GFRA2005 identified 96 million hectares of new conservation forest land, occurring in all regions of the planet except northern, eastern, and southern Africa, for a global total of 400 million hectares. This figure represents about 11 percent of the globe's total forest area. Between 2000 and 2005, the United States added nearly 10 million hectares (38,000 square miles) of forest land to conservation status.[17]

Limitations and gaps in the data make it more difficult to arrive at reliable estimates of trends in forest carbon storage, but the GFRA2005 finds generally that between 1990 and 2005 carbon biomass declined in Africa, Asia, and South America, while it increased in Europe and North America. Once again, these trends correlate roughly with wealth and economic growth; the nations with the highest growth rates of carbon biomass were Chile, China, most European countries, India, Japan, and the United States. The United States added carbon biomass of 146 million metric tons per year over the last five years in its forest lands, which amounts to roughly nine percent of net U.S. carbon emissions per year.

Not surprisingly, the worst-performing continent in the GFRA2005 was the poorest—Africa. In the midst of this continuing bad news, however, a case study emerged that vindicates the principle that property rights and economic growth can have significant and rapid benefits even in the most impoverished nations. The *New York Times* reported in February of this year that significant reforestation is taking place in Niger.[18] Niger, new studies show, is now greener than it was 30 years ago. "Millions of trees are flourishing," the *Times*' Lydia Polgreen reported. More than seven million acres of land have been reforested, "without relying on the large-scale planting of trees and other expensive methods often advocated by African politicians and aid groups for halting desertification."

How did this turnaround come about? Polgreen explains:

> Another change was the way trees were regarded by law. From colonial times, all trees in Niger had been regarded as the property of the state, which gave farmers little incentive to protect them. Trees were chopped for firewood or construction without regard to the environmental costs. Government foresters were supposed to make sure the trees were properly managed, but there were not enough of them to police a country nearly twice the size of Texas.
>
> But over time, farmers began to regard the trees in their fields as their property, and in recent years the government has recognized the benefits of that outlook by allowing individuals to own trees. Farmers make money from the trees by selling branches, pods, fruit and bark. Because those sales are more lucrative over time than simply chopping down the tree for firewood, the farmers preserve them.

III. China Update

The data in the previous section regarding China's aggressive reforestation program prompt an update of the extensive discussion of Chinese environmental prospects and trends in last year's *Index*. The special section on China considered the application of the "Environmental Kuznets Curve" (EKC)—which holds that economic growth is the basis of environmental improvement—and noted a number of trends indicating that China might be nearing a transition point after which its environment would begin to show marked improvement. Recent news, however, makes that transition point seem a bit further off.

"China Reveals That Pollution Is Getting Worse," the *Wall Street Journal* reported in an August 20 headline. The story noted a critical report from the Environment and National Resources Protection Committee of the National People's Congress, which detailed stagnant or negative trends in air and water pollution. According to the most recent data from China's State Environmental Protection Agency, sulfur dioxide (SO_2) emissions, chiefly from coal-fired power plants and steel mills, have risen more than 25 percent over the last four years (see Figure 12). Meanwhile, discharge of untreated wastewater has increased 26 percent since 2000, despite massive investment in new wastewater treatment facilities. Chinese air pollution is estimated to cause more than 400,000 premature deaths a year. Near the end of the year China reported that it is considering an SO_2 emission trading program similar to that used in the United States to curb acid rain.

Ironically, these gloomy high-profile Chinese government reports and news stories may be an indicator that the EKC transition point is closer at hand than is widely thought. In Hong Kong, for example, recent opinion polls and surveys of business leaders show that air pollution is considered a significant *economic* issue for the city. "Hong Kong Smog Hurts Business," the *Wall Street Journal* reported in October, noting that high pollution levels are starting to deter some executives from relocating to the city, while some employers are now having to offer hardship bonuses on top of already generous compensation packages.

China Reveals That Pollution Is Getting Worse

By Shai Oster

BEIJING—China's notoriously pol-
luted capital will be cleaned up by the
hosts the 2008 Olympic Games,

Hong Kong Smog Hurts Business

By Jane Spencer

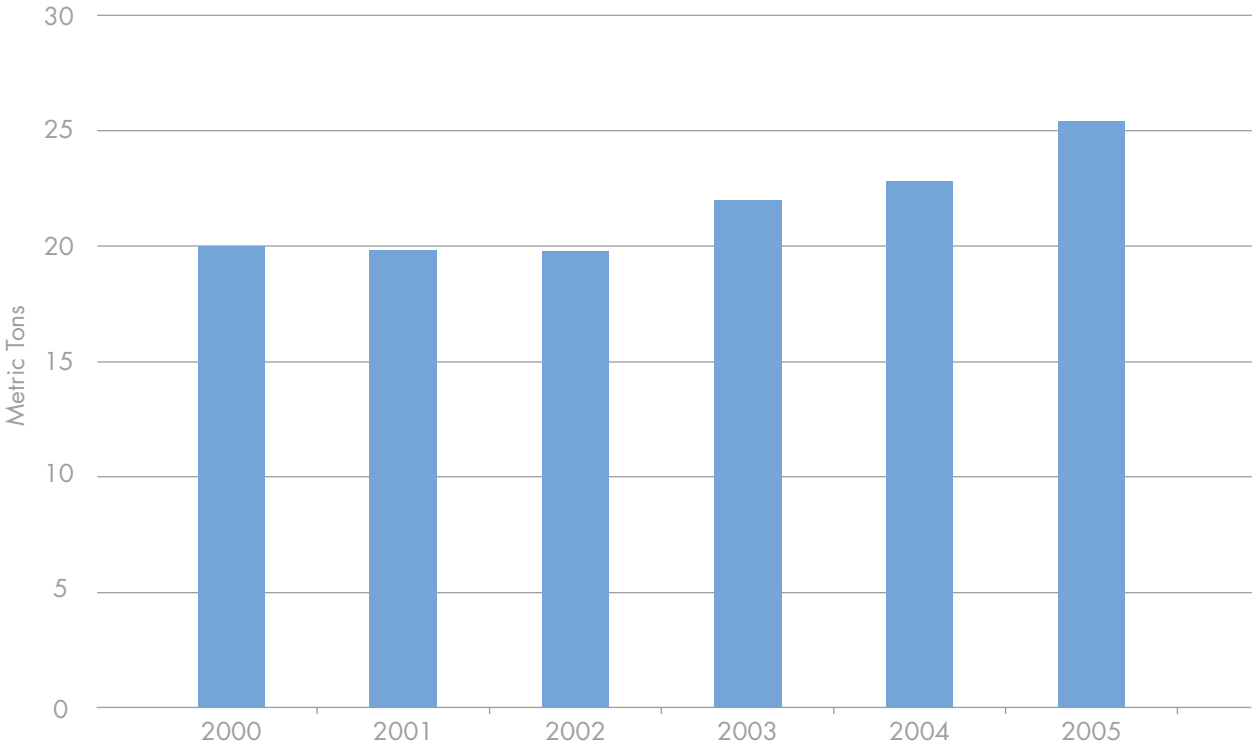
The smog hanging over Hong Kong is
threatening more than the views of its fa-
mous setting: Air pollution is making the
city less attractive to foreign investors and
is driving some executives out, according
to a survey by the American Chamber of
Commerce in Hong Kong.

of international companies with a Hong
Kong presence, including FedEx Corp.,
Morgan Stanley, Time Warner Inc. and
Exxon Mobil Corp. It will be circulated to-
day in the August issue of "AmCham," the
chamber's magazine.

Air pollution was of particular concern
to executives with families and children.
Of the respondents, 95% said they were

Nearly 40 percent of employers reported in an A.C. Nielsen survey that they are having difficulty recruiting employees because of high pollution, while 79 percent said high pollution levels are making Hong Kong less attractive to foreign firms. The rising economic pressures on environmental quality in China will likely offer another vindication of the positive effects of globalization.

Figure 12: SO_2 Emissions in China



(Source: State Environmental Protection Agency)

IV. Energetic Investment in Alternative Energy

"There is a world-wide boom in investment in green technology already under way." So says Alun Anderson, former editor-in-chief of *The New Scientist*, in Edge.org's quirky annual symposium of experts on the subject "What Are You Optimistic About?"[19] Indeed, even as the political class in Washington continues to gnash its teeth and wring its hands over energy policy and to demand that the United States embark on a "Manhattan Project for clean energy," the private sector is quietly dashing ahead with the job.

The volatile market for oil and natural gas over the last few years, combined with the increasing interest in developing low- or non-carbon forms of energy for the purpose of climate-change abatement, has led to a significant increase in venture-capital investment in alternative energy. Bill Gross of Idealab calls it "a distributed Manhattan Project." "What you find when visiting U.S. innovation hubs," *New York Times* columnist Thomas Friedman wrote in a May 2006 column, "is that no one is waiting for Washington to declare the next big Manhattan Project for, say, energy independence. American innovators are growing their own."

Since much private equity investment is not publicly disclosed, accurate estimates of alternative-energy investment are hard to generate. According to one estimate from Venture Business Research, private investment in alternative energy accounted for more than eight percent of total venture-capital spending in the United States in 2006, up from about only one percent in 1998 (see Figure 13). Total alternative-energy investment from all sources is thought to have more than doubled, from $30 billion in 2005 to more than $63 billion in 2006. The stepped-up investment may be starting to pay off in terms of scaled-up energy supply. Figure 14 displays the trend in installation of solar photovoltaic capacity worldwide.

Many of the leading venture capitalists who propelled the Internet and technology boom of the 1990s now see alternative energy as "the next big thing." Ray Lane, a partner in the powerhouse venture-capital firm Kleiner, Perkins, Caufield & Byers (KPCB), says, "This is bigger than the Internet, I think by an order of magnitude. Maybe two." KPCB is investing more than $100 million in clean technology; KPCB's John Doerr is hopeful that the tech community can discover for alternative energy the equivalent of Moore's Law for microchips (i.e., the progressive doubling of capacity combined with a consistent fall in price).[20]


Kleiner's Green Investment Machine

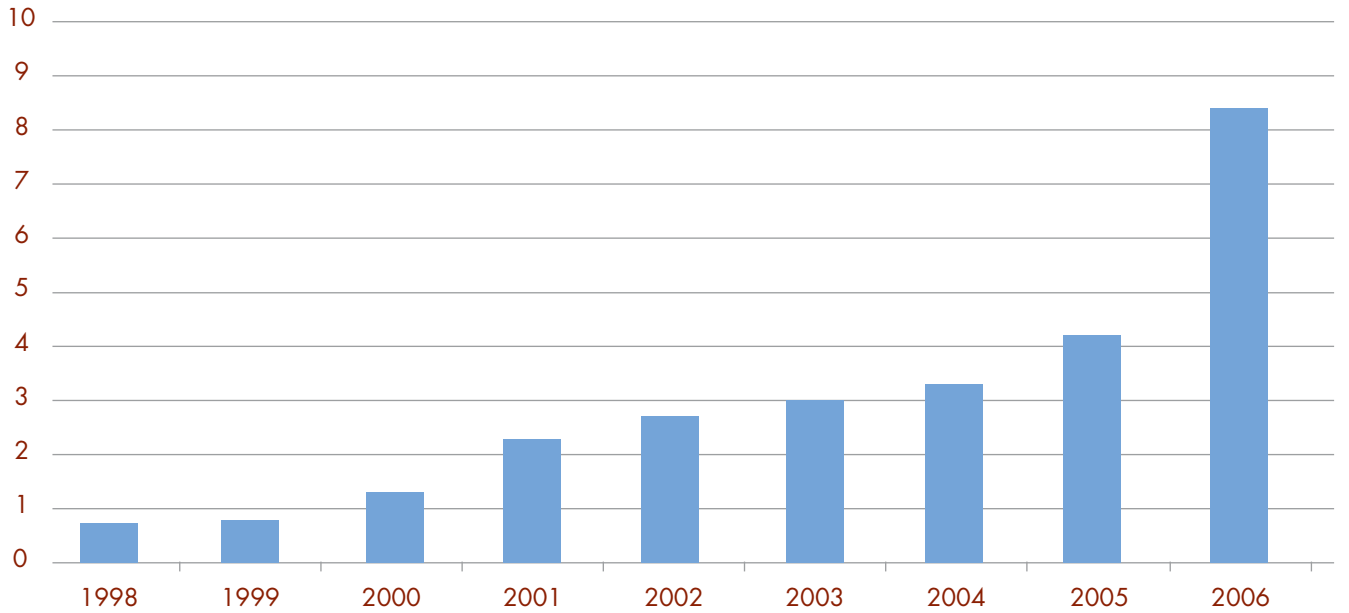
Why the Fledgling Clean-Tech Industry Is Gaining Interest Among Venture-Capital Firms

By Jim Cramer

Of course, cynics will note that the Internet bubble ended in tears for many and will wonder whether we may be seeing the beginning of an "alternative-energy bubble." "The flood of money into clean energy is better news for society than it is for investors," *The Economist* cautions. "Almost all clean energy relies on government subsidies to make it competitive with fossil fuels." This raises the problem that some private investment may be directed more toward rent-seeking opportunities than toward technologies with intrinsic merit.

The growth of wind power in the United States, for example, is wholly dependent on highly generous tax incentives, without which very little wind power would be developed. The wind-power tax incentives

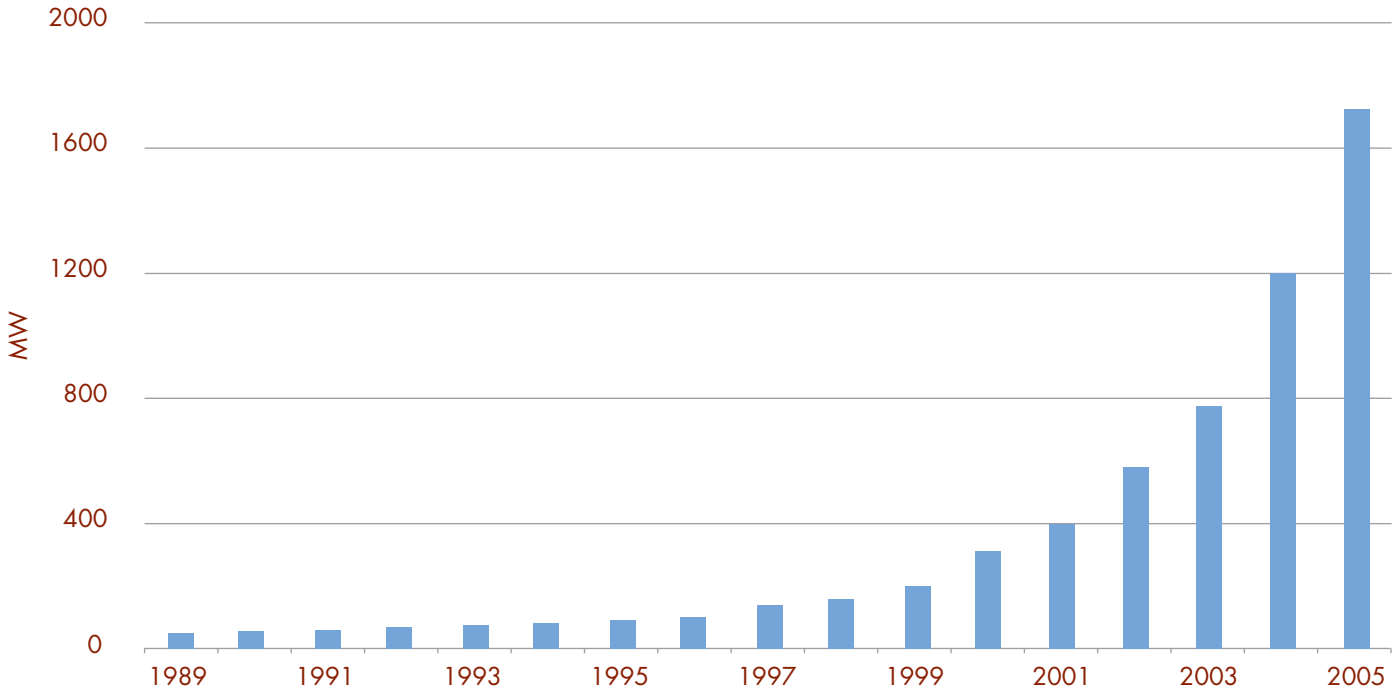
Figure 13: Venture-Capital Investment in Clean Energy



(Source: Venture Business Research)

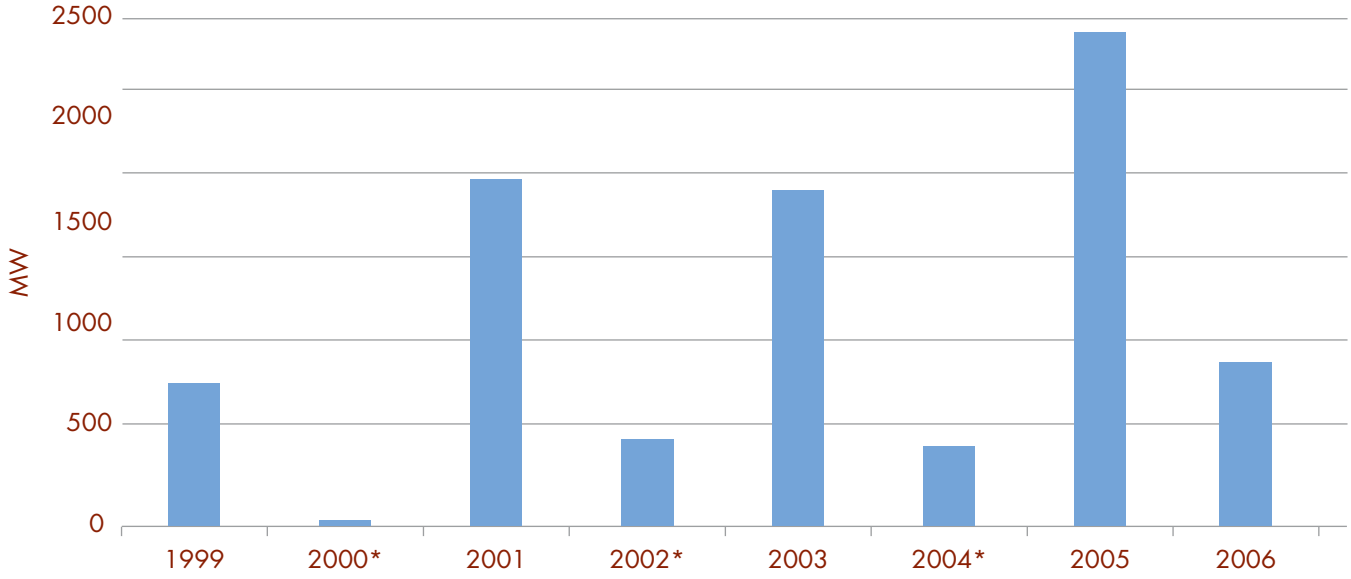
expire every other year, and, as Figure 15 shows, wind-power installation slows to a trickle when the tax subsidy is absent. This is not a recipe for sustainable energy in the fullness of time. As *The Economist* notes, "Fashions fade, and voters may begin to question the logic of certain subsidies as ever more firms take advantage of them and the bills begin to rise … The prospects of a business so dependent on the whims of politicians are bound to be uncertain."[21]

Figure 14: Global Shipments of Solar Photovoltaic Capacity



(Source: U.S. Department of Energy)

Figure 15: Installed U.S. Windpower Capacity, 1999–2006



(*Tax Credit Lapsed)
(Source: American Wind Energy Association)

V. Miscellaneous News You May Have Missed

- One of the most significant developments of 2006 was the decision by the World Health Organization, following the lead of the U.S. Agency for International Development (USAID), to support the use of DDT to control malaria in the developing world, especially in Africa, where one million people a year are estimated to perish from the disease. *Nature* magazine noted that DDT is "possibly the most reviled chemical on the planet." The return of DDT represents the slow triumph of science over sensationalism, and a long-overdue reversal of the legacy of Rachel Carson's *Silent Spring*. The 10th edition of the *Index* (2005) noted the bracing judgment of the *New York Times*' Tina Rosenberg, who wrote, "DDT killed bald eagles because of its persistence in the environment. *Silent Spring* is now killing African children because of its persistence in the public mind."[22] Rosenberg's revisionist views are now gaining endorsements from the medical community. Don Roberts, professor of tropical public health at the Uniformed Services University of the Health Sciences in Maryland, told *Nature*: "I think the whole push of the environmentalists like Rachel Carson and many others to eliminate all uses of DDT [is], quite honestly, responsible for millions and millions and millions of human deaths."[23]

- Greenpeace, Meet Cookie Jar: Environmentalists often bristle when charged with being addicted to gloom-and-doom messages, but every now and then an environmental group will confirm the stereotype. In April 2006 Greenpeace mistakenly posted an incomplete draft press release on its Web site that read: "In the twenty years since the Chernobyl tragedy, the world's worst nuclear accident, there have been nearly [FILL IN ALARMIST AND ARMAGEDDONIST FACTOID HERE]."

- Finally, *National Journal* correspondent and blogger Danny Glover (www.carnivaloftribute.blogspot.com) offers this musical "Tribute to the EPA" from his late grandfather Wayne ("Grandpa Tumblebug") Kerns:

When the EPA gets a hold on you,
they say, "Now, sir, this is what you're gonna do!"
And when you get it done, they say,
"This is not enough."
Now we gotta change it, or they'll slap a fine on us.

They closed up the steel mills, they shut down the mines;
now they're working on oil and gas for a time.
If you wonder why the fall in our economic way,
you can put the blame completely on the EPA.
They tell us that freon, which is heavier than air,
floats up to the ozone and makes a hole up there.
They try to tell us that the earth is warming up from this;
if it gets any warmer, we will all freeze to death.

Now chlorine is a chemical that's used everywhere,
From the kitchen to industry and chemical warfare.
It purifies our water and makes it safe to use,
Now the EPA thinks that's gotta go, too.
The people of the USA should be aware
what the EPA is doing to our country fair.
Now our jobs are gone and our factories are dead.
We have to buy our clothes from the Orient instead.
When our Congress set up the EPA,
they gave it the power to destroy USA.
What Hitler and Tojo couldn't do across the tide,
Now the EPA is doing inside.

Chorus:
They say, "You gotta change this, you gotta change that."
They make so many changes that I don't know where I'm at.
They're paddin' up their bank accounts with our money
While they play a little game called their "job security."

Glover's full tribute can be found at: http://beltwayblogroll.nationaljournal.com/archives/2006/07/grandpa_tumbleb_1.php. You can hear Grandpa Tumblebug's musical performance of the "Ode" at: http://carnivaloftribute.blogspot.com/2006/07/grandpa-tumblebug-ode-to-epa_04.html.

Notes

1 Stephen Ansolabehere, Thomas E. Curry, and Howard Herzog, "Trends in Public Attitudes on Global Warming," MIT, October 2006, available at http://sequestration.mit.edu/research/syrvey2006.html.
2 Irene Lorenzoni and Nick F. Pidgeon, "Public Views on Climate Change: European and USA Perspectives," *Climatic Change*, No. 77 (2006), pp. 73–95.
3 Juliet Eilperin, "Debate on Climate Shifts to Issue of Irreparable Change," *Washington Post*, January 29, 2006, p. A1.
4 Cited in George F. Will, "Warming to a Candidacy?" *Washington Post*, June 11, 2006, p. B7.
5 From Nexis transcript, *60 Minutes*, March 19, 2006.
6 *Time*, March 24, 2006.
7 *Seed*, April 18, 2006.
8 Michael McCarthy, "Greenhouse Gases Are Already Past Threshold That Spells Disaster," *The Independent*, February 11, 2006, p. 2.
9 Stacey Shelton, "Studies change debate's climate; Naysayers persist, but evidence gives credence to concerns," *Atlanta Journal-Constitution*, July 11, 2006, p. 1C.
10 "Reaching a Tipping Point," *Nature*, June 15, 2006, p. 785.
11 John Lukacs, *A New Republic: A History of the United States in the Twentieth Century* (New Haven: Yale University Press, 2004), pp. 264–265; see also Lukacs's longer discussion of public opinion and public sentiment in *Historical Consciousness, or, The Remembered Past* (New York: Schocken Books, 1985), pp. 75–85.
12 "America's Optimists: More Republican, but Fewer of Them," November 20, 2006; http://pewresearch.org/obdeck/?ObDeckID=94.
13 Available at http://www.fao.org/docrep/008/a0400e/a0400e00.htm.
14 See especially Steven F. Hayward, "The China Syndrome and the Environmental Kuznets Curve," *Environmental Policy Outlook*, November–December 2005. Available at http://www.aei.org/publications/pubID.23617/pub_detail.asp.
15 Pekka E. Kauppi, Jesse H. Ausubel, Jingyun Fang, Alexander S. Mather, Roger A. Sedjo, and Paul E. Waggoner, "Returning Forests Analyzed with the Forest Identity," *Proceedings of the National Academy of Sciences*, November 14, 2006, available at www.pnas.org/cgi/doi/10.1073/pnas.0608343103.
16 Kauppi et al, p. 17,575.
17 GFRA2005, p. 39.
18 Lydia Polgreen, "In Niger, Trees and Crops Turn Back the Desert," *New York Times*, February 11, 2007.
19 http://edge.org/q2007/q07_index.html. Several of the more than 150 scientists and thinkers who responded to the survey mentioned energy and the environment as reasons for optimism. Ray Kurzweil wrote, "I am confident that the acceleration and expanding purview of information technology will solve the problems with which we are now preoccupied within twenty years…. Almost all of the discussions I've seen about energy and its consequences such as global warming fail to consider the ability of future nanotechnology based solutions to solve this problem. This development will be motivated not just by concern for the environment, but by the $2 trillion we spend annually on energy. This is already a major area of venture funding."
20 Jim Carlton, "Kleiner's Green Investment Machine," *Wall Street Journal*, December 14, 2006, p. B3.
21 "Green Dreams," *The Economist*, November 18, 2006, p. 13.
22 Tina Rosenberg, "What the World Needs Now Is DDT," *New York Times Magazine*, April 11, 2004.
23 Apoorva Mandavilli, "DDT Returns," *Nature* online, July 27, 2006, http://news.nature.com//news/2006/060724/nm0806-870.html.

Black Ink, Green News: Media Roundup 2006

By Steven F. Hayward

"Were it not for the obvious ramifications for ratings and circulation, the media would love to cover the End of the World."

—*Washington Post* reporter
Joel Achenbach, May 28, 2006

CLIMATE CHANGE SO OVERWHELMED the 2006 media coverage of the environment that it seems all other environmental coverage combined couldn't equal the column inches and broadcast minutes spent on climate. The climate monomania so annoyed Michael Palmer, general manager of two TV stations in Maine (WVII and WFVX), that he issued an edict to the news staffs to stop covering global warming "until Bar Harbor is under water."

A few other media organizations did manage to break from the pack to report some contrarian—as opposed to skeptical—climate perspectives. In April, BBC Radio produced "Overselling Climate Change," a special broadcast report featuring such heterodox themes as government and media overstating the most sensational and extreme climate-change claims. The BBC reported that "all of the climate scientists we spoke to fervently believe global warming is being caused by human activity. Many agree there's also a major problem with alarmism." One scientist told the BBC: "If we cry wolf too loudly or too often, no one will believe us when the beast actually comes for dinner."[1]

The *Los Angeles Times* distinguished itself, as in our previous surveys, with a front-page feature expressing doubt that the summer heat wave of 2006 should be taken as a certain indicator of climate change. In "Hot? Yes. Global Warming? Maybe," *Times* staff writers Robert Lee Hotz and Erin Cline report that "few events occur with such regularity or are so quickly forgotten as Southland heat waves…. Climate experts cautioned that no single event—no matter how unusual—could be directly attributed to global warming and the effects of pollution. 'To call it global warming would be overdoing it,' said climatologist Daniel R. Cayan of Scripps and the U.S. Geological Survey. 'This is largely natural variability.'"

The story also noted past heat waves that have faded from memory: "In July 1931, sweltering Angelenos bemoaned the 37th straight day of extreme high temperatures—at that point the longest stretch of hot, humid local weather in the history of the National Weather Service. Few recalled that, a generation earlier, as temperature records were shattered in July 1891, perspiring businessmen sought shelter in the cool of the Grand Opera House and worried that such searing temperatures might mar efforts to market California's perfect climate to Easterners."[2]

In August, *Boston Globe* columnist Alex Beam broke from the media pack with a column defending MIT climatologist Richard Lindzen from the persistent attacks he receives from former Vice President Al Gore and other climate pessimists. When Beam heard that "the debate is over" and that skeptical arguments like Lindzen's should be dismissed out of hand, his natural journalistic instincts kicked in: "Are these convincing arguments? And directed at journalists, who are natural questioners and skeptics, of all people? What happens when you are told not to eat the apple, not to read that book, not to date that girl? Your interest is piqued, of course. What am I not supposed to know?" Beam decided to hear out Lindzen for himself. After meeting with him and considering his perspective, Beam concluded: "Lindzen isn't a fake scientist, he's an inconvenient scientist. No wonder you're not supposed to listen to him."[3]

Other Environmental News and Analysis

Even with the media's constant focus on climate change, other environmental stories did break through. Both *The Economist* and *Newsweek* ran cover stories with the same theme: "The Greening of America." "Environmentalism waxes and wanes in importance in American politics, but it appears to be on the upswing now," *Newsweek*'s Jerry Adler writes. This may be what people indicate to pollsters, yet *The Economist* reports that visits to America's principal environmental treasures—the national parks—have been declining sharply over the last decade. However, the more notable anomaly of *Newsweek*'s sprawling feature (which quotes the author of this report) is that it dealt mostly with how businesses and individuals are rapidly adopting green technologies and habits, but it failed to note the important fact that this is taking place in the absence of government mandates or regulations, and often in reaction to market incentives. Where, exactly, is the politics here?

Other notable news features and commentaries from the past year include:

- Jon Gertner, "A Nuclear Renaissance?", *New York Times Magazine*, July 16, 2006; William Sweet, "The Nuclear Option," *New York Times*, April 26, 2006. Gertner, a frequent *Times Magazine* contributor, and Sweet, author of *Kicking the Carbon Habit: Global Warming and the Case for Renewable and Nuclear Energy*, reiterate the growing case for reviving nuclear power. Gertner offers a typically long *Times Magazine*–style tour through the problems and promises of nuclear power to arrive at a mixed conclusion, while Sweet's op-ed article comes directly to the point: "If we're to get into step with the world effort to reduce greenhouse gases, we are going to need to rely more, not less, on carbon-free nuclear energy."

- Michael Grunwald, "Par for the Corps: A Flood of Bad Projects," *Washington Post*, May 14, 2006. Grunwald, whose work has been noted in previous *Index* media surveys, hits the charts again with a scathing critique of the "ecologically disastrous, economically dubious, politically inspired water projects" of the Army Corps of Engineers. Sample: "Somehow, America has concluded that the scandal of Katrina was the government's response to the disaster, not the government's contribution to the disaster. The Corps has eluded the public's outrage—even though a useless Corps shipping canal intensified Katrina's surge, even though poorly designed Corps floodwalls collapsed just a few feet from an unnecessary $750-million Corps navigation project, even though the Corps had promoted development in dangerously low-lying New Orleans floodplains and had helped destroy the vast marshes that once provided the city's natural flood protection."

- Jim Carlton, "It's Easier Being Green at the Local Level; Stymied in Washington, Environmentalists Cultivate Republican Allies on the Farm," *Wall Street Journal*, May 17, 2006; Jon Christensen, "Unlikely Partners Create Plan to Save Ocean Habitat Along With Fishing," *New York Times*, August 8, 2006. Carlton, who has long covered environmental conflicts on the state and local level, and Christensen examine two instances of local cooperation between environmental groups and business interests, which usually clash. Carlton reported on small farmers and environmental groups in Nebraska forming an alliance to express concern about proposed large-scale feedlots, which are considered a source

of surface-water pollution. The farmers and environmentalists lobbied together for tougher manure-management plans. Christensen reported from California's central coast on cooperation between fishermen and environmental groups to designate large areas of coastal waters as "no-trawl" zones to allow rockfish and other species to recover from decades of over-fishing. A key piece of the deal was a buyout by environmental groups of five of the six remaining trawling permits, at a cost of several hundred thousand dollars apiece, thus reducing the economic resistance to the conservation zone.

- Anne Applebaum, "Tilting at Windmills," *Washington Post,* April 19, 2006; John Tierney, "Not in the Kennedys' Backyard," *New York Times,* January 17, 2006. Op-ed columnists Applebaum and Tierney both turn a critical eye on controversies over wind power. Applebaum finds it ironic that it is now environmentalists who oppose wind-power projects, in a variation on the time-honored American NIMBY tradition. Applebaum wonders: "Still, energy projects don't even have to be viable to spark opposition: Already, there are activists gearing up to fight the nascent biofuel industry, on the grounds that fields of switch grass or cornstalks needed to produce ethanol will replace rainforests and bucolic country landscapes. Soon the nonexistent 'hydrogen economy' will doubtless be under attack as well. There's a lot of earnest, even bipartisan talk nowadays about the need for clean, emissions-free energy. But are we really ready, politically, to build any new energy sources at all?" Tierney looks at one specific fight—the opposition, spearheaded by the Kennedy family, to a wind-power project offshore from Cape Cod. Along the way Tierney quotes from PRI fellow Tom Tanton: "When you add up the tax breaks and other federal aid to wind farms, the subsidy per unit of energy produced is more than double the subsidy given to nuclear and fossil-fuel power plants."

- Elizabeth Rosenthal, "Once a Dream Fuel, Palm Oil May Be an Eco-Nightmare," *New York Times,* January 31, 2007. Rosenthal highlights another instance of the law of unintended consequences—in this case, how European enthusiasm for palm oil as an alternative fuel is leading to the destruction of tropical forests in southeast Asia as nations there rush to meet demand. "[T]his green fairy tale began to look more like an environmental nightmare," Rosenthal writes. "Rising demand for palm oil in Europe brought about the clearing of huge tracts of Southeast Asian rainforest and the overuse of chemical fertilizer there. Worse still, the scientists said, space for the expanding palm plantations was often created by draining and burning peatland, which sent huge amounts of carbon emissions into the atmosphere."

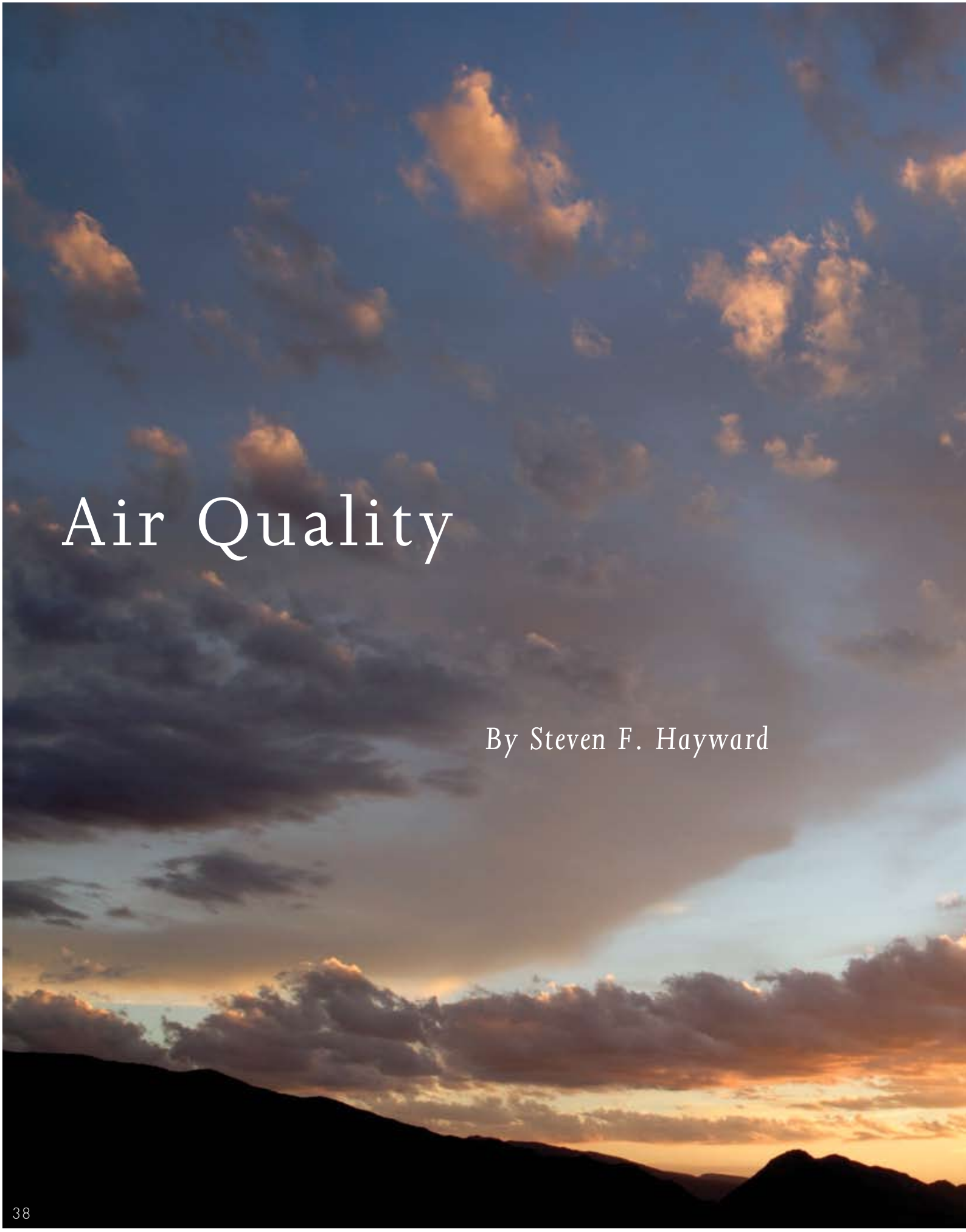
- "'Boutique' Is for Clothing—Not for Gasoline," unsigned editorial, *USA Today,* May 9, 2006. *USA Today,* which has gotten some environmental facts badly wrong in editorial and news features in the past, offers this spot-on editorial criticizing the patchwork of specialized gasoline blends in use around the United States. These custom blends once arguably helped reduce air pollution, but with the advancement in auto technologies their advantages are now negligible. They mostly benefit the refining industry, which can extract higher margins through having a more segmented market. "There are 15 or 16 categories of boutique

fuel," *USA Today* observes. "Gasoline is becoming like coffee at Starbucks—unnecessarily complex and pricey…. Variety is fine for ketchup, beer, and toothpaste. Not so for gasoline. Too many exotic fuels are flowing around the country, producing too few environmental benefits and too much pain at the pump."

- Philip Armour, "Save Your Whale and Eat It, Too," *New York Times*, May 23, 2006. Armour, the former editor of the Swedish edition of *Outside* magazine, commits the high heresy of advocating the resumption of commercial whaling: "The time has come for regulations that recognize that whaling, handled right and in moderation, can be sustainable."

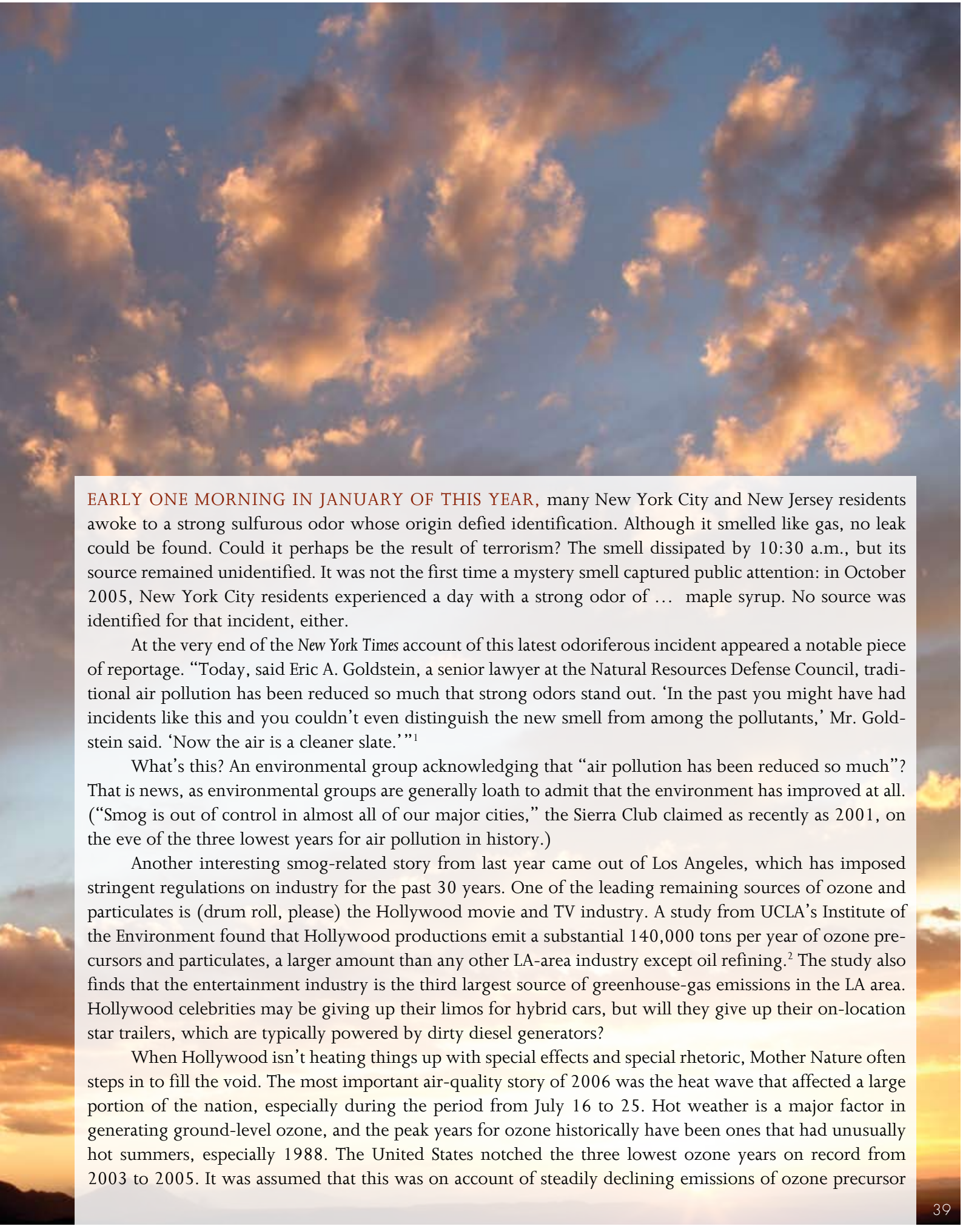
Notes

1 http://www.bbc.co.uk/radio4/thebattleforinfluence/pip/abkim/.
2 Robert Lee Hotz and Erin Cline, "Hot? Yes. Global Warming? Maybe.", *Los Angeles Times*, July 26, 2006.
3 Alex Beam, "MIT's Inconvenient Scientist," *Boston Globe*, August 30, 2006.



Air Quality

By Steven F. Hayward



EARLY ONE MORNING IN JANUARY OF THIS YEAR, many New York City and New Jersey residents awoke to a strong sulfurous odor whose origin defied identification. Although it smelled like gas, no leak could be found. Could it perhaps be the result of terrorism? The smell dissipated by 10:30 a.m., but its source remained unidentified. It was not the first time a mystery smell captured public attention: in October 2005, New York City residents experienced a day with a strong odor of … maple syrup. No source was identified for that incident, either.

At the very end of the *New York Times* account of this latest odoriferous incident appeared a notable piece of reportage. "Today, said Eric A. Goldstein, a senior lawyer at the Natural Resources Defense Council, traditional air pollution has been reduced so much that strong odors stand out. 'In the past you might have had incidents like this and you couldn't even distinguish the new smell from among the pollutants,' Mr. Goldstein said. 'Now the air is a cleaner slate.'"[1]

What's this? An environmental group acknowledging that "air pollution has been reduced so much"? That *is* news, as environmental groups are generally loath to admit that the environment has improved at all. ("Smog is out of control in almost all of our major cities," the Sierra Club claimed as recently as 2001, on the eve of the three lowest years for air pollution in history.)

Another interesting smog-related story from last year came out of Los Angeles, which has imposed stringent regulations on industry for the past 30 years. One of the leading remaining sources of ozone and particulates is (drum roll, please) the Hollywood movie and TV industry. A study from UCLA's Institute of the Environment found that Hollywood productions emit a substantial 140,000 tons per year of ozone precursors and particulates, a larger amount than any other LA-area industry except oil refining.[2] The study also finds that the entertainment industry is the third largest source of greenhouse-gas emissions in the LA area. Hollywood celebrities may be giving up their limos for hybrid cars, but will they give up their on-location star trailers, which are typically powered by dirty diesel generators?

When Hollywood isn't heating things up with special effects and special rhetoric, Mother Nature often steps in to fill the void. The most important air-quality story of 2006 was the heat wave that affected a large portion of the nation, especially during the period from July 16 to 25. Hot weather is a major factor in generating ground-level ozone, and the peak years for ozone historically have been ones that had unusually hot summers, especially 1988. The United States notched the three lowest ozone years on record from 2003 to 2005. It was assumed that this was on account of steadily declining emissions of ozone precursor

chemicals (chiefly, volatile organic compounds and other hydrocarbons, known as VOCs, and nitrogen oxides, or NO_x). Or was it just because those years had unusually cool summers? The heat wave of 2006 would provide a test. It will be many months before the EPA reports national figures for ozone levels during this time period; however, it is possible to sample the real-time monitors for a few select locations and compare their data with data from 2005 to see if ozone levels appear to have spiked last year.

We surveyed every daily air-quality monitor for three metropolitan regions—Dallas, Washington D.C./suburban Virginia, and Los Angeles—for the months of July 2005 and 2006, counting the number of exceedences of the eight-hour ozone standard of .085 parts per million (ppm), and noting the peak ozone levels recorded, at the worst monitor location in each metro area.[3] In July 2005 (with an average temperature of 77.9 degrees F) the worst monitor location in Virginia (Fairfax County) recorded three exceedences of the eight-hour ozone standard (that is, three days in which ozone levels rose above .085 ppm); in July 2006 (with an average temperature of 78.7 degrees F) Fairfax County was again the worst monitor location, and it again recorded three exceedences of the standard. (It should be kept in mind that the average temperature records from the National Oceanic and Atmospheric Administration [NOAA] are very crude and general measures and do not adequately reflect the peak heat-wave temperatures that drive higher ozone levels.) In July 2005, Fairfax County recorded a peak ozone level of .094 ppm, while in 2006 its peak level was .125 ppm—a significant differential.

The numbers for Dallas show a narrow difference between 2005 and 2006. In July 2005, when the average temperature was 85.7 degrees F, the worst monitor location recorded six exceedences of the ozone standard; in 2006, when the average July temperature was 88.5 degrees F, the worst location recorded only four exceedences. The worst peak level in 2005 was .103 ppm; in 2006, the worst peak level was also .103 ppm. Despite hotter temperatures, Dallas showed no difference from 2005 to 2006.

In the greater Los Angeles basin, which continues to experience smog levels in a different league from the rest of the nation, the worst location recorded 69 exceedences of the eight-hour ozone standard in 2005 (with an average July temperature of 68.6 degrees F), but only 59 in 2006 (with an average July temperature of 74.3 degrees F). The peak ozone level at the worst location was .173 ppm in 2005 and .156 ppm in 2006.

The slight decrease in the worst readings in Los Angeles in a hotter than normal summer, along with the mostly flat trend in Dallas, is a preliminary indication that the United States continues to make progress on reducing ozone levels. By contrast, for example, in 1988 Los Angeles recorded nearly 175 exceedences of the then-prevailing one-hour ozone standard (the eight-hour standard was not adopted until the late 1990s). We shall have to await the EPA's full revision and reporting of the 2006 data several months from now to confirm this.

Recent Emission Trends

The EPA has noticeably slowed down in its reporting of annual updates of ambient air-pollution levels, so it is not possible to report national ambient data beyond 2003, which is the latest year reported in previous editions of this *Index*. However, in 2006 the EPA did revise emissions estimates through the end of 2005. The

results are displayed in Table 1. We have done our own preliminary tabulation of the EPA's ozone monitors, which show that exceedences of the Clean Air Act's newer and stricter eight-hour ozone standard resumed their downward trend after a minor rise in 2005. Last year was the second-lowest (after 2004) ozone year since extensive monitoring began in the 1970s, and the last three years are the three lowest ozone years. This trend is displayed in Figure 1.

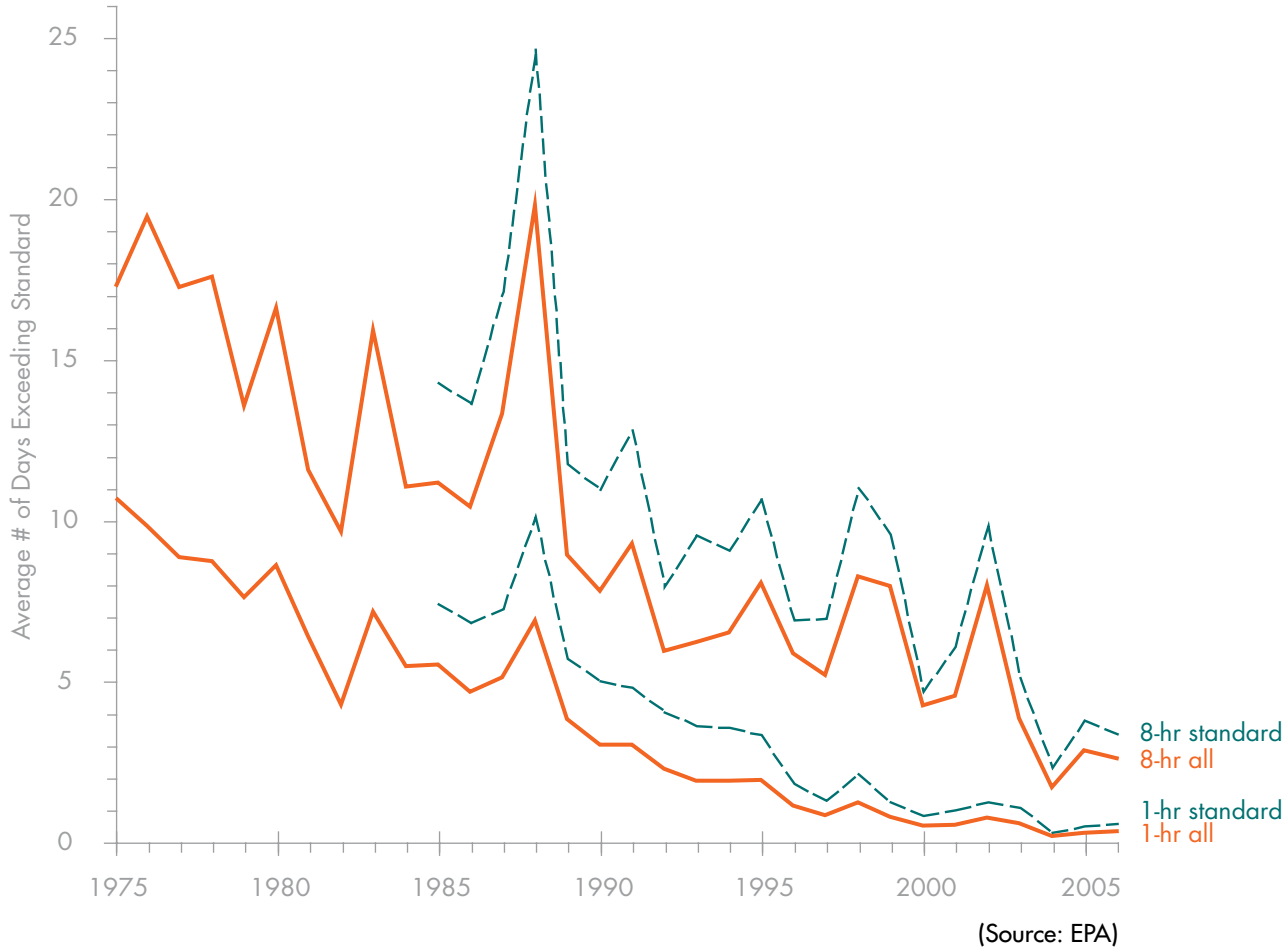
Table 1: Emissions Trends, 1970 – 2005 (million tons)

	CO	NO_x	PM10	SO_2	VOCs	Lead	Total
1970	197.3	26.9	12.2	31.2	33.7	0.221	301.521
1975	184.4	26.4	7.0	28.0	30.2	0.160	276.160
1980	177.8	27.1	6.2	25.9	30.1	0.074	267.174
1985	169.6	25.8	3.6	23.3	26.9	0.022	249.222
1990	143.6	25.2	3.2	23.1	23.1	0.005	218.205
1995	120.0	24.7	3.1	18.6	21.6	0.004	188.004
2000	102.4	22.3	2.3	16.3	16.9	0.003	160.203
2005	89.0	19.0	2.0	15.0	16.0	0.003	141.003
Change	–54.9%	–29.4%	–83.6%	–51.9%	–52.5%	–98.6%	–53.2%
2000–2005	–13.1%	–14.8%	–13.0%	–8.0%	–5.3%	0.0%	–12.0%

(Source: EPA)

In December 2006 the NOAA announced new satellite findings showing that NO_x emissions are declining rapidly in the eastern United States.[4] "New satellite observations mark the first time space-based instruments have detected the regional impact of pollution controls implemented by coal-burning electric power plants in the 1990s," the NOAA announced. "High-precision instruments aboard European satellites have detected a 38 percent decline in nitrogen dioxide in the Ohio River Valley and nearby states between 1999 and 2005, according to the study."

Figure 1: Average Number of Days Exceeding 8- and 1-Hour Ozone Standard, All Monitors



(Source: EPA)

Other Air-Quality News You May Have Missed

- The *Sacramento Bee* reported that in the never-ending quest to identify and reduce every possible source of air pollution, federal regulators have turned their attention to microwave popcorn, wondering whether home consumers of the popular product are at risk of contracting "popcorn worker's lung disease." More than 50 different brands of microwave popcorn were tested. Did they get to screen movies with the popcorn?
- Animal-rights activists from People for the Ethical Treatment of Animals (PETA) protested plans by a University of California professor to attach tiny air-quality monitors to 20 pigeons to gather unconventional data on air-quality conditions. PETA professed "shock" and "outrage" that such animal cruelty was even considered.

- Past editions of this *Index* have followed the controversy over New Source Review (NSR), the command-and-control regulatory system most environmental groups favor, and the Bush Administration's proposal to reduce sulfur-dioxide emissions through a tradable emissions system. Environmentalists have complained that the Bush EPA is attempting to "roll back the Clean Air Act" and delay further pollution reduction, while the Bush Administration claims its plan will reduce sulfur dioxide and other emissions by 70 percent over the next 20 years. Many aspects of this controversy continue to be litigated, with the Bush Administration winning some rounds and losing others.

  Last summer the National Academy of Sciences weighed in with a report concluding that Bush's latest version of his plan—the Clean Air Interstate Rule (CAIR) for eastern states—would clean up the air just as quickly and effectively as the older NSR approach.[5] The report notes "uncertainties" in trying to model emissions trends 20 years into the future (does this sound familiar?), but offers this observation on why the Bush plan might be more sensible: "The IPM [emissions model] analysis suggests that a national market-based trading program with emission caps below those specified by CAIR could produce emission reductions at approximately *one-third or less* the cost of aggressive implementation of the pre-revision NSR rules. This is primarily because a more traditional regulatory approach, such as the NSR rules, tends to be less cost efficient at achieving emission reductions across multiple facilities than market-based approaches." (Emphasis added.)

- Finally, from Maastricht University in the Netherlands comes a study of air-pollution hazards of candles and incense burned in church. "Air inside churches may be a bigger health risk than that beside major roads, research suggests," the BBC reported. "Church air was found to be considerably higher in carcinogenic polycyclic hydrocarbons than air beside roads traveled by 45,000 vehicles daily. It also had levels of tiny solid pollutants (PM 10s) up to 20 times the European limits." This may explain declining church attendance in Europe.

Notes

1 Anthony DePalma, "All the Sensitive Noses Show Just How a City Has Changed," *New York Times*, January 10, 2007.

2 Janet Wilson, "Another Hollywood Production: Smog," *Los Angeles Times*, November 14, 2006. http://www.ioe.ucla.edu/report-card-06.html.

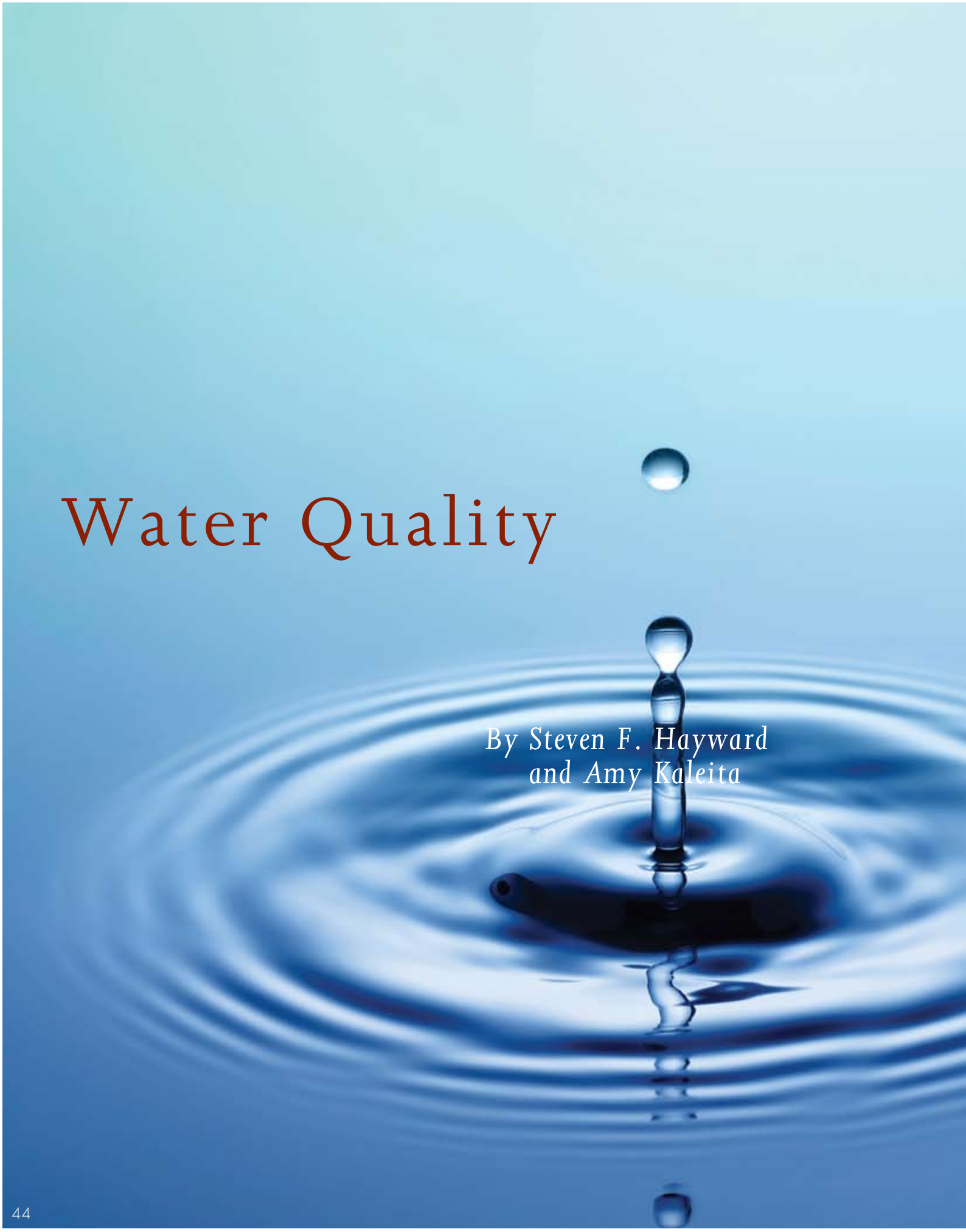
3 Washington D.C./suburban Virginia has 29 ozone monitors, Dallas has 52, and Los Angeles has 30.

4 http://www.noaanews.noaa.gov/stories2006/s2754.htm

5 *New Source Review for Stationary Sources of Air Pollution*, National Academies Press, 2006. http://books.nap.edu/catalog.php?record_id=11701.

Water Quality

By Steven F. Hayward
and Amy Kaleita



Surface-Water Quality

PREVIOUS EDITIONS OF THIS REPORT HAVE LAMENTED the inadequacies, gaps, and inconsistencies of our national water-quality monitoring programs, which fall far short of the thoroughness and utility of our air-quality monitoring programs. In 2000, the General Accounting Office issued a report noting that the EPA and the states could not make statistically valid inferences about water quality and lacked data to support management decisions. In 2001 a National Research Council report found that a uniform, consistent approach to ambient monitoring and data collection was necessary to support core water programs.

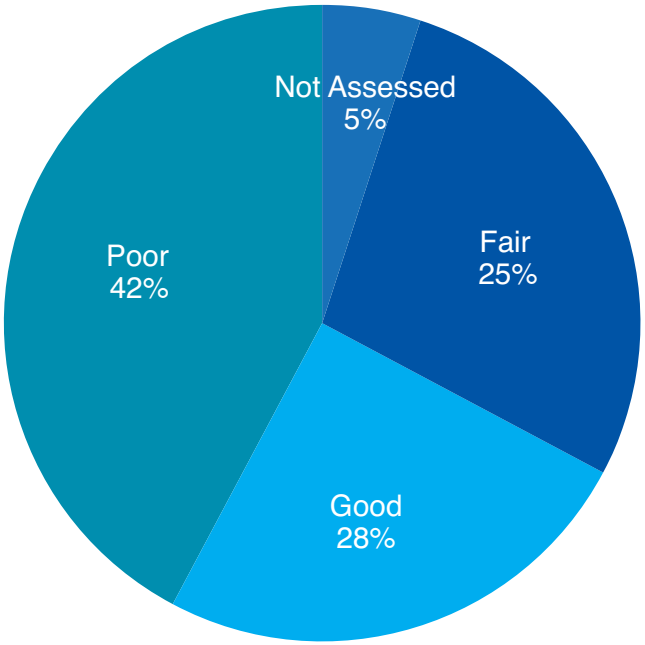
As we have pointed out before, monitoring water quality is an order of magnitude more difficult than monitoring air quality. The EPA quite sensibly gave up on using the National Water Quality Inventory (NWQI) as its primary assessment tool and has launched in its place the National Wadeable Streams Assessment (NWSA), which promises to be more useful. The EPA issued the first report of the NWSA in December 2006, describing it as "the first statistically defensible summary of the condition of the nation's streams and small rivers."[1] (Small, "wadeable" streams and rivers account for 90 percent of river and stream miles in the United States.)

For the first time, the EPA and its partners in state government agencies are using a random-sampling method to gather data from more than 1,300 streams and small rivers across the 48 contiguous states. (Efforts are underway to include Alaska and Hawaii in future iterations of the NWSA.) Aimed primarily at determining the biological, chemical, and physical conditions of streams and rivers, the first NWSA report arranges the nation's streams according to the number of miles rated as being in "good," "fair," or "poor" condition. For the nation as a whole, the first assessment finds 41.9 percent of river and stream miles to be in "poor" biological condition, 24.9 percent in "fair" condition, and 28.2 percent in "good" condition (see Figure 1).

There were significant regional variations in the findings, as displayed in Figure 2. Western rivers and streams were in better condition than those in the central plains and eastern highlands. This is not surprising, as the leading contaminants of streams are nitrogen and phosphorus, typical runoff of agricultural activity.

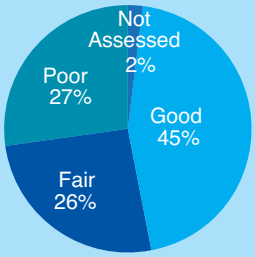
Two points should be kept in mind. First, the designation of a "poor" condition covers a wide swath of problems—some of them naturally occurring (such as erosion)—and should not be taken as a certain indicator either that the pollution was caused by human activity or that the river is severely degraded. (See the item on p. 52 about the proportion of wild-animal sources of water pollution, for example.) It is also worth

Figure 1: Biological Condition of Wadeable Streams Nationwide



(Source: EPA)

Figure 2: NWSA Regional Breakdown



Western Region

Plains & Lowlands

Eastern Highlands

(Source: EPA)

noting the internals of the NWSA, in which a substantial majority of streams and rivers are ranked as being in "good" condition on individual indicators of stress; it is only when the effects of many different stressors are aggregated that the report yields a composite finding that 42 percent of the nation's streams are in "poor" condition. In other words, relatively few streams are comprehensively polluted or degraded. This more detailed assessment will help policy makers better tailor individual measures for local problems. Second and more important, the NWSA has established a baseline against which, for the first time, follow-up surveys can judge progress, and policies can be measured for their effectiveness.[2] Future updates to the NWSA will be released on a rolling basis.[3]

Groundwater Quality

As explained in the 2000 NWQI:

> Evaluating our nation's ground water quality is a complex task. Ground water quality can be adversely affected by human activities that introduce contaminants into the environment. It can also be affected by natural processes (such as leaching)… that result in elevated concentrations of certain constituents. Ground water contamination can occur as relatively well-defined, localized plumes emanating from specific sources…. Ground water quality degradation can also occur over a wide area due to diffuse nonpoint sources such as agricultural fertilizer and pesticide applications. Frequently, ground water contamination is discovered long after it has occurred. One reason for this is the slow movement of ground water through aquifers. In some cases, contaminants introduced into the subsurface decades ago are only now being discovered.

To date there are no coordinated, repeated efforts to assess groundwater quality in a comprehensive way. Nonetheless, some information can be gleaned from the reports prepared by individual states and territories in compliance with the Clean Water Act's reporting requirements. These reports were last compiled and summarized in 2000, when all but nine states had reported on groundwater. Results show that where there are groundwater impairments, the main sources are localized phenomena such as underground storage tanks, septic tanks, landfills, and spills. Fertilizer applications also represent a significant source of reported impairments.

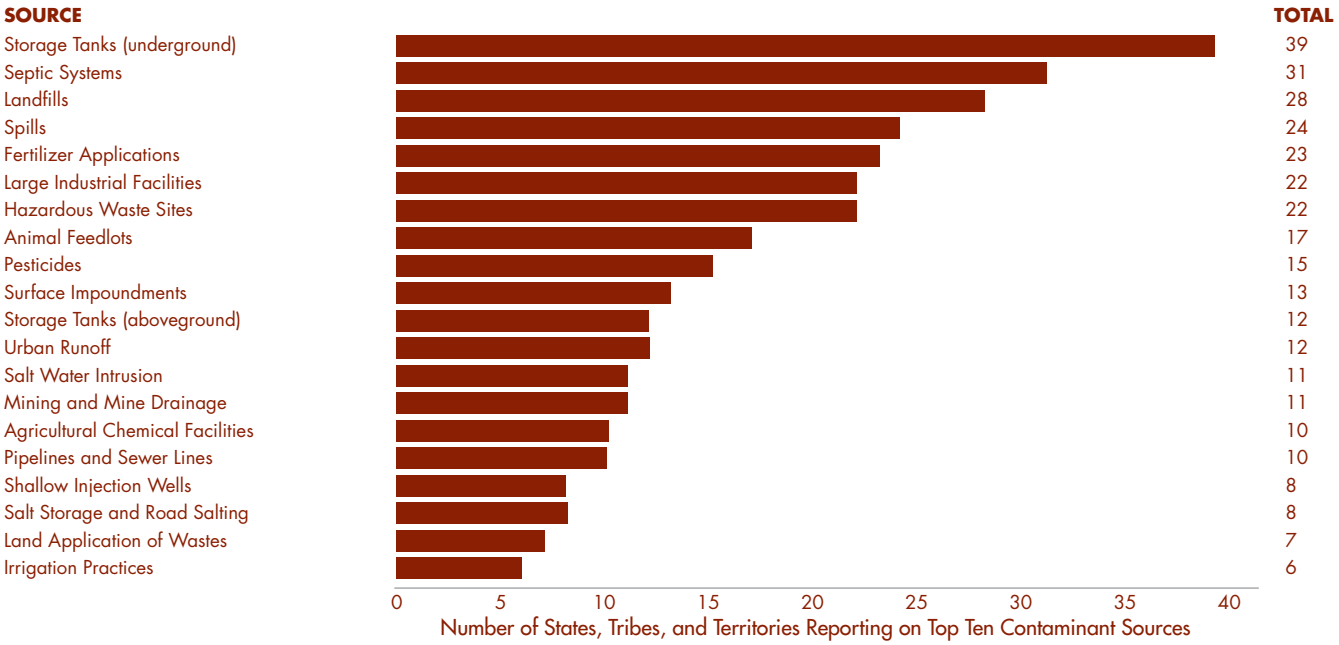
One groundwater reserve of particular interest is the High Plains Aquifer, more commonly known as the Ogallala, an underground water source that underlies eight states from South Dakota through Texas.

For the purposes of assessing the quality of water in this aquifer, the United States Geological Survey (USGS) divided it into three regions. The report for the Central High Plains was released in 2002,[4] and for the Southern High Plains in 2003.[5] Preliminary findings have been posted for the Northern High Plains; the full report is still in review.

In the Central High Plains, moderately high levels of minerals (calcium the most common) were found in 22 percent of the wells sampled. The detected levels of minerals were above the secondary standard level, set for aesthetic rather than health reasons. Levels of nitrate, a common cause of surface-water quality impairment, exceeded the drinking-water standard in only four percent of the samples. While 24 percent of the samples contained detectable pesticides (atrazine the most common), no concentrations exceeded the drinking-water standards. A full 78 percent of those locations with detectable pesticides were in areas where the aquifer is located relatively close to the surface (less than 200 feet).

Results from the Southern High Plains showed similar characteristics. Moderately high levels of minerals (calcium and magnesium the most common) were found in 60 percent of the wells sampled. Nitrate was detected at levels higher than the standard in 13 percent of the samples. Pesticides were detected in 17 percent of the samples, but never above the drinking-water standard. Atrazine and its breakdown products were the most common. Radon was detected in all samples, with 78 percent being above the proposed standard.

Figure 3: Major Sources of Ground Water Contamination



(Source: 2000 National Water Quality Inventory, EPA)

In the Northern High Plains, preliminary reporting reveals similar trends.

Perhaps of more concern than the quality of the water in the Ogallala is the quantity, since this aquifer is the largest supply of water in the nation. Irrigation withdrawals, which increased dramatically from 1940 to 1980 (but have more or less stabilized since), account for the largest discharge from the aquifer. Recharge is primarily from precipitation, but return flow from irrigation and seepage from surface water bodies also contribute.

The USGS began tracking water levels in the High Plains Aquifer in 1981, in response to reported water-level declines of as much as 100 feet in some locations since "predevelopment" (i.e., pre-irrigation, about 1950). The most recent report summarizes findings from the 2003 surveys of wells in the Ogallala.[6] Water-level changes since predevelopment ranged from a rise of 86 feet to a drop of 223 feet, with an area-weighted average of a 12.6-foot decline. Nine percent of the total area had more than a 50-foot decline. The largest of these areas occurred in southwestern Kansas, east-central New Mexico, the central part of the Oklahoma panhandle, and the western part of the Texas panhandle. The decline is fairly steady, indicating that depletion is occurring more rapidly than recharge.

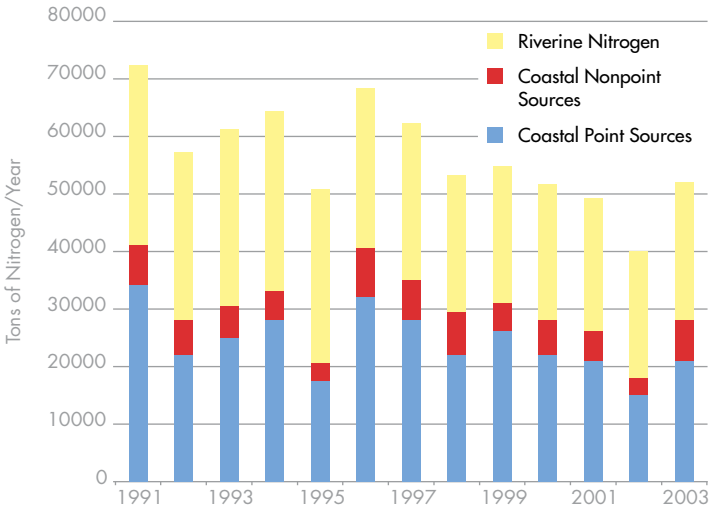
This water-level status represents a loss of approximately 7.4 percent of estimated total water storage within the entire aquifer. This includes some areas where the water is becoming harder to withdraw, leading to increased pumping costs or the need for deeper well drilling. The growing construction of ethanol plants, which require significant amounts of water, in these agricultural regions adds to the potential for increased depletion rates.

CASE STUDY: LONG ISLAND SOUND

Along with the Gulf of Mexico, Long Island Sound has been a focus of concern over persistent hypoxia (low oxygen level) from pollution. The Sound experiences from 30 to 80 days of hypoxia during the summer. Back in 1985 the EPA set in motion the Long Island Sound Study (LISS), which has developed 40 indicators of environmental conditions in and around the Sound.[7]

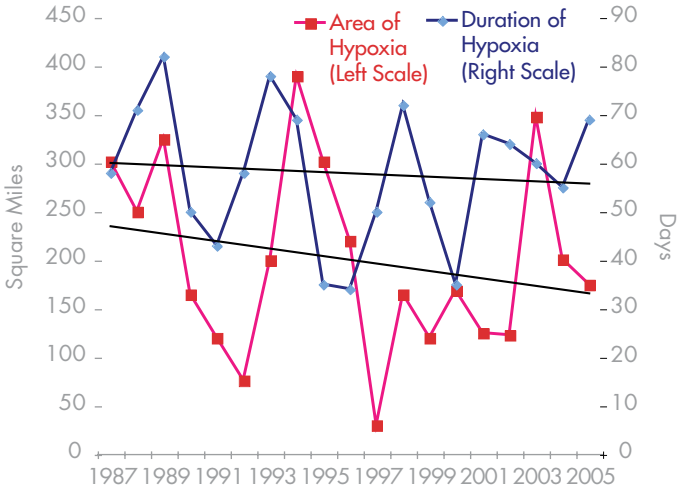
A few highlights from the LISS are worth noting. The region has been making slow but steady progress in its goal of reducing nitrogen discharge from all sources by 58 percent by the year 2014 (see Figure 4). Hypoxia levels are worst in the western reaches of the Sound, which are closest to New York City and where there is the least circulation of ocean currents. They show wide year-over-year variability—a reflection of rainfall variation more than pollution levels—as shown in Figure 5. Chlorophyll levels have displayed a sharp rise in recent years after nearly a decade of steady decline (see Figure 6).

FIGURE 4: NITROGEN LOADINGS INTO LONG ISLAND SOUND



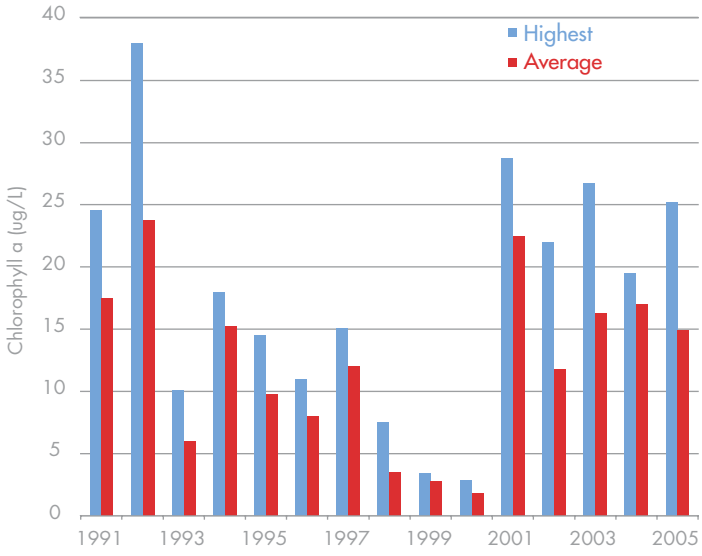
(Source: LISS)

FIGURE 5: AREA AND DURATION OF LONG ISLAND SOUND HYPOXIA



(Source: LISS)

FIGURE 6: LONG ISLAND SOUND CHLOROPHYLL LEVELS



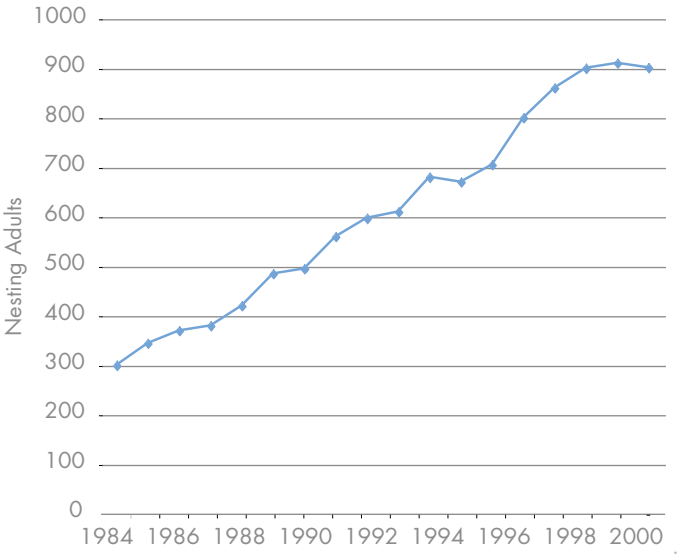
(Source: LISS)

Wildlife indicators show a mixed picture. The number of nesting osprey has tripled over the last 17 years (see Figure 7); this trend tracks the upward trend in osprey sightings around the Great Lakes. The number of piping plovers has begun to increase in recent years after being flat from 1984 through 2000. The number of nesting least terns has declined about 25 percent since 1985; however, the 2006 LISS reports signs of a turnaround in recent years: "What is extremely encouraging is the increase in young fledged per nesting pair [of least terns], which in Connecticut was 1.32 during 2004 compared to 0.11 in 2000. From Connecticut's 239 pairs in 2000, only 26 young were fledged. However, in 2004 the number of young fledged from 158 pairs was high at 209."

Fish trends are equally mixed. Winter flounder numbers are down significantly since 1984, but the summer flounder population has increased sharply over the past five years. Striped bass have made a major comeback. Overall fish biomass has held steady or increased slightly over the last decade.

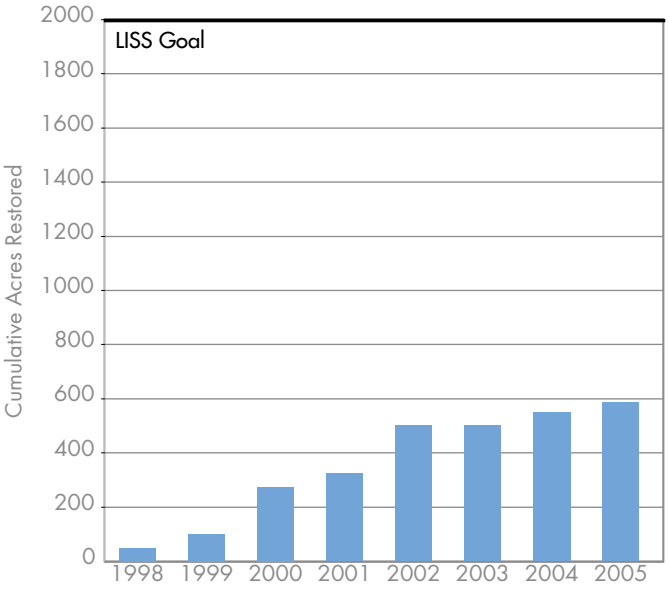
State and local governments, along with private conservation organizations, have undertaken

FIGURE 7: NESTING ADULT OSPREY



(Source: LISS)

FIGURE 8: COASTAL HABITAT RESTORATION

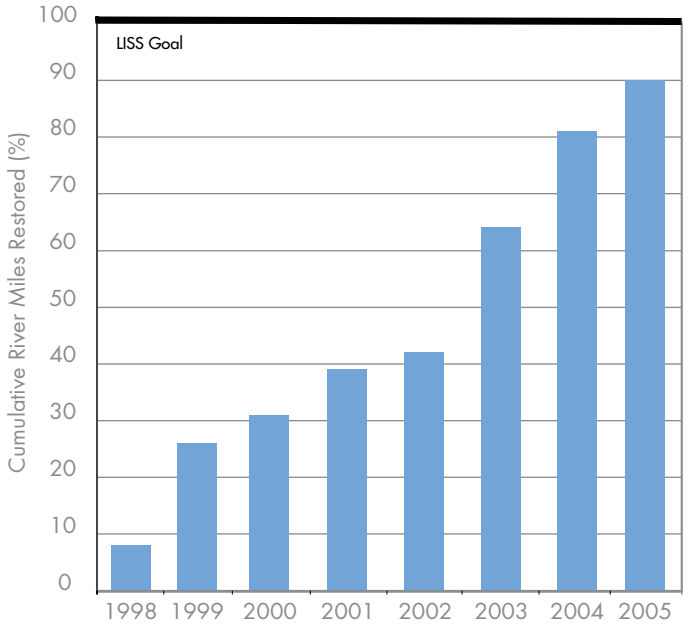


(Source: LISS)

an ambitious Habitat Restoration Initiative. Efforts at restoring coastal wildlife habitat have achieved only 28 percent of the region's goal, but efforts to improve fish passageways are currently at 90 percent of the target (see Figures 8 and 9). Figure 10 shows the trends in inland wetlands in Connecticut, where efforts to reverse wetland loss and create new wetlands are bearing fruit. (Wetland data for New York are unavailable.)

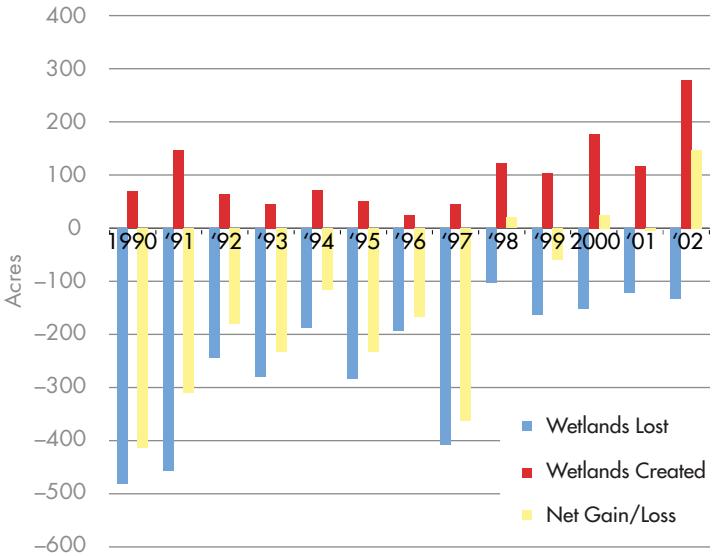
The LISS, and the protection/restoration efforts it enables us to measure, is a model of state and local cooperation on behalf of the environment. Above all, the LISS indicators show that despite the significant population pressures of the region (nine million people live in the Long Island Sound watershed), the area is far from being in a state of ecological collapse. To the contrary, the LISS indicators suggest a picture of a region long assailed by development pressures that is turning a corner toward sustained improvement.

FIGURE 9: FISH PASSAGEWAY RESTORATION



(Source: LISS)

FIGURE 10: CONNECTICUT WETLAND TRENDS



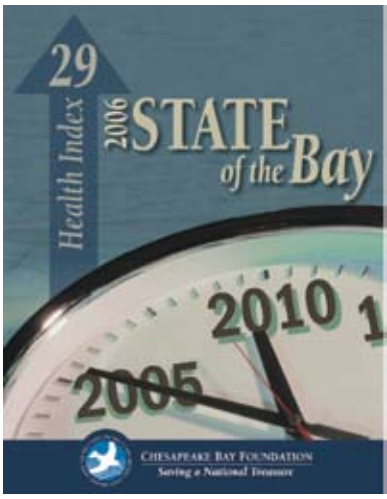
(Source: LISS)

Other Water News You May Have Missed

- In September 2006 the *Washington Post* reported on a number of studies of watersheds in Virginia and Maryland that drain into the Potomac River. These studies found that waste from geese, muskrats, deer, raccoons, and other wild animals accounts for a substantial amount of water pollution detected in those watersheds.[8] One study concluded that humans are responsible for less than one-quarter of the water pollution in the Anacostia and Potomac Rivers. According to the data in this study, wild-animal waste would need to be reduced by 83 percent to achieve statutory clean-water standards. "That leaves scientists and environmentalists struggling with a more fundamental question," wrote *Post* correspondent David Fahrenthold: "How clean should we expect nature to be? In certain cases, they say, the water standards themselves might be flawed, if they appear to forbid something as natural as wild animals leaving their dung in the woods."

  Robert Boone, president of the environmental group the Anacostia Watershed Society, put it this way: "If you were here when Captain John Smith rode up the Anacostia River [in 1608], and you tested the water, it would probably have a good bit of coliform in it" because of wildlife.

- Another important regional assessment worth checking annually is the Chesapeake Bay Foundation's *State of the Bay* (SOTB) report. The SOTB tracks 13 indicators of the Bay's ecological health.[9] The SOTB has developed a 0–100 scale, allowing relative conditions and progress to be judged. It assigns letter grades to aspects of the current year's progress and uses them in tabulating an overall score. The 2006 SOTB gives four Fs and two Ds for the current condition and a composite score of 29 on the 0–100 scale, up from the low points of 23 in 1983 and 27 in 2004 and 2005. (The foundation's goal is to reach a composite score of 70 by the year 2050.) Although the composite score of 29 puts the Bay on the threshold of a condition the foundation considers "improving," the current report card states that "the Bay is still in critical condition." The value of SOTB is that it sets clear benchmarks and goals for policy makers.



- Last year's edition of the *Index* reported early findings that the water around New Orleans had failed to become the "toxic soup" predicted in the immediate aftermath of Hurricane Katrina. These early findings were confirmed in September 2006, at a four-day session at the American Chemical Society meeting in San Francisco. Several panels of scientists reported that they have found no widespread elevated levels of pesticides, petroleum products, or metals in lake, streambed, or flood-residue sediment. There appears to have been no significant effect on seafood or outbreaks of water-borne diseases. "This concept of toxic soup simply wasn't so," said Chris Piehler, an

environmental scientist with the Louisiana Department of Environmental Quality. The EPA has concluded that, "in general, the sediments left behind by the flooding from the hurricanes are not expected to cause adverse health impacts to individuals returning to New Orleans."

Notes

1 http://www.epa.gov/owow/streamsurvey/WSA_Assessment_Dec2006.pdf.

2 As the NWSA states: "Water quality managers can use these data to set protection and restoration goals, to decide what indicators to monitor and how to interpret monitoring results, to identify stresses to the waterbody and decide how they should be controlled, and to assess and report on the effectiveness of management actions…. Although this WSA provides a snapshot of the current conditions in the nation's streams, future surveys will allow us to detect trends in stream conditions and in the stressors that affect them."

3 The NWSA states: "For lakes and reservoirs, a field survey will occur in 2007 with a national assessment report of the results in 2009. Rivers will be surveyed in 2008, and a national assessment report will follow in 2010. Wadeable streams will be surveyed again in 2009, and the assessment report that follows in 2011 will include all flowing waters—both rivers and streams. That report will also evaluate any changes in biological condition that occurred in streams. A NCCR assessment will be repeated in 2012, with the results of the field survey from 2010. Wetlands will be surveyed during the 2011 sampling season, followed by a national assessment report in 2013. From that point on, the surveys and national assessment reports will be repeated in sequence, with changes and trends becoming a greater focus for each resource survey."

4 Ground-Water Quality in the Central High Plains Aquifer, Colorado, Kansas, New Mexico, Oklahoma, and Texas, 1999. USGS National Water-Quality Assessment Program, Water-Resources Investigations Report 02-4112.

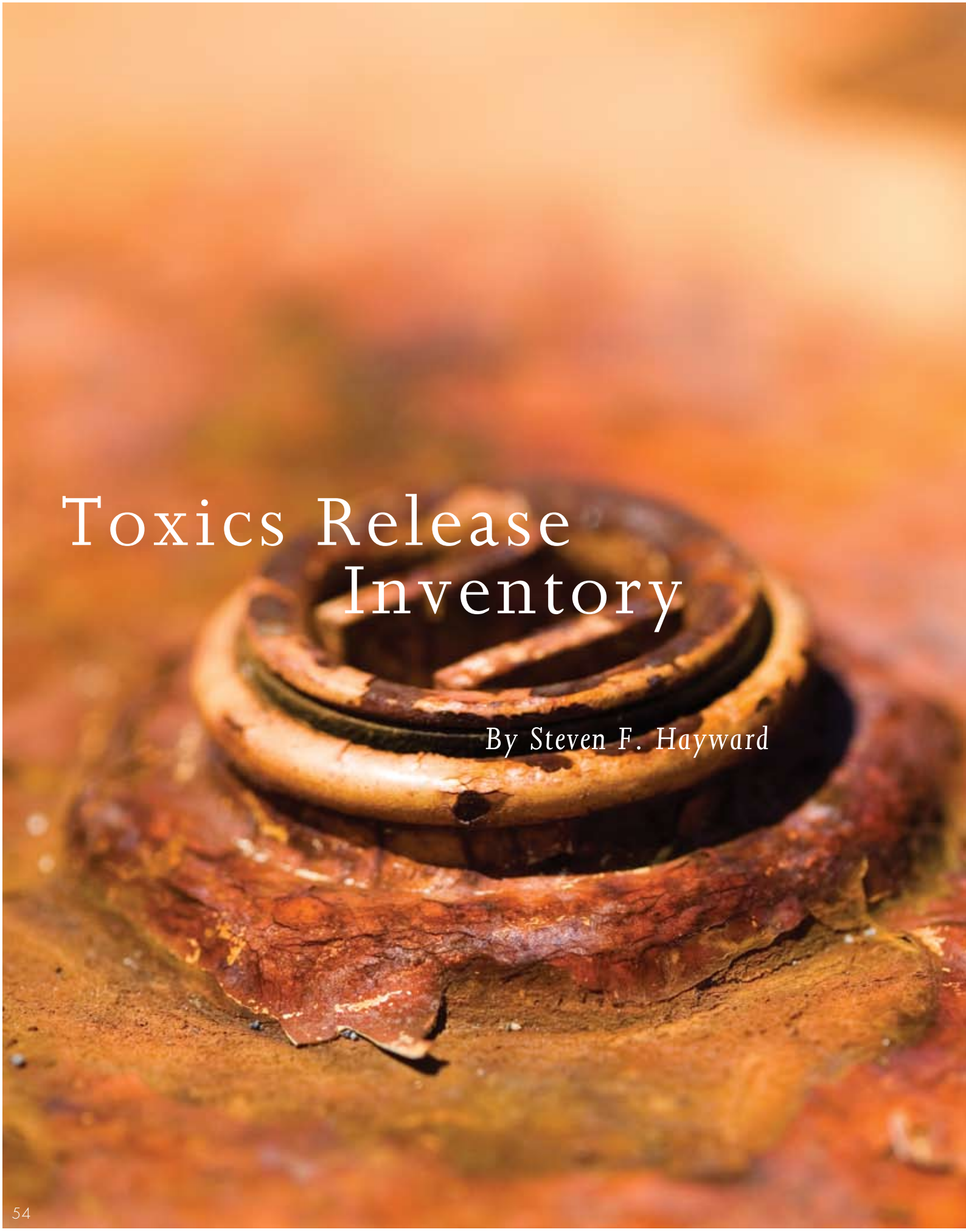
5 Ground-Water Quality of the Southern High Plains Aquifer, Texas and New Mexico, 2001. USGS National Water-Quality Assessment Program, Open-File Report 03-345.

6 Water-Level Changes in the High Plains Aquifer, Predevelopment to 2003 and 2002 to 2003, USGS Fact Sheet 2004-3097, September 2004.

7 http://www.longislandsoundstudy.net/indicators/index.htm.

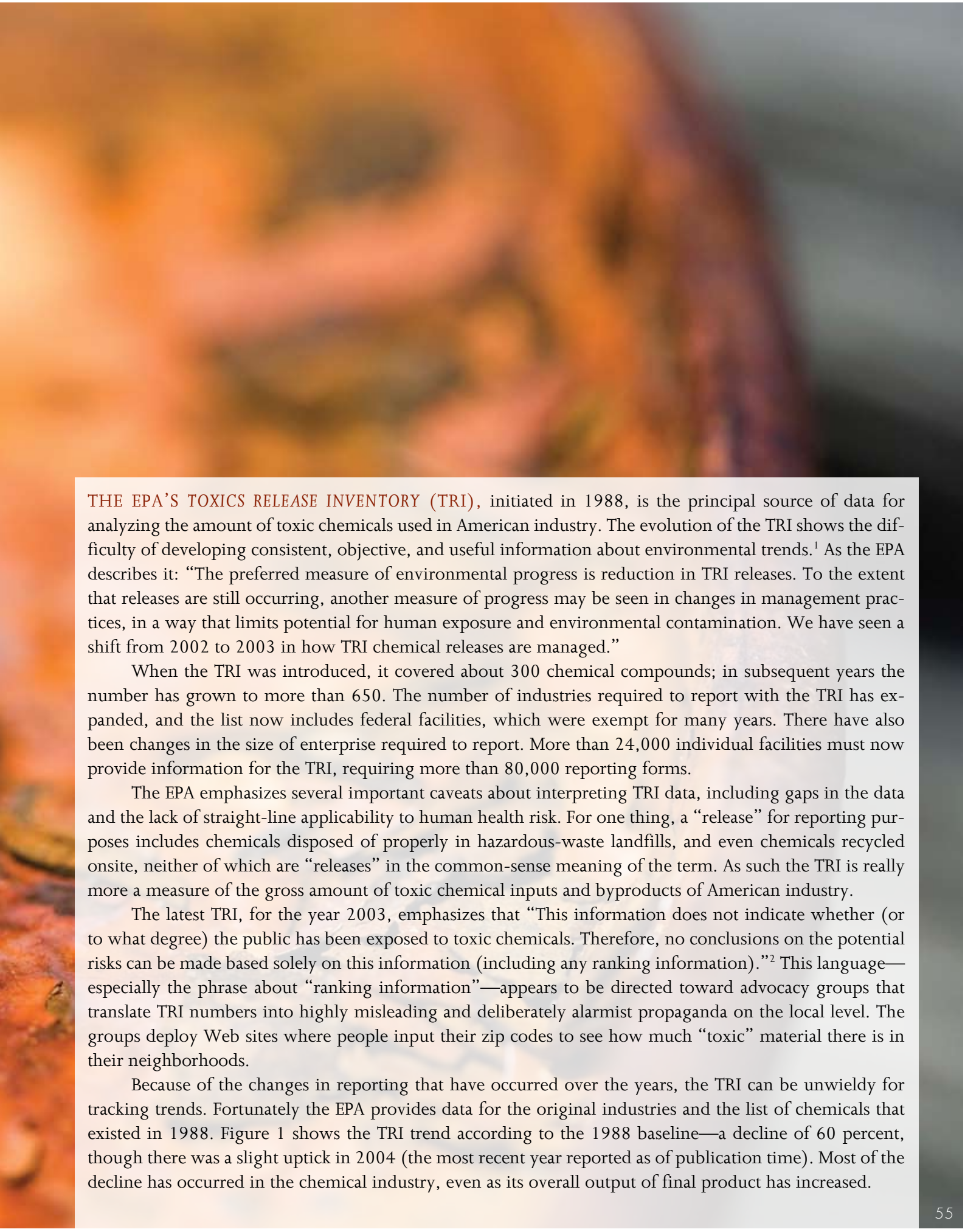
8 David A. Fahrenthold, "Wildlife Waste Is Major Water Polluter, Studies Say," *Washington Post*, September 29, 2006.

9 The 13 are nitrogen, phosphorus, dissolved oxygen, riparian forest buffers, wetlands, underwater grasses, resource lands, rockfish, toxics, water clarity, blue crabs, oysters, and shad.



Toxics Release Inventory

By Steven F. Hayward



THE EPA'S *TOXICS RELEASE INVENTORY* (TRI), initiated in 1988, is the principal source of data for analyzing the amount of toxic chemicals used in American industry. The evolution of the TRI shows the difficulty of developing consistent, objective, and useful information about environmental trends.[1] As the EPA describes it: "The preferred measure of environmental progress is reduction in TRI releases. To the extent that releases are still occurring, another measure of progress may be seen in changes in management practices, in a way that limits potential for human exposure and environmental contamination. We have seen a shift from 2002 to 2003 in how TRI chemical releases are managed."

When the TRI was introduced, it covered about 300 chemical compounds; in subsequent years the number has grown to more than 650. The number of industries required to report with the TRI has expanded, and the list now includes federal facilities, which were exempt for many years. There have also been changes in the size of enterprise required to report. More than 24,000 individual facilities must now provide information for the TRI, requiring more than 80,000 reporting forms.

The EPA emphasizes several important caveats about interpreting TRI data, including gaps in the data and the lack of straight-line applicability to human health risk. For one thing, a "release" for reporting purposes includes chemicals disposed of properly in hazardous-waste landfills, and even chemicals recycled onsite, neither of which are "releases" in the common-sense meaning of the term. As such the TRI is really more a measure of the gross amount of toxic chemical inputs and byproducts of American industry.

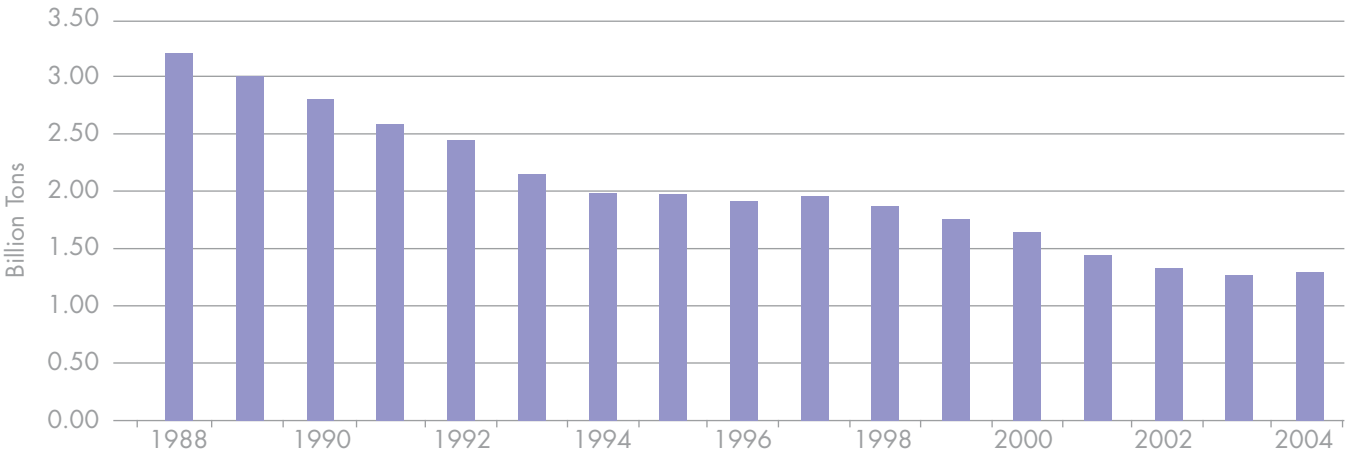
The latest TRI, for the year 2003, emphasizes that "This information does not indicate whether (or to what degree) the public has been exposed to toxic chemicals. Therefore, no conclusions on the potential risks can be made based solely on this information (including any ranking information)."[2] This language—especially the phrase about "ranking information"—appears to be directed toward advocacy groups that translate TRI numbers into highly misleading and deliberately alarmist propaganda on the local level. The groups deploy Web sites where people input their zip codes to see how much "toxic" material there is in their neighborhoods.

Because of the changes in reporting that have occurred over the years, the TRI can be unwieldy for tracking trends. Fortunately the EPA provides data for the original industries and the list of chemicals that existed in 1988. Figure 1 shows the TRI trend according to the 1988 baseline—a decline of 60 percent, though there was a slight uptick in 2004 (the most recent year reported as of publication time). Most of the decline has occurred in the chemical industry, even as its overall output of final product has increased.

Figure 2 shows the trend for the last seven years—a 45-percent decline, even though the TRI for those years includes twice the number of chemicals and of parties required to report. The latest TRI reveals a decline in toxic releases in 2004 of 180 million tons, or about 4 percent. The EPA notes decreases in air emissions and surface water discharges, along with large increases in disposal of toxic chemicals in hazardous-waste landfills and increases in the amounts of toxic compounds recycled or treated onsite.

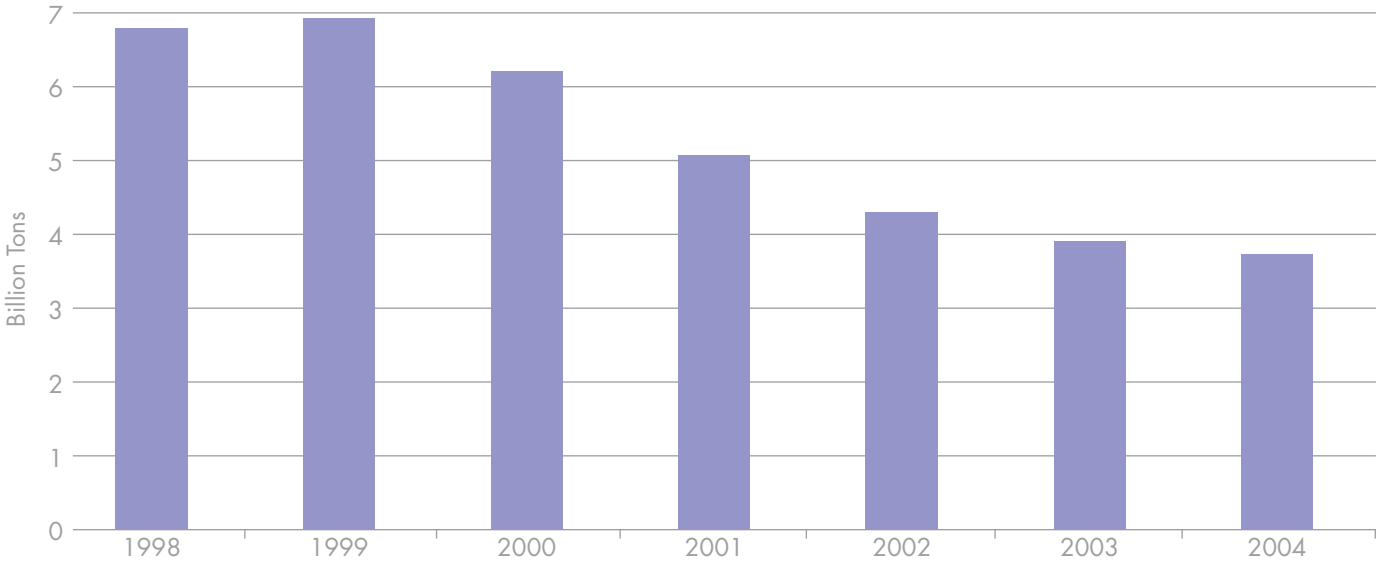
One of the largest declines in TRI accounting has occurred in the metal mining business, as shown in Figure 3. Declines from this single sector account for most of the total decline in the TRI since 1998.

Figure 1: Toxics Release Inventory, 1988 Baseline



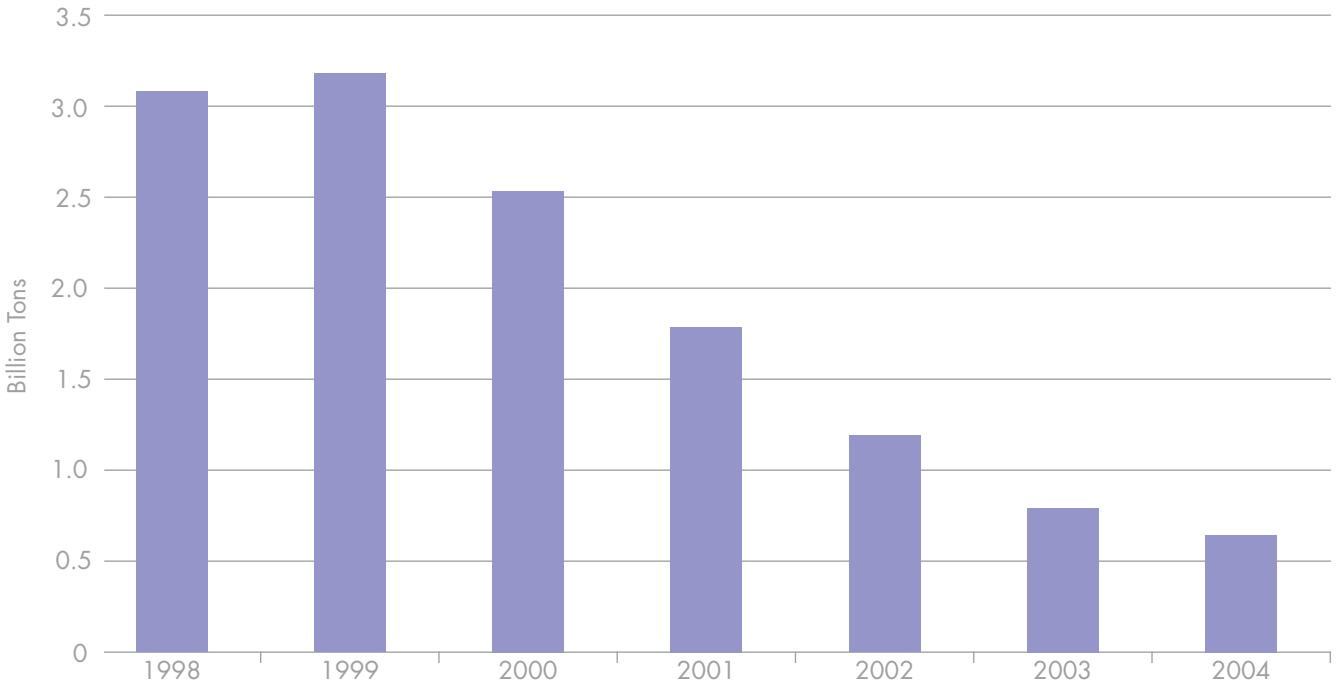
(Source: EPA)

Figure 2: Toxics Release Inventory, 1998 Baseline



(Source: EPA)

Figure 3: Toxics Release Inventory, Metal Mining Industry



(Source: EPA)

Notes

1 The TRI can be downloaded from the EPA Web site at www.epa.gov/tri/. Individual state fact sheets are also available on this site.

2 In addition, "toxic" chemicals are not all created equal, which is why a crude measure of mere "tons" of toxics "released" is not an especially helpful measure of health or environmental risk. As the EPA notes, "Some high-volume releases of less toxic chemicals may appear to be a more serious problem than lower-volume releases of more toxic chemicals, when just the opposite may be true. For example, phosgene is toxic in smaller quantities than methanol. A comparison between these two chemicals for setting hazard priorities or estimating potential health concerns, solely on the basis of volumes released, may be misleading."

In an effort to make possible better judgments about the relative risks of different kinds of toxic chemicals, the EPA is developing the Integrated Risk Information System (IRIS) on its Web site (see www.epa.gov/iris/index.html). IRIS contains the results of ongoing toxicological screens of many of the chemicals on the TRI, along with links to other studies and EPA standards for exposure to the chemical. IRIS is not easy for the non-specialist to use, but it represents a major effort to adapt the massive reporting of the TRI into a useable product for local risk assessment. Another resource is EPA's chemical fact sheets, which are available at www.epa.gov/chemfact/.

Biodiversity

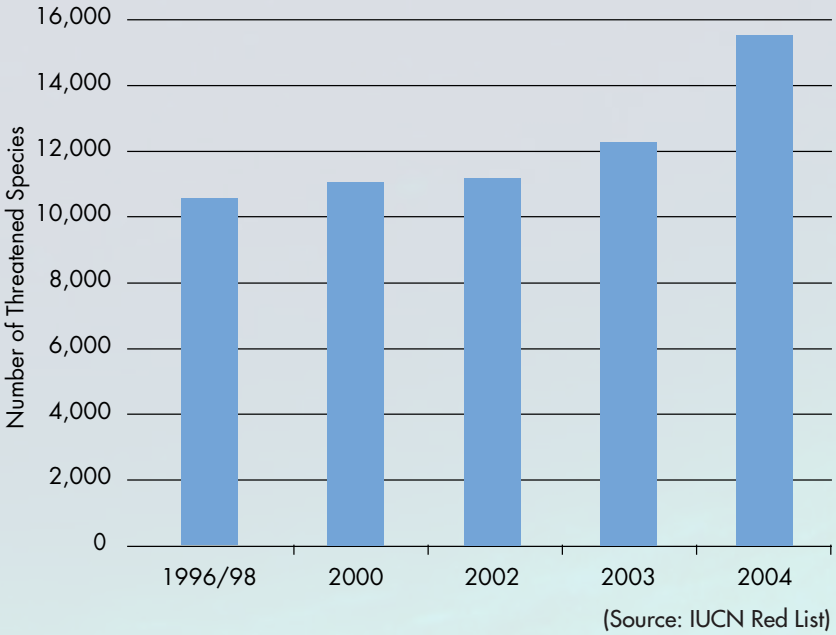
By Steven F. Hayward

BIODIVERSITY, THE TERM COMPRISING SPECIES EXTINCTION, habitat fragmentation and loss, and ecosystem health, continues to be the environmental area about which we have the deepest concern, the sketchiest data, and a lack of coherent policy priorities or approaches. There is no doubt that biodiversity is under significant pressure on the global scale, though the extent to which it should be considered in "crisis" depends on which guesstimate of the magnitude of the problem one finds most plausible. As usual, the more alarmist projections receive the most media notice.

As a group of 19 environmental scientists wrote in *Nature* magazine last summer, "Biodiversity is also intrinsically more complex than other environmental concerns, such as the stratospheric ozone hole or even global climate change."[1] Why isn't there, these authors ask, a global biodiversity equivalent of the Intergovernmental Panel on Climate Change (IPCC)? Unfortunately for advocates of the idea, its chief champion at the moment is French president Jacques Chirac, which dooms its chances of serious consideration.

The lack of reliable metrics for the bundle of factors that constitute the issue of biodiversity makes it difficult to assess progress or regress. The UN Convention on Biological Diversity, which commits 188 nations to achieving a "significant reduction" in the loss of biodiversity by 2010, lacks any benchmarks or even a framework for judging progress. Right now the most prominent proxy on the global level for threatened species is the World Conservation Union's "Red List" (see www.iucn.org). In 2006, the Red List was updated from the previous version (2004). As noted in

Figure 1: IUCN "Red List" of Threatened Species



(Source: IUCN Red List)

the 2005 edition of the *Index*, the 2004 Red List reports 15,503 endangered species worldwide, up from 12,259 in 2003 (out of a database of about 1.5 million "described" species). The United States has 1,143 species on the Red List (see Figure 1).

An important caveat should be kept in mind: Since estimates of the total number of species in the world vary by two orders of magnitude (from a low of 1.5 million to more than 100 million), the Red List numbers suggest that only a tiny fraction are endangered. This, however, is an indication of the limits of the Red List itself. Other techniques generate much higher percentages of biota thought to be at risk of extinction.

Biodiversity in the News

Even with limited data to go on, it is worth taking note of a number of interesting anecdotes and news stories that surfaced during 2006:

- Last year we reported on the Global Amphibian Assessment (GAA, www.globalamphibians.org), an offshoot of the IUCN Red List that tracks the status of frogs, toads, salamanders, caecilians, and other amphibians. The GAA updated its estimates in 2006, adding 179 new species to bring the grand total of identified species to 5,918. The GAA identifies 1,896 species—nearly one-third (32 percent) of the world's total amphibian species—as threatened (with the most severe declining trends found in Latin America). By comparison, just 12 percent of all bird species, and 23 percent of all mammal species are threatened. And at that, the GAA believes the amphibian figures may be an underestimate, because more than 20 percent of amphibian species are regarded as "data deficient," i.e., a lack of adequate data prevents judgment about the species' condition.

  The United States ranks ninth in terms of the number of different amphibian species found in its territory, with 263 identified species, of which 51 are considered threatened—one of the lower percentages among nations with 10 or more amphibian species. (The United States has the highest number of salamander species—168—in the western hemisphere.) Brazil has the largest number of amphibians, with 731 identified species, of which 110 are considered threatened. Haiti has the worst prospects: 92 percent of its amphibians are threatened. Habitat loss is the leading cause of amphibian decline, although fungal disease seems to be on the rise. (For more on amphibian species, see *Disappearing Jewels: The Status of New World Amphibians*, available at www.natureserve.org/publications/disappearingjewels.jsp.)

- The renowned Harvard biologist Edward O. Wilson has established the E.O. Wilson Biodiversity Foundation to advocate on behalf of biodiversity (www.eowilson.org). Actor Harrison Ford is on the board of directors. The website includes a short video where Wilson tells the story of his famous experiment in the Florida Keys 40 years ago, when he attempted to exterminate all insect life on a tiny island to see how quickly life recovered. This story is told in detail in Charles Mann and Mark Plummer's fine 1995 book *Noah's Choice: The Future of Endangered Species*.[2]

- In May two bald eagles were spotted making a nest in metro Milwaukee, Wisconsin. It was the first time in more than 100 years that a bald eagle built a nest in southeastern Wisconsin. Eagle census figures show that the number of bald-eagle nests in the entire state has grown from 108 in 1973 to 1,020 in 2005.

- The London *Times* reported in August on efforts to bring back the woolly mammoth from extinction by using frozen mammoth sperm. Did they have mammoth sperm banks 10,000 years ago? No, but several frozen mammoths have been found in Siberia in such good condition that a Canadian team of scientists believes that intact DNA can be extracted and used to generate mammoths through cross-breeding with elephants.

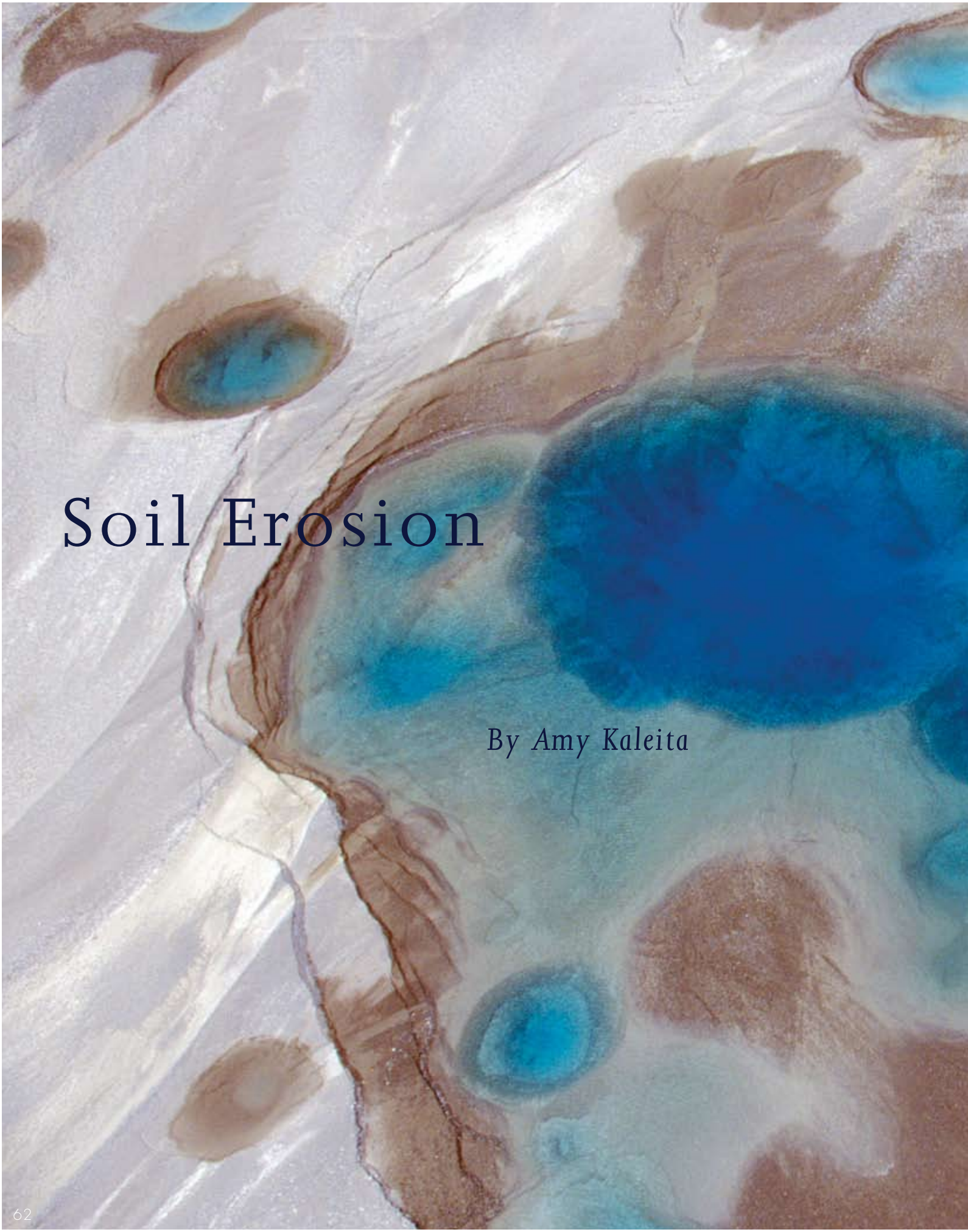
  And a study by a scientist at the University of Alaska has advanced the theory that climate change, and not human hunting, was probably responsible for the extinction of the mammoth. Wetter, warmer summers led to changes in vegetation—specifically too many trees—to which the mammoth was unsuited.

- The *Anchorage Daily News* reported in July on the dramatic surge in red salmon in recent years, which biologists attribute to—global warming.[3] In the early 1970s, the Alaska Department of Fish and Game reports, there were as few as 2,654 red salmon counted running up the Russian River in the Kenai Peninsula to spawn. In recent years the count has exceeded 60,000, surpassing the number biologists thought was possible in the best of conditions. "Fisheries biologists thought the [climate] change would help rebuild the early run of Russian River reds," *News* reporter Craig Medred wrote, "but they never expected to witness runs like those that have returned to the river the past five years."

- National Public Radio's "Morning Edition" reported in January of this year that "record numbers of whooping cranes have returned to the Texas coast for the winter. As few as 15 of the birds were seen in Texas in the 1940s. This year, 237 birds made the trek to Texas from Canada."

Notes

1 Michel Loreau et al., "Diversity Without Representation," *Nature*, 20 July 2006, pp. 245–246.
2 http://www.eowilson.org/index.php?option=com_content&task=view&id=16&Itemid=33
3 Craig Medred, "Annual Red Return Leaps," *Anchorage Daily News*, July 9, 2006.



Soil Erosion

By Amy Kaleita

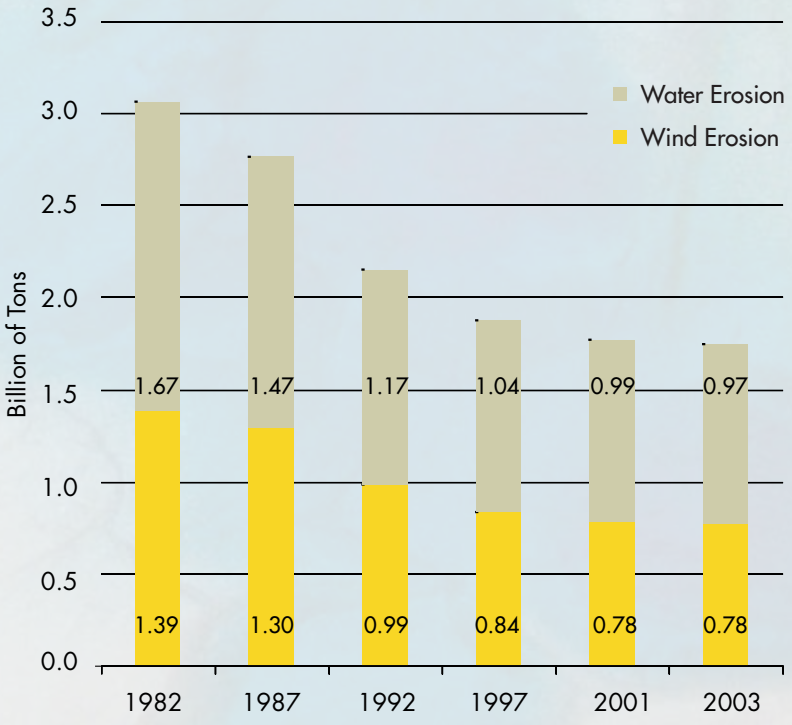
IN MAY 2006, the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) released the results of its 2003 National Resources Inventory (NRI), which addresses land use, condition of wetlands, and soil erosion on non-federal land. The NRI assessments of wind and water erosion use empirical relationships among climate, topography, soil characteristics, and land management (such as vegetation cover and agricultural tillage) to estimate annual average soil loss. NRI data are not based on direct measurement of erosion rates. The soil-loss estimates do not include streambank erosion or "gully" erosion, where large channels not correctable by tillage are formed in the soil primarily because of localized phenomena.

Between 1982 (when NRI data collection began) and 2003, estimated soil-erosion rates decreased by 43 percent. The greatest decreases occurred between 1987 and 1992, with only a slight decrease between 1997 and 2003.

Equally interesting is a look at where the remaining erosion is predominantly coming from. Most (51 percent) of the water erosion comes from the heavily farmed upper Midwest and mid-to-northern Great Plains, while the Rio Grande River basin in Texas has the highest rates of wind erosion. The greatest reductions in total erosion have occurred in the Missouri River and Upper Mississippi River basins.

It is difficult to say whether the current levels of soil erosion are sus-

Figure 1: Annual Erosion on Cropland by Year



tainable or dangerous. Some degree of soil erosion is natural, and indeed valuable for recharging naturally eroding coastal areas with sediment delivered from land upstream. As such, zero soil erosion is not an appropriate target. To assess whether soil loss is adequately controlled, the NRCS uses a "T-value," or measurement of tolerable soil loss, which is the level of soil erosion above which significant long-term productivity losses are likely to occur. In 2003, 72 percent of all cropland was eroding at or below this tolerable level, compared to only 60 percent in 1982. However, most experts consider the T-values to be an inadequate measure. Among other things, these values address problems only at the origin of soil loss and do not address the problems associated with eroded sediments downstream—such as silting up of water bodies, disruption of aquatic habitat, and transport of chemicals that tend to stick to the sediments.

What is behind these declines in soil-erosion rates? Beginning in response to the Dust Bowl conditions of the 1930s, the federal government undertook research and policy initiatives to address soil conservation. In the 1985 Food Security Act, the federal government required farmers on land classified as "highly erodible" to engage in conservation efforts in order to receive government payments, a strong incentive encouraging practices that limit soil erosion.

In addition to this conservation compliance program, there are several other federal conservation programs. The Conservation Reserve Program (CRP), started in 1985, gives farm owners direct payments for taking land out of tillage and returning it to grassy or forested areas. (Without tillage and with dense vegetation cover, erosion rates on these lands theoretically decrease.) The Conservation Reserve Enhancement Program (CREP), begun in 1996, is an offshoot of the CRP, combining federal resources with state and private efforts. The Environmental Quality Incentives Program (EQIP), started in 1996, provides education and technical assistance to farmers, encouraging them to adopt environmental conservation practices. Expenditures on these programs have been upwards of $27 million.

A 2006 survey by the U.S. Government Accountability Office (formerly the U.S. General Accounting Office) indicated that the primary incentive for farmers to participate in USDA conservation programs was to receive payments.[1] And it is not clear whether these government programs are the main reason for the decline in erosion rates. Significant reductions in soil erosion have occurred through unsubsidized conservation practices and on land that does not qualify for federal conservation programs.

Farmers, like any other group, respond to a variety of stimuli, including policy, economic, and personal concerns. One analysis of the conservation compliance programs by the USDA's Economic Research Service indicated that only about 25 percent of the net reduction in soil erosion between 1982 and 1997 could be attributed to government programs.[2] However, these programs have received wide participation from farms containing highly erodible land, especially land particularly susceptible to wind erosion, so one could argue that the programs have been effective at targeting the most vulnerable areas.

At the same time, it is probable that practices like conservation tillage, in which different tillage techniques are employed to preserve a protective cover of crop residue on the soil surface, would eventually have been adopted where they are cost-effective, regardless of federal programs. Conservation tillage tends to retain moisture in the soil, so this approach can also serve as a water-management technique. Thus, in several regions of the country, it is an attractive option for maintaining productivity through soil and water conservation, apart from its strictly environmental benefits.

Beginning in the 1970s, technological innovations made conservation-tillage machinery widely available. Use of conservation tillage is continually on the rise. Between 1989 and 2004, the percentage of total U.S. cropland acres in conservation tillage increased from 25.7 to 40.7. During the same period, the percentage of cropland acres that were not tilled at all—the most conservative approach—increased from 5.1 to 22.6.[3] Some experts believe that high fuel and fertilizer costs, due to the price of crude oil, will further promote adoption of conservation tillage.[4]

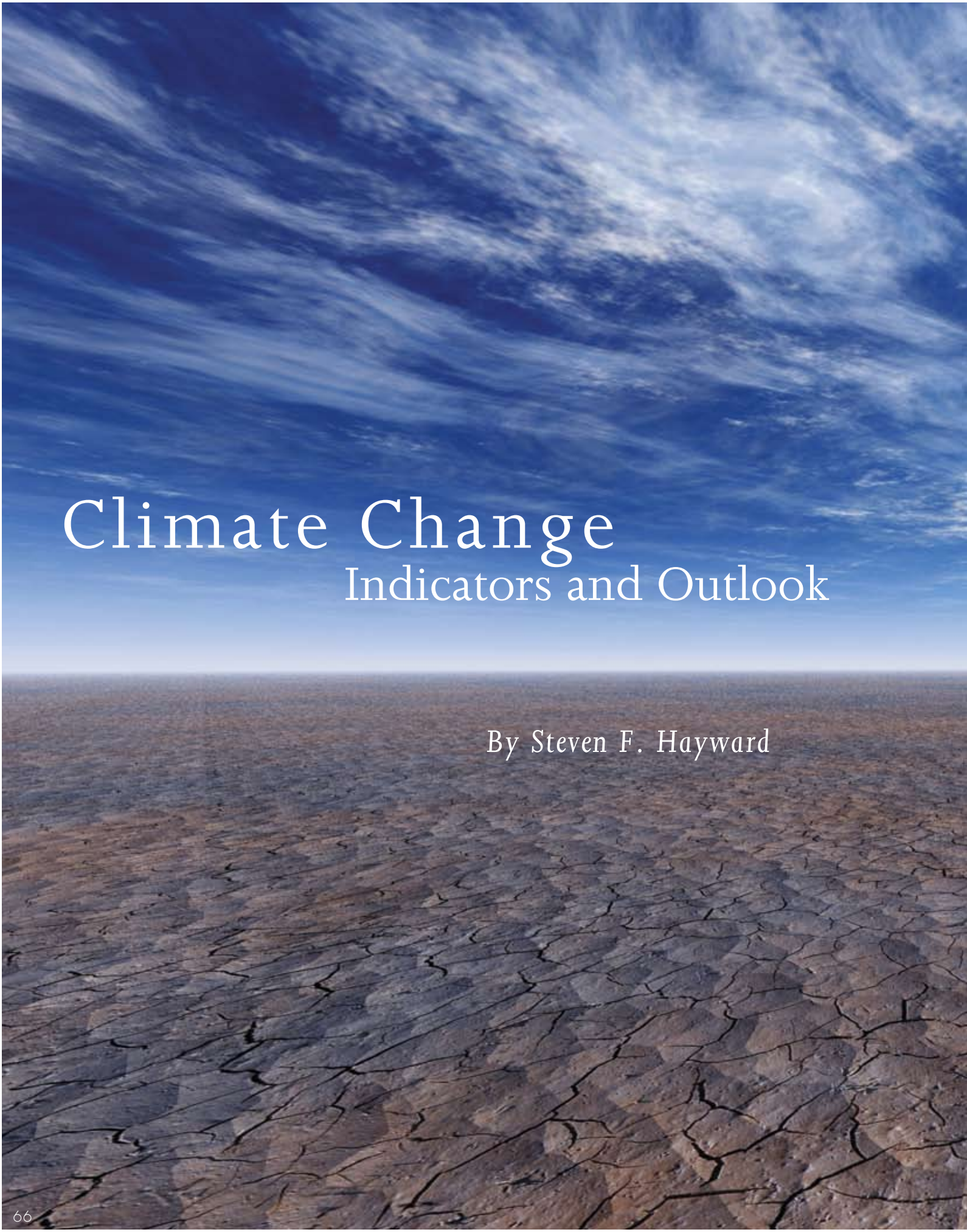
Notes

1 USDA Conservation Programs: Stakeholder Views on Participation and Coordination to Benefit Threatened and Endangered Species and Their Habitats, GAO-07-35, November 15, 2006.

2 ERS analysis of 1997 NRI and 1997 Agricultural Resource Management Survey data, presented in http://www.ers.usda.gov/publications/aer832/, Environmental Compliance in U.S. Agricultural Policy: Past Performance and Future Potential.

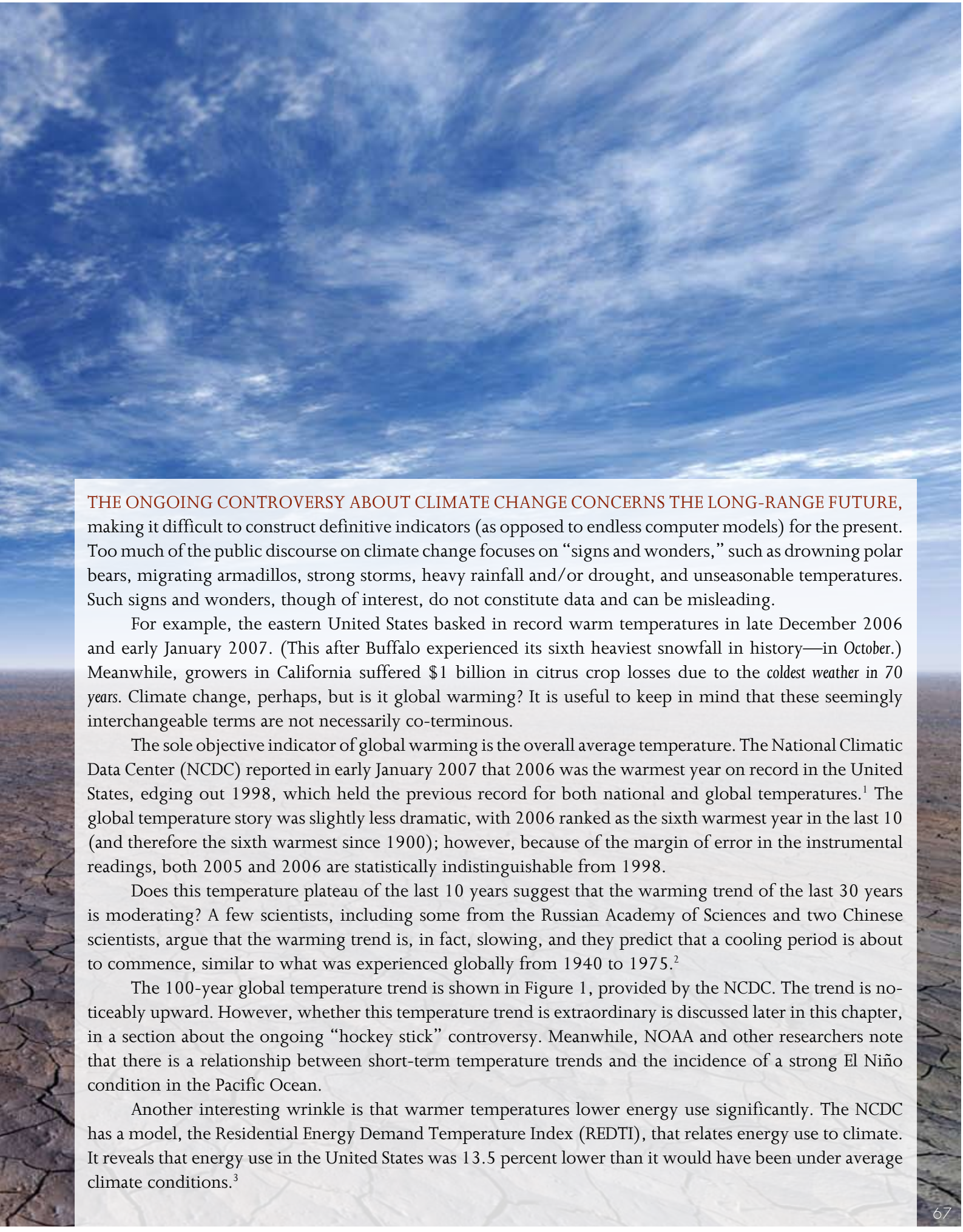
3 Conservation Technology Information Center (CTIC), National Crop Residue Management Surveys, Prepared by the Agronomy Department, Iowa State University, http://extension.agron.iastate.edu/soils/pdfs/CTIC/cticus2.pdf

4 Conservation tillage is not without other environmental side effects. It often requires or results in higher levels of herbicide use, since tillage is not used to kill weeds and leftovers from the previous crop.



Climate Change
Indicators and Outlook

By Steven F. Hayward



THE ONGOING CONTROVERSY ABOUT CLIMATE CHANGE CONCERNS THE LONG-RANGE FUTURE, making it difficult to construct definitive indicators (as opposed to endless computer models) for the present. Too much of the public discourse on climate change focuses on "signs and wonders," such as drowning polar bears, migrating armadillos, strong storms, heavy rainfall and/or drought, and unseasonable temperatures. Such signs and wonders, though of interest, do not constitute data and can be misleading.

For example, the eastern United States basked in record warm temperatures in late December 2006 and early January 2007. (This after Buffalo experienced its sixth heaviest snowfall in history—in *October*.) Meanwhile, growers in California suffered $1 billion in citrus crop losses due to the *coldest weather in 70 years*. Climate change, perhaps, but is it global warming? It is useful to keep in mind that these seemingly interchangeable terms are not necessarily co-terminous.

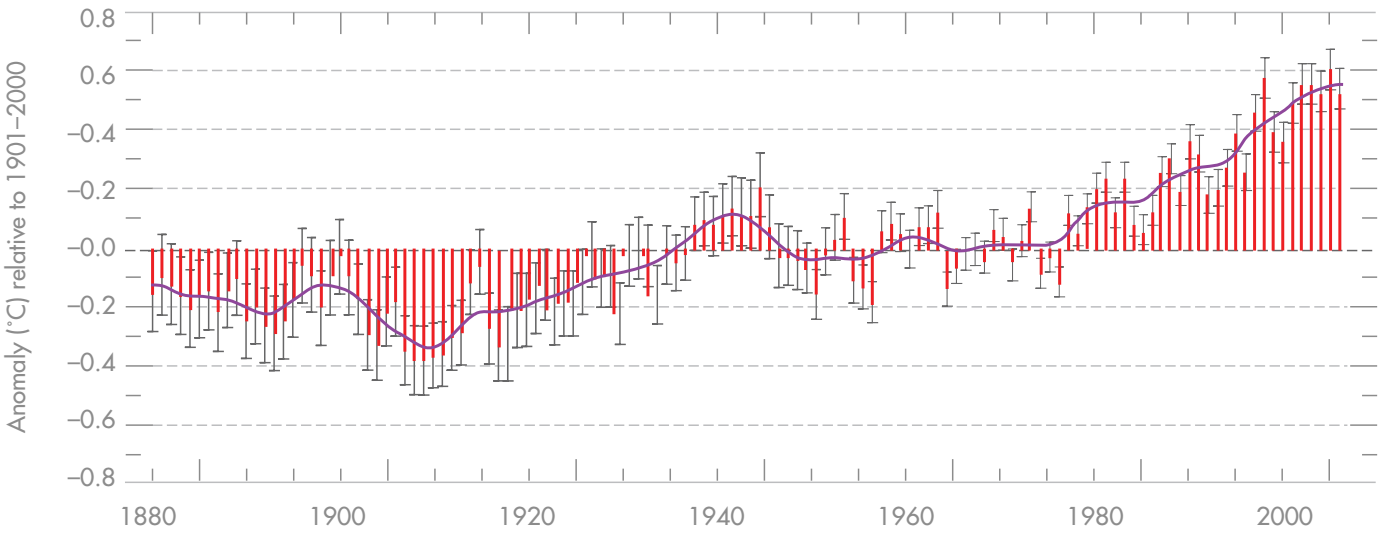
The sole objective indicator of global warming is the overall average temperature. The National Climatic Data Center (NCDC) reported in early January 2007 that 2006 was the warmest year on record in the United States, edging out 1998, which held the previous record for both national and global temperatures.[1] The global temperature story was slightly less dramatic, with 2006 ranked as the sixth warmest year in the last 10 (and therefore the sixth warmest since 1900); however, because of the margin of error in the instrumental readings, both 2005 and 2006 are statistically indistinguishable from 1998.

Does this temperature plateau of the last 10 years suggest that the warming trend of the last 30 years is moderating? A few scientists, including some from the Russian Academy of Sciences and two Chinese scientists, argue that the warming trend is, in fact, slowing, and they predict that a cooling period is about to commence, similar to what was experienced globally from 1940 to 1975.[2]

The 100-year global temperature trend is shown in Figure 1, provided by the NCDC. The trend is noticeably upward. However, whether this temperature trend is extraordinary is discussed later in this chapter, in a section about the ongoing "hockey stick" controversy. Meanwhile, NOAA and other researchers note that there is a relationship between short-term temperature trends and the incidence of a strong El Niño condition in the Pacific Ocean.

Another interesting wrinkle is that warmer temperatures lower energy use significantly. The NCDC has a model, the Residential Energy Demand Temperature Index (REDTI), that relates energy use to climate. It reveals that energy use in the United States was 13.5 percent lower than it would have been under average climate conditions.[3]

Figure 1: January–December Global Mean Temperature over Land & Ocean



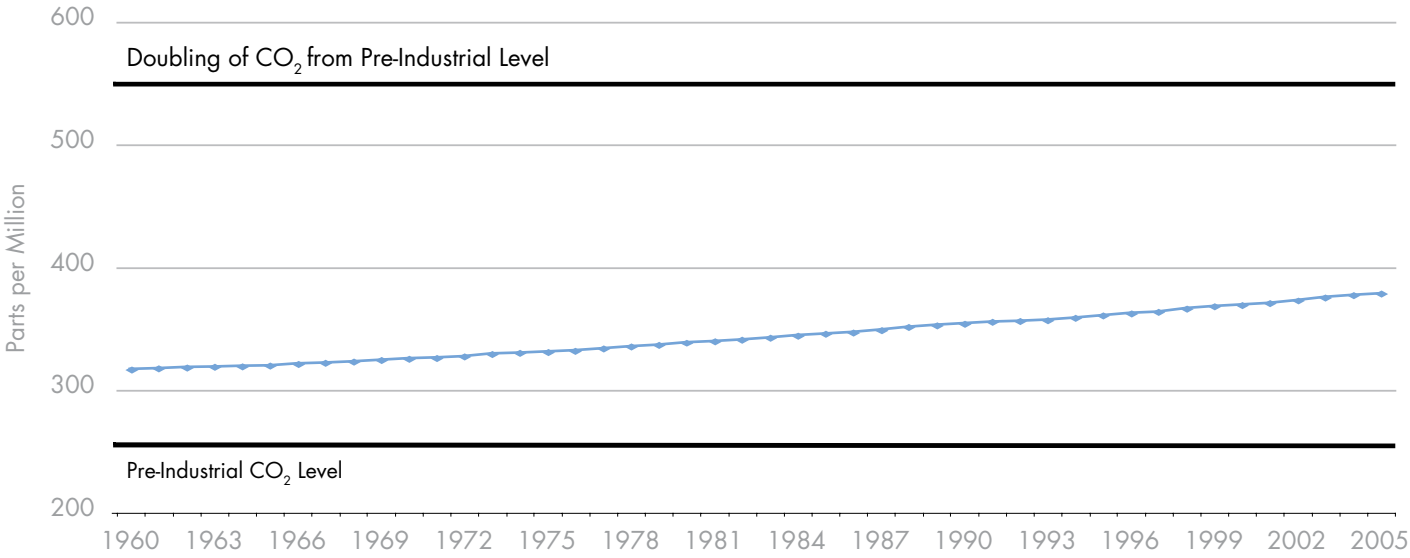
(Source: NCDC/NESDIS/NOAA)

I. Climate Policy Indicators

For policy purposes the relevant indicators of dynamic change in the factors of human-induced climate change are ambient global greenhouse gas (GHG) levels (principally CO_2 and methane), GHG emissions, and GHG intensity (i.e., the amount of GHG emitted per dollar of GDP). This latter metric is arguably the most important for policy purposes as it is a measure of the change in energy efficiency relative to economic growth. It is more useful in comparing relative efforts internationally than the Kyoto framework of emissions relative to the 1990 baseline. The ultimate goal of sensible climate policy will be to encourage improvement in the intensity of GHG emissions at a faster rate than the average rate of economic growth.

Figures 2–8 display measures for these metrics, from which several observations emerge. Figure 2 displays the trend in global CO_2 concentration in the atmosphere, taken from the monitoring series of the Mauna Loa Observatory in Hawaii. This time series is often shown on a narrow y-axis scale, such that the increase in CO_2 appears steep and rapid, "alarming" even. (Sometimes very long-term CO_2 levels are depicted on a logarithmic y-axis scale that produces even more dramatic but misleading imagery.) Here the trend is displayed on a wider y-axis scale, with two benchmarks to note the pre-industrial level of atmospheric CO_2

Figure 2: Atmospheric CO_2 Concentration



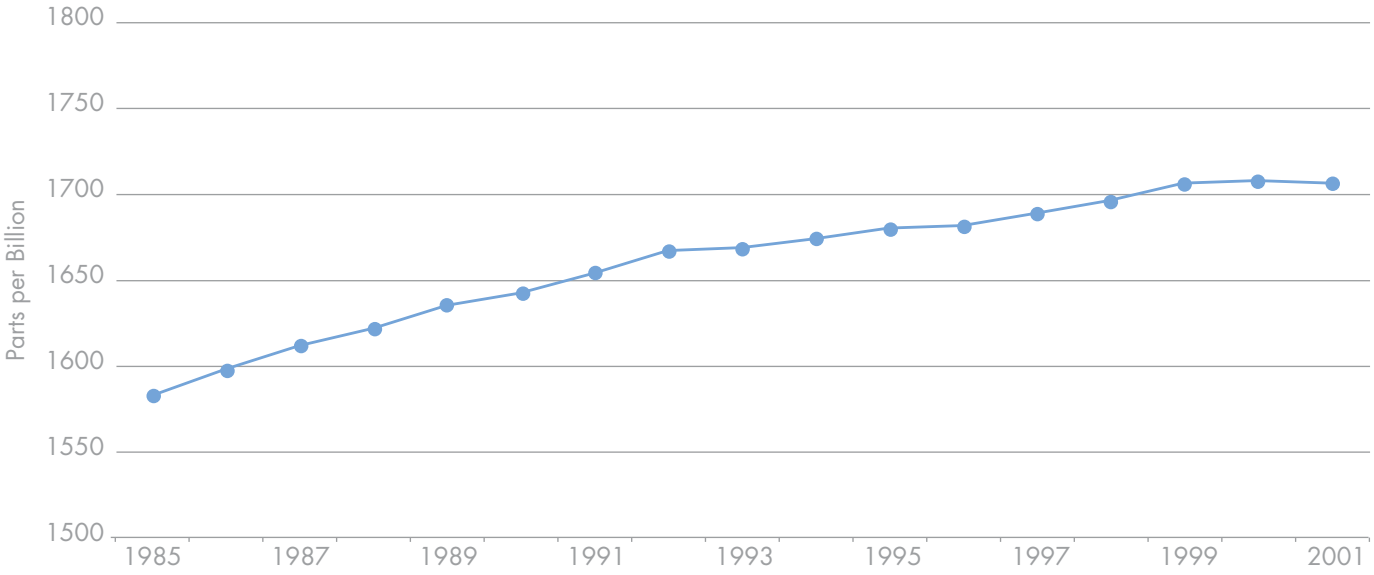
(Source: Keeling & Whorf, Mauna Loa Observatory)

and the level representing a doubling of CO_2 (about 550 ppm), which has become the arbitrary target for carbon stabilization at some future point, beyond which it is presumed—though far from proven—that dramatic harm to the planet will occur.

Figure 2 makes evident an important fact typically left out of discussion: it has taken 200 years to go a little more than one-third of the way toward a doubling of CO_2 levels in the atmosphere. Moreover, since close monitoring began in the late 1950s, the increase has been steady, at an average of 0.41 percent per year, or about 1.5 ppm per year. The rate has increased only slightly since global economic growth started accelerating in the 1980s. At these rates, it will be well into the 22nd century before the CO_2 level reaches twice its pre-industrial level.

Most projections of high temperature increase from GHG assume that this trend will break sharply upward very soon—that the rate at which CO_2 is accumulating in the atmosphere will more than double from the long-term historical trend. Despite the common-sense case that the surging emissions from the developing world—especially China and India, together projected to exceed emissions from the currently developed nations within the next few years—might push up the rate of CO_2 accumulation in the atmosphere,

Figure 3: Atmospheric Methane Levels, 1985–2001

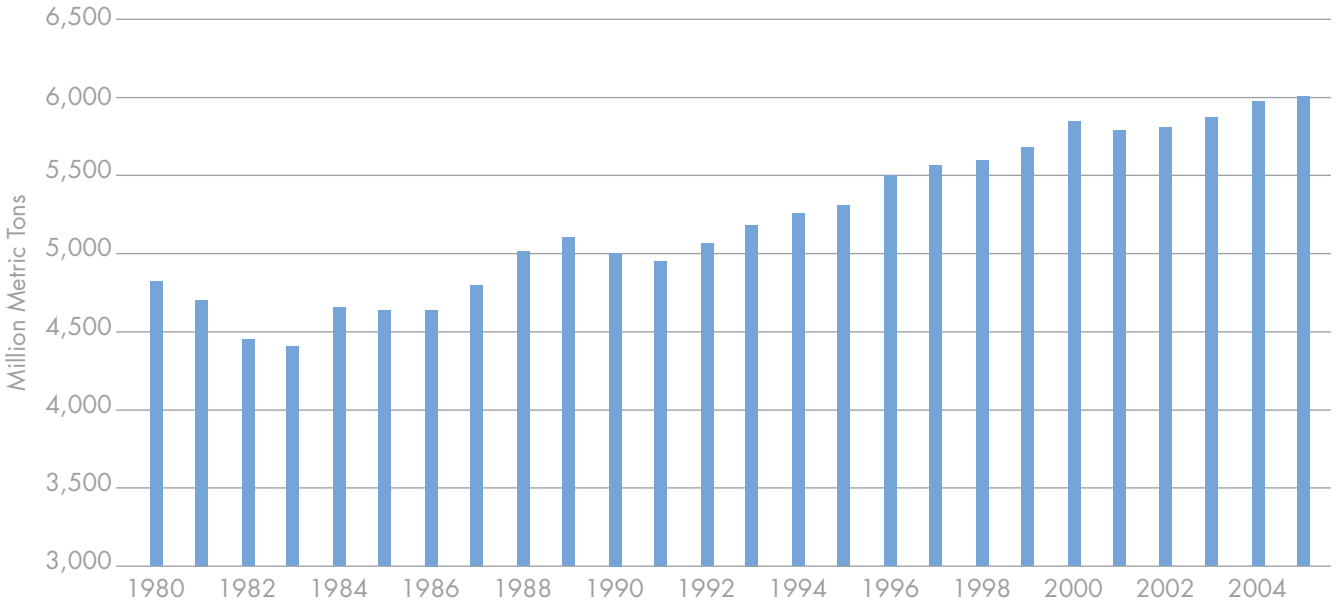


(Source: Steele, Krummel, & Langenfelds, Commonwealth Scientific and Industrial Research Organisation, Victoria, Australia, 2003)

there are reasons to doubt that a sharp temperature increase will occur.

Global measures of ambient methane (CH_4) are not as consistent as measures of CO_2, nor do the records on CH_4 extend back as far as those on CO_2; still, there is some evidence that CH_4 levels may be stabilizing (see Figure 3, generated from Australian tracking data). However, recent findings on methane, summarized later in this chapter (see "The Methane Mystery"), cast doubt on our grasp of the dynamics of atmospheric methane. "Somewhat mysteriously," *American Scientist* magazine reported in November, "the rise in atmospheric methane levels has ceased."

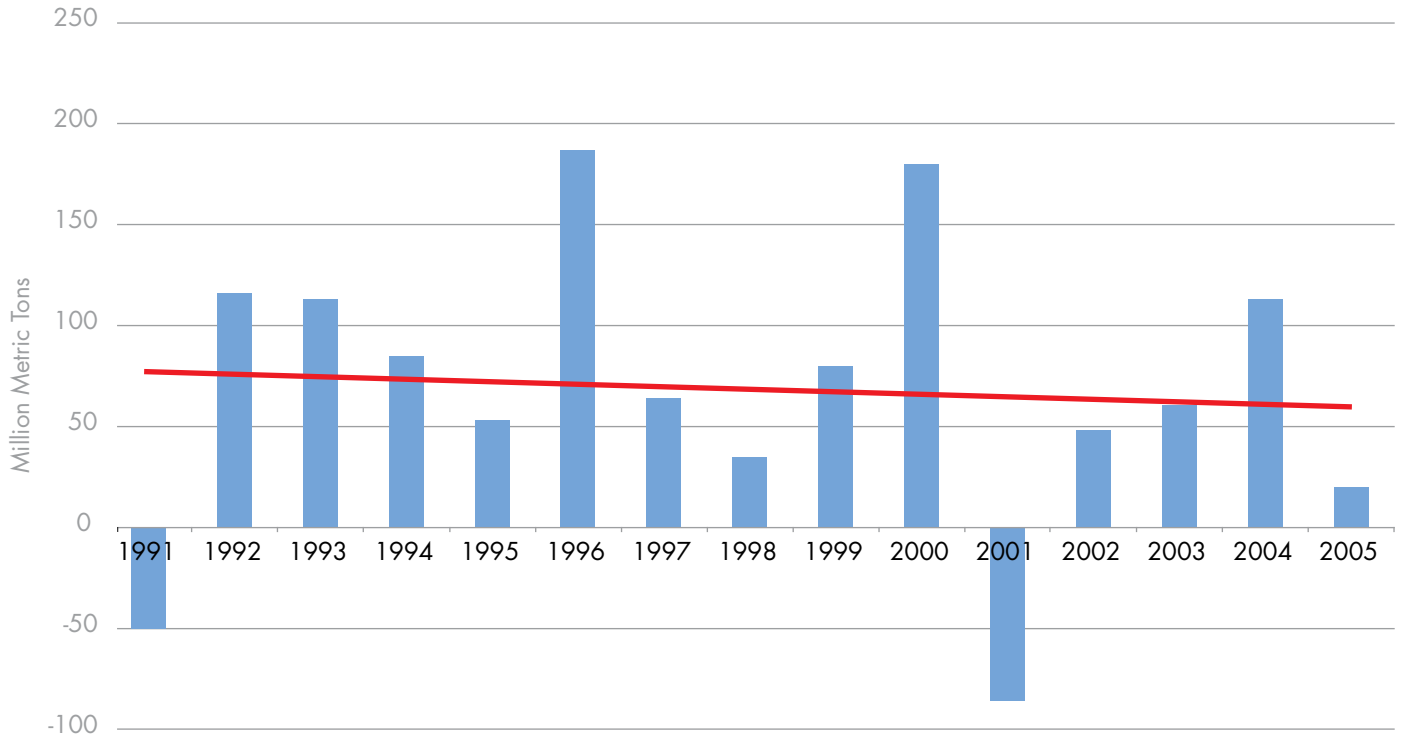
Figure 4: U.S. Carbon Dioxide Emissions, 1980–2005



(Source: Energy Information Administration [EIA], Emissions of Greenhouse Gases in the U.S. 2005)

This complicated and contentious aspect of climate-change prediction is beyond the scope of this brief survey. (The DVD accompanying this edition of the *Index* offers additional perspectives on the larger scientific and political controversies.) However, there are a few observations about current GHG emission trends in the United States that are relevant to the larger picture. As Figure 4 shows, CO_2 emissions in the United States are still rising, but the rate of growth of CO_2 emissions in the United States is falling. During the Clinton Administration, CO_2 emissions rose 12.8 percent. On the current trend, CO_2 emissions will grow by less than half that amount by the time the Bush Administration ends in 2009.

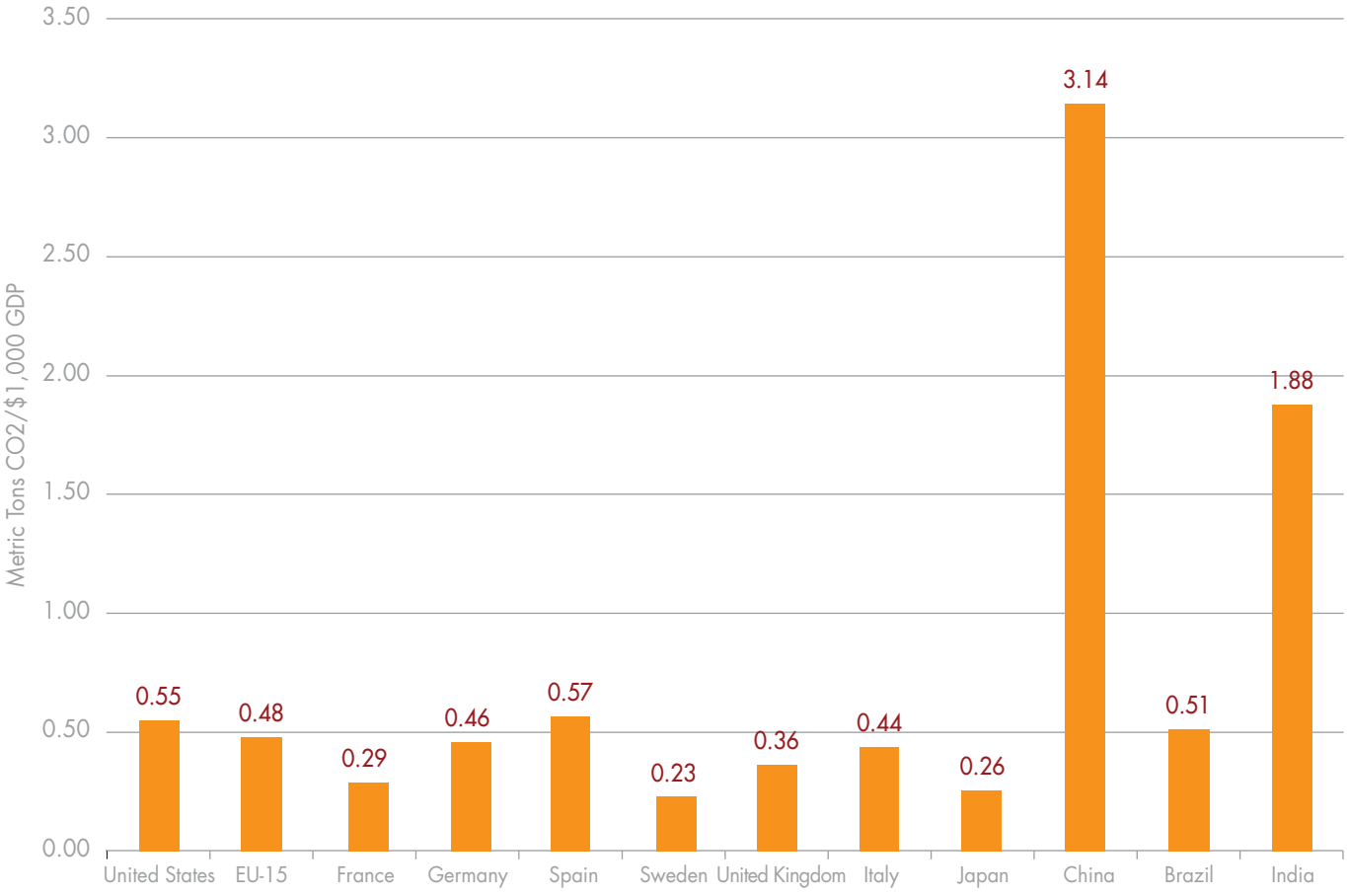
Figure 5: Annual Change in U.S. CO_2 Emissions, 1990–2005



(Source: EIA, Emissions of Greenhouse Gases in the U.S. 2005)

The change in the trend is perhaps better seen in Figure 5, which displays the year-by-year changes in U.S. CO_2 emissions. Emissions data for 2006 were not available at press time for this report, but it is possible that CO_2 emissions may have declined absolutely for the first time in a non-recession year; in other words it would mark the first time that GHG intensity has improved at a faster rate than economic growth.

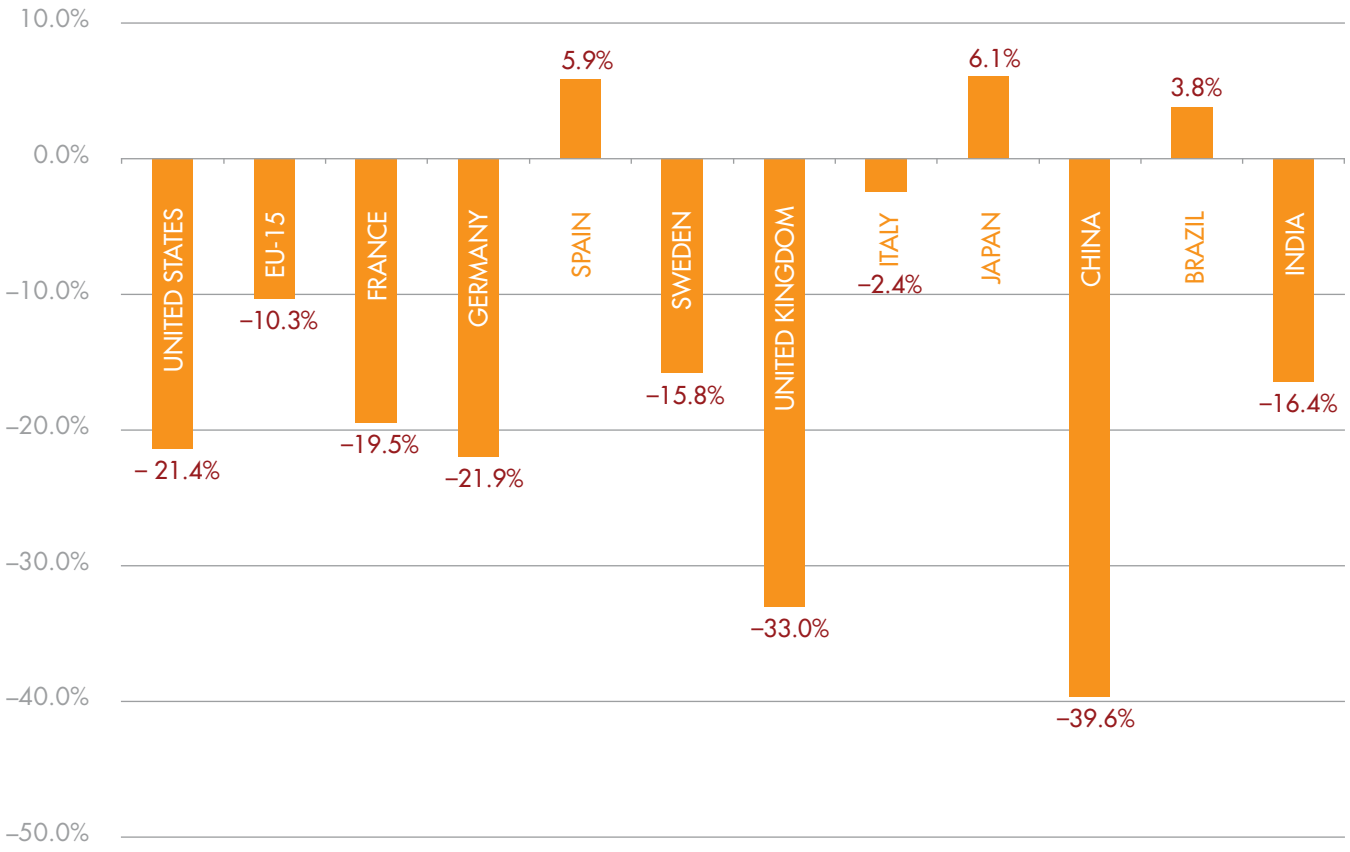
Figure 6: GHG Emission Intensity, 2004



(Source: EIA, Emissions of Greenhouse Gases in the U.S. 2005)

The next level of refinement in this analysis is to consider measures of GHG intensity—that is, the amount of greenhouse gases emitted per dollar of economic output. The common view is that the United States is vastly less energy efficient than European nations. This is true only of the transportation sector, where Americans' love of larger cars produces most of the gap between the United States and Europe on GHG intensity. When measured on an output-adjusted basis, American GHG intensity is only slightly higher than that of the wealthy EU-15 nations, as shown in Figure 6. Japan is actually the emissions-intensity champion among the G-8 nations.

Figure 7: Change in GHG Intensity, 1991–2004

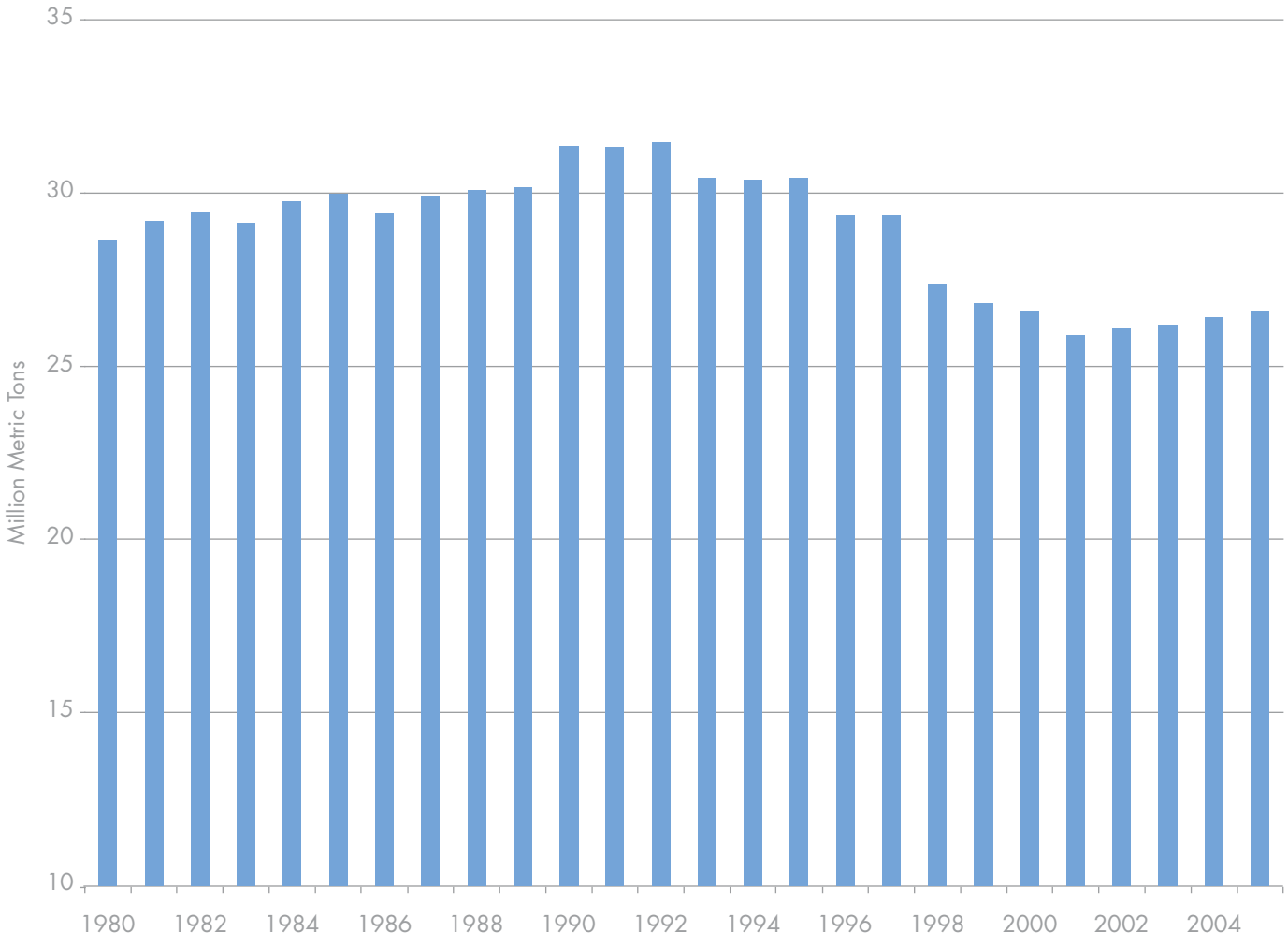


(Source: EIA, Emissions of Greenhouse Gases in the U.S. 2005)

Going forward, the most useful metric to watch will be the rate of change in GHG intensity. Here, the record of the United States is enviable. Since 1991, the year after the Kyoto Protocol benchmark, U.S. GHG intensity has declined by 21.4 percent, compared to 10.3 percent for the EU-15 (see Figure 7). It appears that the improvement in U.S. GHG intensity has been accelerating over the last five years.

The improvements in GHG intensity that Germany and the U.K. experienced are due partly to one-time extraordinary circumstances. In the case of the U.K., the decision, made prior to 1990, to make the transition from coal to natural gas for electricity generation accounts for much of the improvement. Germany owes much of its improvement to the shutting down of old and inefficient facilities in the former East Germany after unification in 1990. By

Figure 8: U.S. Methane Emissions, 1980–2005



(Source: EIA, Emissions of Greenhouse Gases in the U.S. 2005)

contrast, the comparable U.S. performance represents continuous improvements in efficiency.

Finally, the United States has enjoyed substantial success in *lowering* methane emissions—by 12.8 percent—from the 1990 baseline year used in the Kyoto Protocol. This is significant because methane is a more potent greenhouse gas than CO_2—23 times more potent, according to most estimates. The reduction in methane emissions of approximately four million metric tons since 1990 represents the equivalent of a reduction in CO_2 emissions of about 90 million tons.

II. Collateral Indicators

Collateral indicators are phenomena commonly thought to be effects of climate change, such as stronger or more frequent tropical storms, rising sea levels, and melting ice and permafrost in the arctic. The data for the first two are not conclusive; the data for arctic warming are more compelling, though they contain some curious inconsistencies.

Hurricanes and Tropical Storms

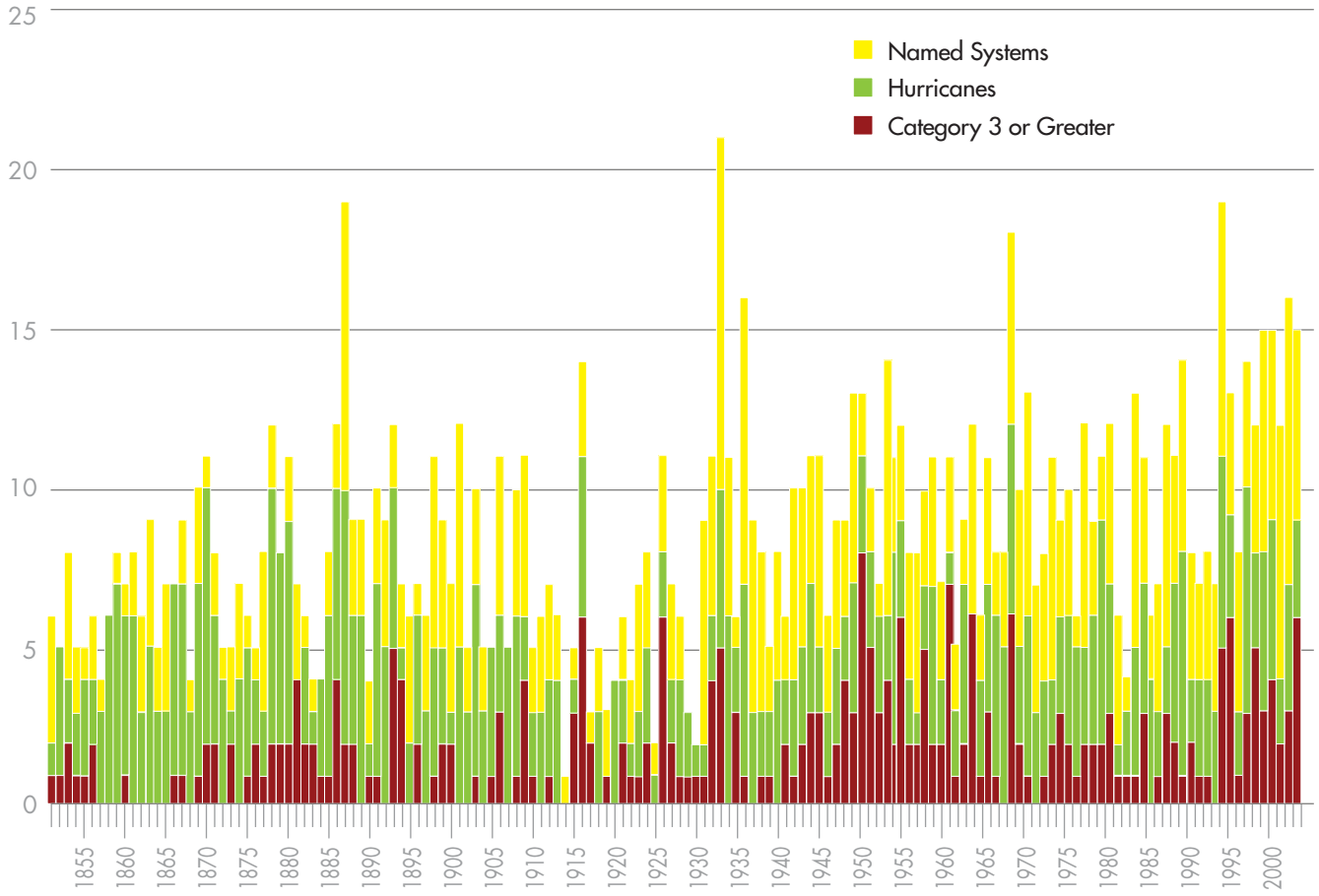
After 2005 finished as the most active hurricane season in modern times, culminating with the Hurricane Katrina catastrophe, there were popular predictions that 2006 would be worse. In fact, the 2006 hurricane season passed quietly, with only a handful of named tropical storms making landfall in the United States, much to the disappointment of climate pessimists and editorial writers everywhere.

Whether hurricanes and tropical storms are becoming more frequent and severe in intensity is highly contested at the moment, with leading scientists publishing studies on both sides of the issue. "Tempers Flare at Hurricane Meeting," *Nature* magazine reported in May, for example. Meanwhile, the World Meteorological Organization recently released a consensus statement that reads: "Though there is evidence both for and against the existence of a detectable anthropogenic signal in the tropical cyclone climate record to date, no firm conclusion can be made on this point."

The basic theory—that warmer ocean waters lead to stronger storms—seems intuitively sensible; the difficulty is a lack of reliable data to confirm both long-term ocean-temperature trends and tropical-storm intensity. Indeed, one startling study published last year found a sharp and unexpected decline in global ocean temperatures over the last three years—too short a time, however, to know if a genuine shift has occurred.[4] Various proxy techniques to estimate storm dynamics from decades ago are vulnerable to the usual statistical critiques. Even estimating the *number* of tropical storms beyond the last 25 years is subject to uncertainties.

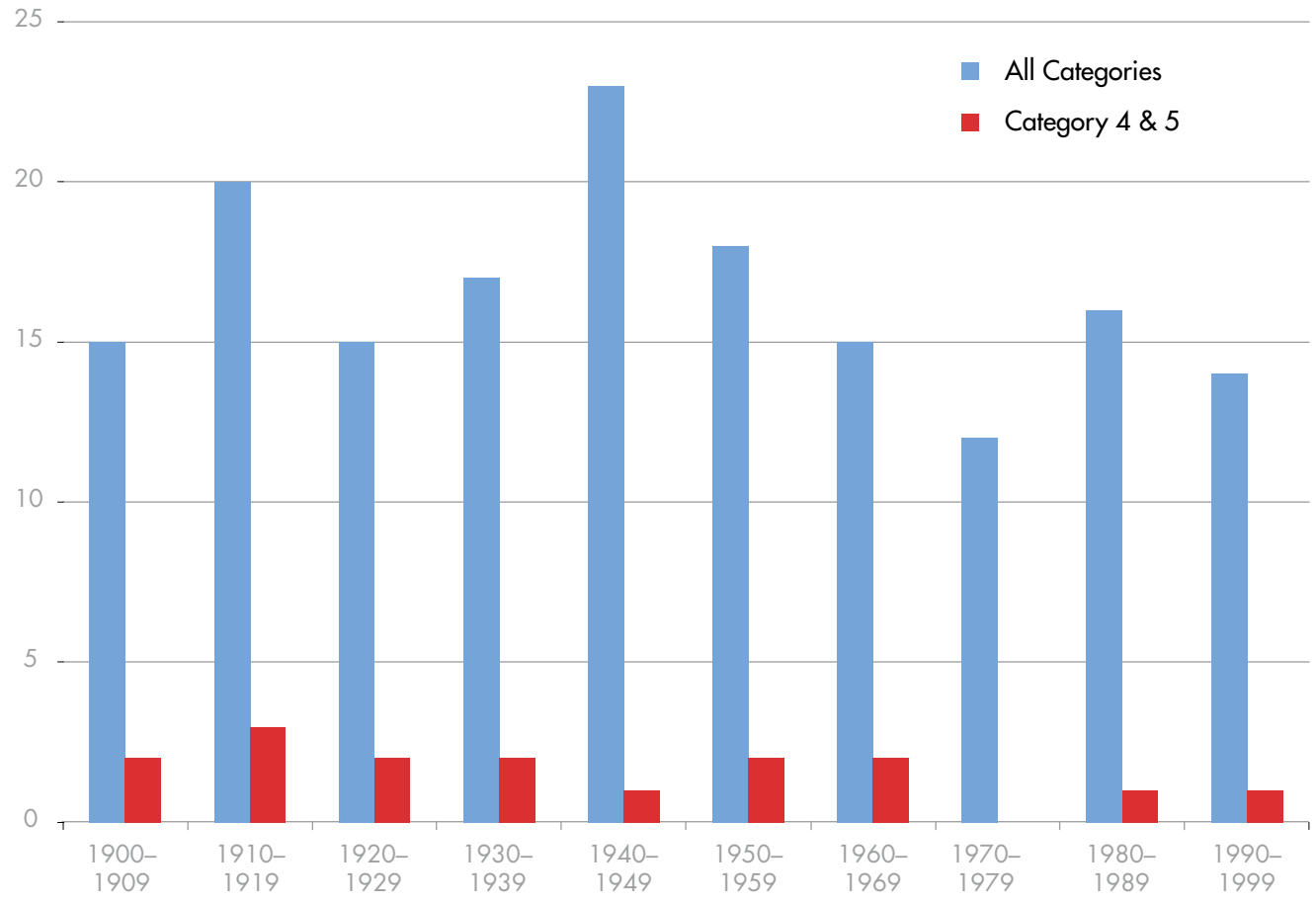
The series displayed in Figure 9 comes from the National Hurricane Center (NHC). It shows only a modest rise, if any, in tropical-storm activity in recent decades. Figure 10, also from data reported by the NHC, displays by decade the tropical storms that made landfall in the United States and suggests no trend of increasing storm activity affecting the United States.

Figure 9: Hurricane and Tropical-Storm Activity 1886–2004



(Source: National Hurricane Center[5])

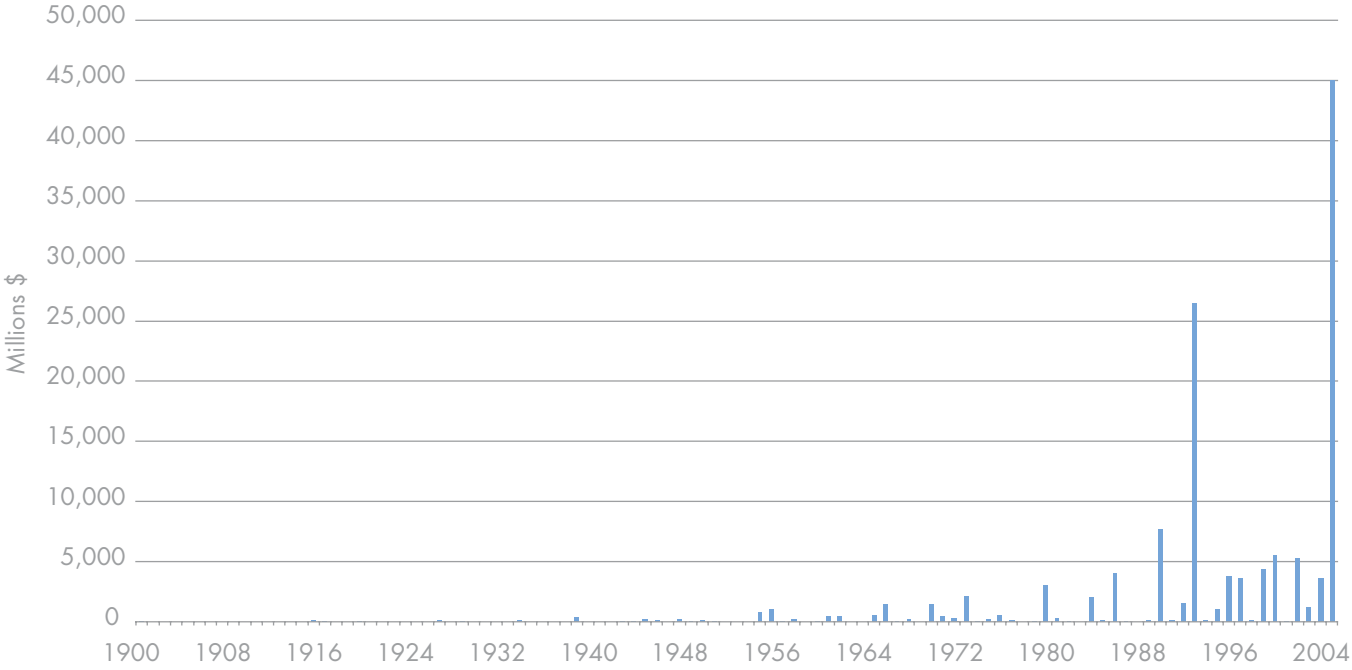
Figure 10: Tropical Storms Making Landfall in the U.S. by Decade



(Source: National Hurricane Center[6])

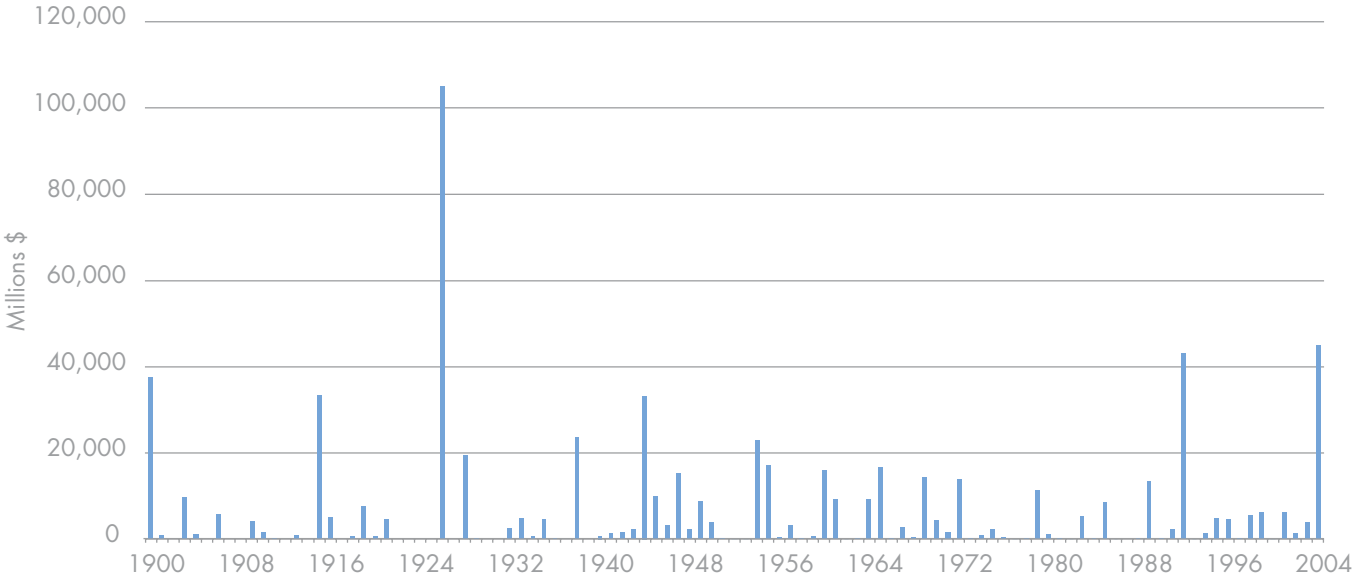
One of the data series former Vice President Gore uses in *An Inconvenient Truth* is a bar graph of monetary damages in the United States from hurricanes. This graph shows damges soaring in recent years, even before Hurricane Katrina. Gore's graph displays the data shown in Figure 11. It is telling that Gore uses nominal dollars and does not adjust for inflation, population growth on the coasts exposed to hurricane damage, and rising wealth (which translates into more expensive structures and therefore higher nominal damage costs). Roger Pielke Jr. and Chris Landsea adjusted the data for all three factors and generated the series shown in Figure 12; the increasing trend disappears, with the 1926 Miami hurricane remaining the most costly hurricane disaster in history prior to Katrina, whose full costs are still being tallied.

Figure 11: Nominal U.S. Monetary Damages from Hurricanes, 1900–2004



(Source: Pielke & Landsea[7])

Figure 12: U.S. Hurricane Monetary Damages, Adjusted for Inflation, Population Growth, & Wealth



(Source: Pielke & Landsea)

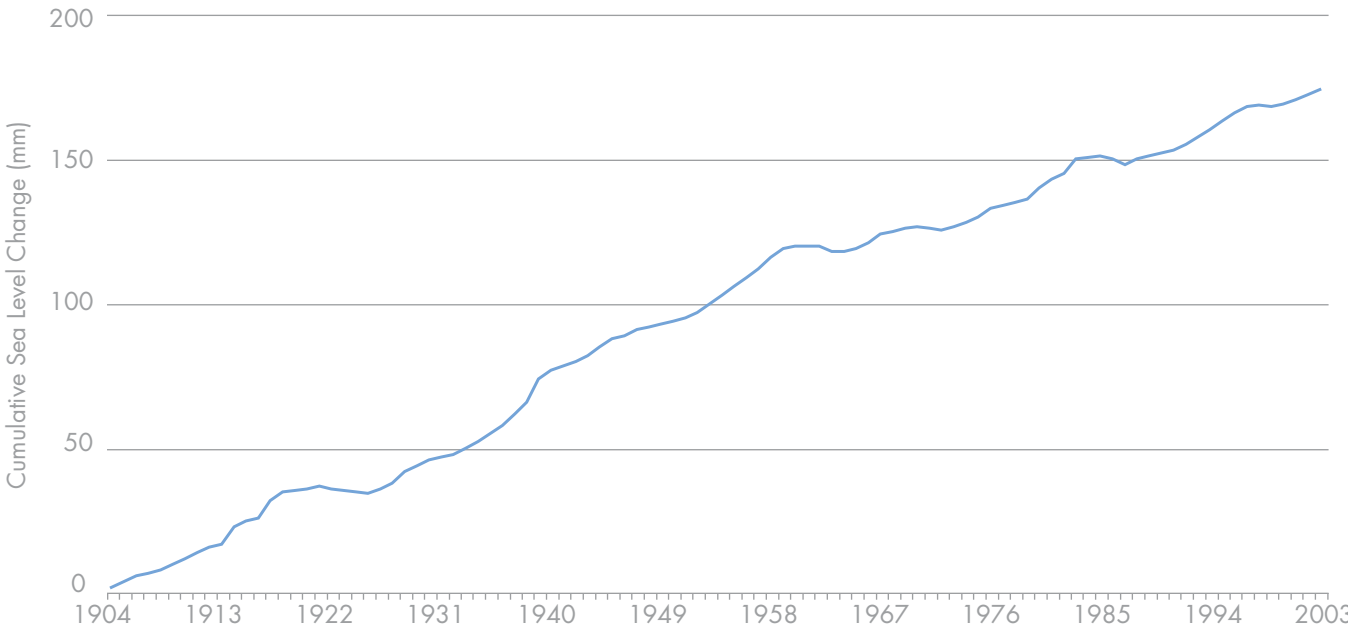
Sea Level

The sea level has been rising at a steady rate since reliable tidal gauges have been generating data (about 200 years). Indeed, the sea level is thought to have been steadily rising since the end of the last ice age 10,000 years ago. Is there evidence that the current rate of sea-level rise is accelerating on account of climate change? The most recently published research indicates that it is not.

Writing in *Geophysical Research Letters*, S.J. Holgate of the Proudman Oceanographic Laboratory in Liverpool, England, examined tidal records from nine gauges thought to have consistent and reliable data going back to 1904.[8] (Three of the nine gauges are located in the United States.) Holgate concluded that "the high variability in the rates of sea level change observed over the past 20 years [was] not particularly unusual. The rate of sea level change was found to be larger in the early part of last century (2.03 ± 0.35 mm/yr 1904–1953), in comparison with the latter part (1.45 ± 0.34 mm/yr 1954–2003).... Over the entire century the mean rate of change was 1.74 ± 0.16 mm/yr."

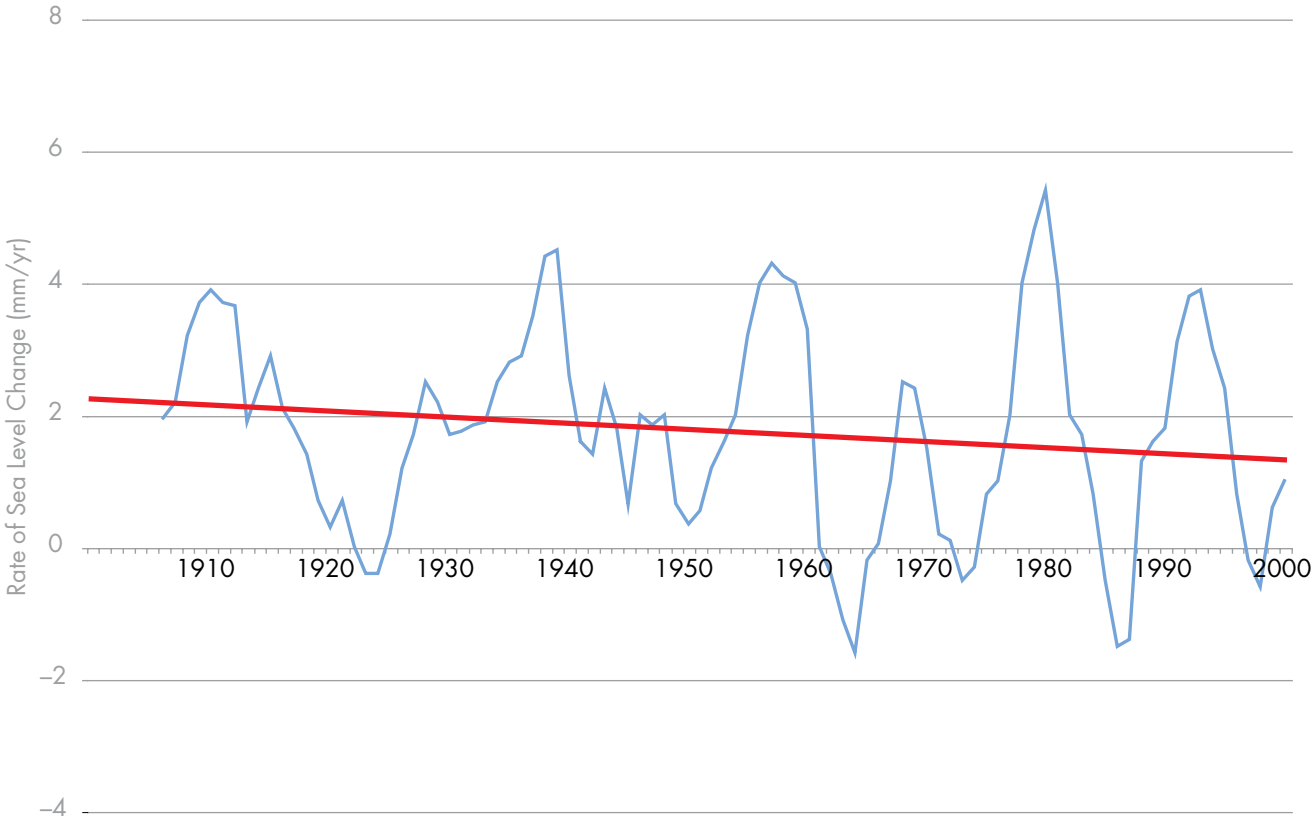
Holgate's finding, it should be noted, is at odds with the conclusion of the summary of the next report of the Intergovernmental Panel on Climate Change (IPCC). This report, released as the *Index* was going to press, found that sea-level rise had accelerated substantially in recent decades. The IPCC summary did not offer details, however, as to which data sets and studies it used to reach this finding, so we shall have to await the release of the full scientific report in May 2007. Holgate's findings for the amount of sea-level rise and the rate of sea-level rise are shown in Figures 13 and 14.

Figure 13: Cumulative Sea-Level Rise, 1904–2003



(Source: Holgate, *Geophysical Research Letters*)

Figure 14: Global Average Rate of Sea-Level Change, 1904–2000



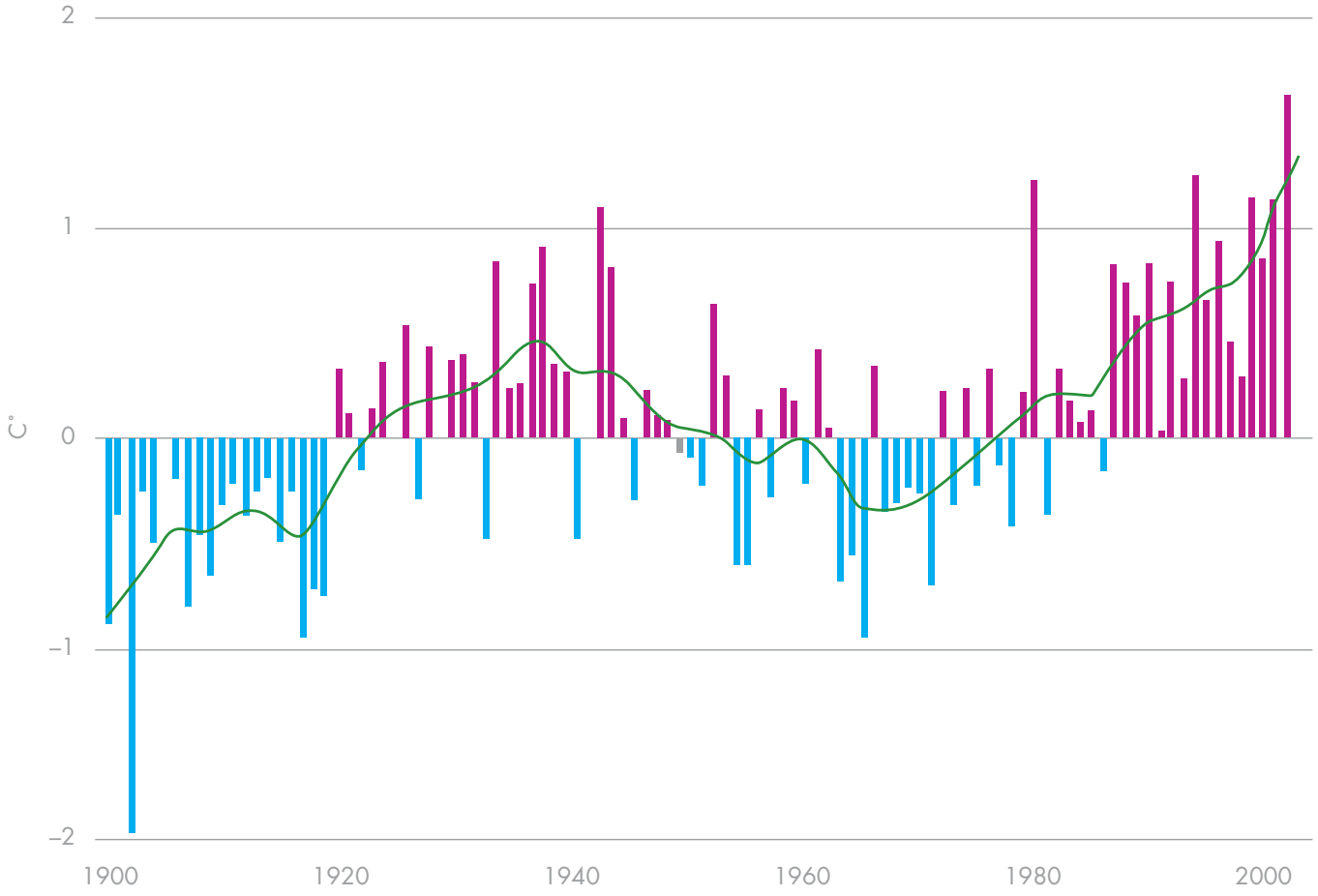
(Source: Holgate, *Geophysical Research Letters*)

Arctic Warming

Although there are conflicting findings on the dynamics of Greenland's ice mass and arctic sea ice, there is no dispute that significant warming has occurred in the arctic region. The best source of indicators is the 2005 Arctic Climate Impact Assessment (ACIA), especially its measures of changes to tundra conditions in Alaska and Canada.[9] These indicators, however, do not necessarily amount to positive proof of human-caused global warming in the region.

For some time, scientists have known that the earth is warming disproportionately in the arctic—by as much as three degrees C in some areas over the last 30 years. As one of the ACIA's own temperature-series charts makes clear, in the 1930s and 1940s the arctic region was nearly as warm as it is today (see Figure 15). Furthermore, some of the ACIA's more alarming findings are vulnerable to the criticism that the authors chose 1970 as their baseline,—when the arctic was near the end of a 30-year period of colder than normal temperatures—a technique guaranteed to generate dramatic but potentially misleading images of climate change.

Figure 15: Observed Arctic Temperature, 1990 to Present

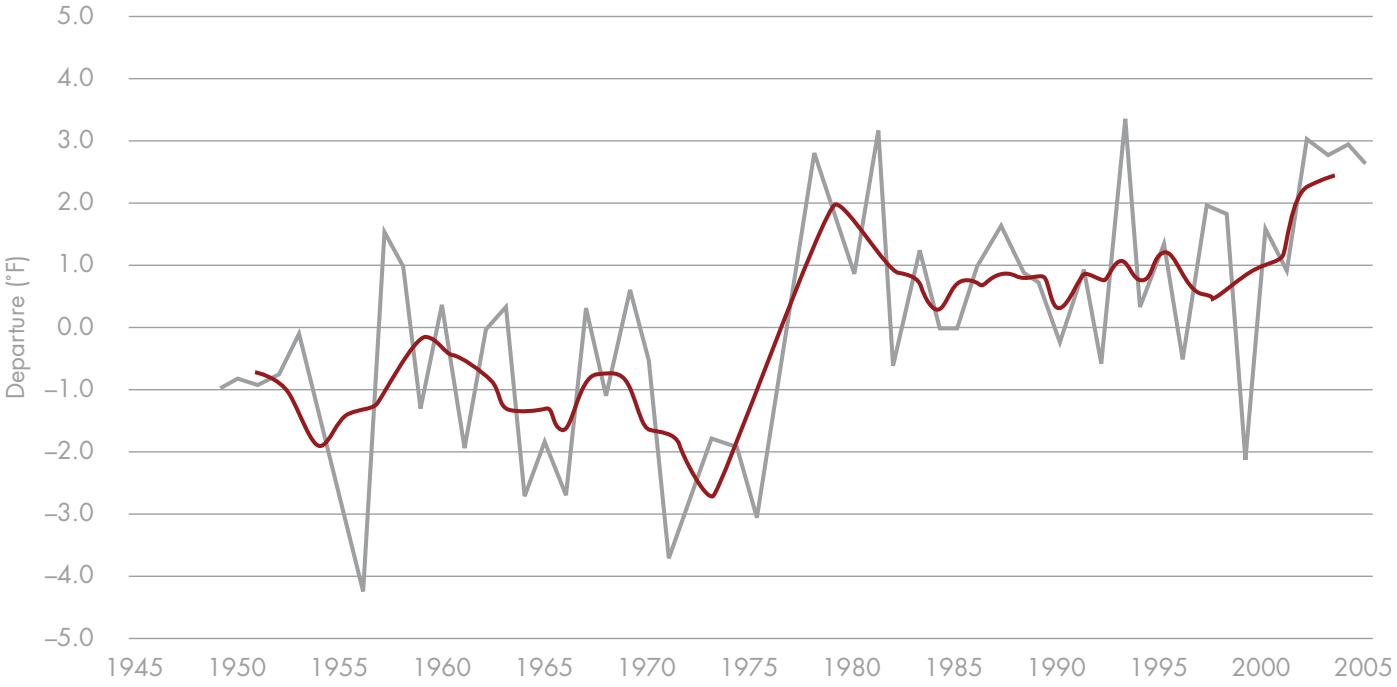


(Source: Arctic Climate Impact Assessment)

When the 50-year temperature series for Alaska is examined, the doubts deepen about explaining arctic temperature increases as predominantly a function of human-caused global warming (see Figure 16). The Alaska temperature record shows a rapid and sharp shift in average temperatures in the late 1970s, sandwiched between relatively stable average temperatures. This sharp, sudden increase is not consistent with computer climate models, and there is some scientific evidence that the recent temperature trends in the arctic may be related to cyclical oscillations of ocean temperatures and currents.[10]

Finally, as this edition of the *Index* was going to press, *Science* published a new study showing that the rapid melting of Greenland glaciers had suddenly stopped; over the last two years, the degree of melting has returned to long-term ranges.[11] As with all such findings, however, one should be careful about making generalizations from short-term data sets.

Figure 16: Alaska Temperature Trends, 1949–2005



(Source: Alaska Climate Research Center)

III. Climate News Highlights from 2006

In addition to a number of important scientific journal articles that received little media notice, there were three major climate-change stories in 2006: the Stern Review, the National Academy of Sciences report on the "hockey stick," and the flurry of new interest in the idea of "geoengineering."

The Stern Review

In September the British government released a 700-page report on the economics of climate change, which became known by the name of the report's lead author, Sir Nicholas Stern.[12] The Stern Review generated startling headlines for its central conclusion that the economic costs of climate change two centuries from now will be staggering—on the order of 20 percent of the world's GDP—but that steep near-term GHG emission reductions would cost only about one percent of current GDP to implement and thus were cost-effective. This represented an unprecedented finding; in previous analyses of the economics of climate change (including those done by the IPCC), near-term GHG abatement fails every cost-benefit test. The IPCC, for example, estimates that serious near-term emission abatement would cost about five percent of GDP. Prime Minister Tony Blair hailed the Stern Review as "the most important report on the future ever published by this government."

A closer examination reveals that the Stern Review employed novel economic assumptions that do not bear close scrutiny, and caused leading academic economists who specialize in climate change to heap scorn on the report. Hamburg University's Richard Tol, one of the leading figures in environmental economics (his work is cited 63 times in the Stern Review) said, "The Stern Review can therefore be dismissed as alarmist and incompetent." Alarmist is a familiar criticism, but incompetent?

In a review paper, Tol notes that "the Stern Review consistently selects the most pessimistic study in the literature," including several studies that were not peer-reviewed. "If a student of mine were to hand in this report as a Master's thesis, perhaps if I were in a good mood I would give him a 'D' for diligence; but more likely I would give him an 'F' for fail," Tol said to the BBC. "Stern consistently picks the most pessimistic for every choice that one can make. He overestimates through cherry-picking, he double counts particularly the risks and he underestimates what development and adaptation will do to impacts." Tol, normally a model of bland scholarly discourse in his published papers, includes some blunt and caustic footnotes in his formal analysis of Stern, such as: "This is a puzzling mistake to make. Sir Nicholas used to be the chief economist at the World Bank. Mistakes like this are usually corrected when one studies for a Master's degree in economics." And: "It is puzzling that economists of HM Treasury can make such basic mistakes."[13]

Yale University economist William Nordhaus, one of the leading scholars on the economics of climate-change policy (and in no way a climate-change skeptic), was more polite than Tol but no less dismissive on the substance: "The radical revision of the economics of climate change proposed by the Review does not arise from any new economics, science, or modeling. Rather, it depends decisively on the assumption of a near-zero social discount rate. The Review's unambiguous conclusions about the need for extreme immediate action will not survive the substitution of discounting assumptions that are consistent with today's market place. So the central questions about global-warming policy—how much, how fast, and how costly—remain open."[14]

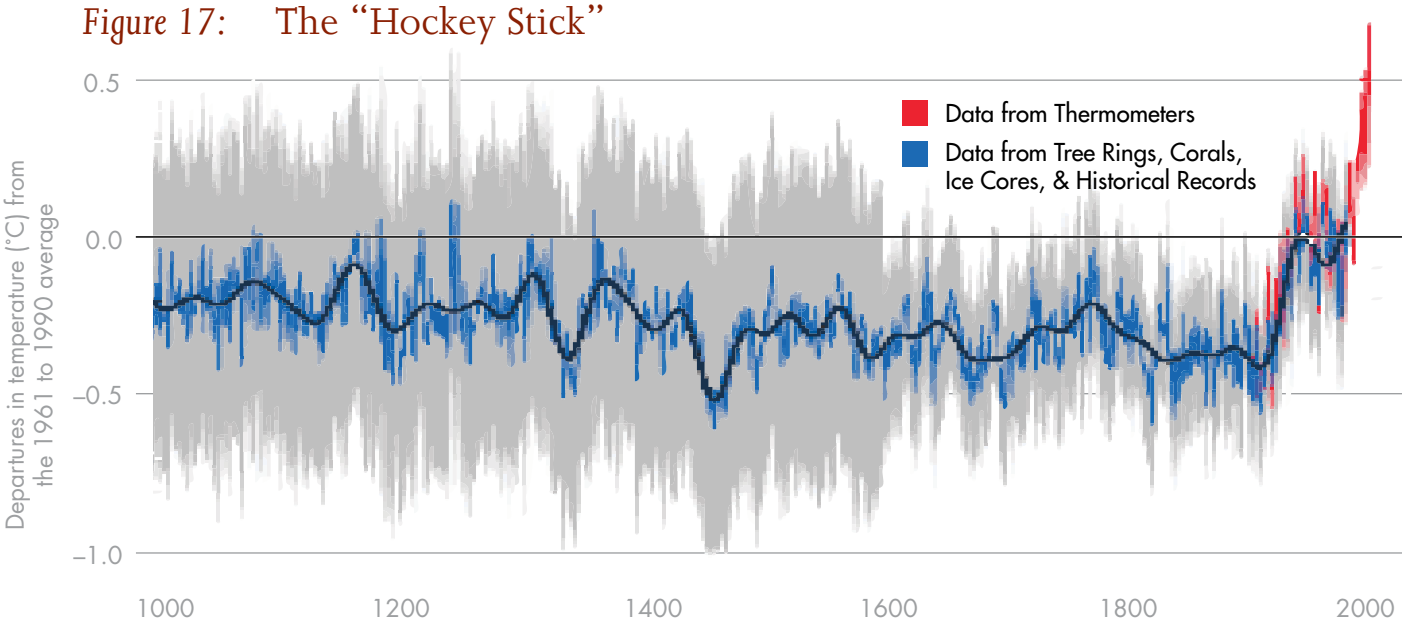
In another highly technical analysis of the Stern Review's economic assumptions and conclusions, Cambridge University economist Partha Dasgupta wrote: "Should we accept the Review's implied recommendations for this country's overall savings? Of course not. A 97.5-percent saving rate is so patently absurd a figure that we must reject it out of hand. To accept it would be to claim that the current generation in the model economy ought literally to impoverish itself for the sake of future generations."[15]

A Stern review indeed.

Hockey Stick Benched

The controversy over the "hockey stick" temperature reconstruction of the last 2,000 years, which was featured prominently in the 2001 IPCC report and commented upon in previous editions of the *Index,* came to a head in 2006 with the conclusion of a National Academy of Sciences (NAS) report.[16] The hockey stick, the artifact principally of climatologist Michael Mann, purported to prove that the temperature trends of the last 50 years placed the earth as being warmer than at any time in the last 2,000 years. It was controversial in part because it erased the hitherto widely accepted "medieval warm period" and "little ice age" (see Figure 17).

Figure 17: The "Hockey Stick"



(Source: NAS)

The NAS report trod carefully, offering tepid affirmation for both the plausibility of the hockey stick and some of the criticisms of it. The NAS study also looked at alternative temperature reconstructions—using the same data, but reaching different findings from Mann and his colleagues. Among the report's conclusions:

> Large-scale surface temperature reconstructions yield a generally consistent picture of temperature trends during the preceding millennium, including relatively warm conditions centered around A.D. 1000 (identified by some as the "Medieval Warm Period") and a relatively cold period (or "Little Ice Age") centered around 1700. The existence and extent of a Little Ice Age from roughly 1500 to 1850 is supported by a wide variety of evidence….
>
> It can be said with a high level of confidence that global mean surface temperature during the last few decades of the 20th century was higher than during any comparable period during the preceding four centuries.
>
> Less confidence can be placed in large-scale surface temperature reconstructions for the period from A.D. 900 to 1600. Presently available proxy evidence indicates that temperatures at many, but not all, individual locations were higher during the past 25 years than during any period of comparable length since A.D. 900. The uncertainties associated with reconstructing hemispheric mean or global mean temperatures from these data increase substantially backward in time through this period and are not yet fully quantified.

This paragraph deserves to be read slowly and carefully:

> Based on the analyses presented in the original papers by Mann et al. and this newer supporting evidence, the committee finds it plausible that the Northern Hemisphere was warmer during the last few decades of the 20th century than during any comparable period over the preceding millennium. The substantial uncertainties currently present in the quantitative assessment of large-scale surface temperature changes prior to about A.D. 1600 lower our confidence in this conclusion compared to the high level of confidence we place in the Little Ice Age cooling and 20th century warming. *Even less confidence can be placed in the original conclusions by Mann et al. (1999) that "the 1990s are likely the warmest decade, and 1998 the warmest year, in at least a millennium."* [Emphasis added.]

The NAS report, it should be added, included an implicit rebuke of Mann and his colleagues for their reluctance to share their data with other researchers when their findings were first called into question: "The committee recognizes that access to research data is a complicated, discipline-dependent issue, and that access to computer models and methods is especially challenging because intellectual property rights must be considered. Our view is that all research benefits from full and open access to published datasets and that a clear explanation of analytical methods is mandatory. Peers should have access to the information needed to reproduce published results, so that increased confidence in the outcome of the study can be generated inside and outside the scientific community."

Most media reports said something along the lines of "NAS Affirms Hockey Stick," but it appears reporters weren't reading or listening very closely to the carefully chosen words of the scientists on the NAS committee. One of the NAS committee members, Kurt Cuffey of the University of California, was more direct in remarks to *Science* magazine: "The IPCC used [the hockey stick] as a visual prominently in the [2001] report. *I think that sent a very misleading message about how resolved this part of the scientific research was.*" (Emphasis added.)

The hockey stick is not going to appear in the next IPCC report.

The Methane Mystery

As reported in the first section of this chapter, atmospheric methane appears to be leveling off. This makes all the more surprising the finding reported early in 2006 that natural sources of methane—especially plants growing in normal aerobic conditions—have apparently been significantly underestimated. A study in *Nature* magazine concluded that plants could contribute from 10 to 30 percent of the total amount of methane entering the Earth's atmosphere. "A Green Source of Surprise," read the *Nature* headline, while another *Nature* headline read: "Methane Finding Baffles Scientists." "My first reaction is skepticism," said biogeochemist Colin Prentice of the University of Bristol. "I find it hard to believe that we missed this." David Beerling of the University of Sheffield said, "My feeling is that this could be very important." Martin Heimann of the Max Planck Institute in Germany said, "It means we neglected a big driving force for the climate."

The methane mystery threatens to upend not only scientific understanding, because it suggests we have incorrectly estimated methane from other sources, but also international climate-policy diplomacy. Accounting conventions for GHG emissions and sinks (natural processes thought to absorb methane) will have to be thrown out and redesigned. Meanwhile, another source of methane emissions drew increased attention last year when the UN Food and Agriculture Organization released a study claiming that livestock, principally cattle and sheep, account for 18 percent of total global greenhouse gases.[17] Maybe the next climate treaty will be the Kobe Protocol, restricting the consumption of beef.

New Climate Topic of the Year: Geoengineering

Perhaps the hottest new climate-change topic of 2006 dealt not with models or assessments of change underway, but whether climate change should be dealt with by creating a man-made volcano. In other words: Save the planet with a giant dust cloud. The more generic and technical term is "geoengineering." We have long known that particulates from large volcano eruptions cool the atmosphere. The 1991 eruption of Mt. Pinatubo in the Philippines was the first modern eruption whose effects were closely measured and studied. In the aftermath of Pinatubo, planetary temperatures were lowered by about one degree F for nearly two years. Could mankind mimic the climate effects of volcanoes by deliberately injecting particulates into the high atmosphere?

The idea is not new. The NAS, among others, studied the concept in the early 1990s and, in a coincidence of bad timing, produced a report just before Mt. Pinatubo erupted, generally discounting the idea for its cost but not categorically dismissing it. The NAS study found that increasing the reflectivity of the earth by just one percent would be enough to compensate for doubling levels of CO_2 in the atmosphere.[18] For the last several years, however, the idea has been virtually taboo in climate-science circles—an example of how commitment to a particular policy regime (GHG emission reductions) can constrain open scientific inquiry. *Rolling Stone* magazine, of all unlikely places, reported in December that when the subject came up at a seminar of Stanford's Energy Modeling Forum held in Aspen last summer, the meeting nearly erupted into a shouting match.[19] The *New York Times* has also reported on the controversy.[20]

A fresh round of scientific discussion emerged in 2006 when *Climatic Change*, a leading journal in the field, published an article by Nobel Prize–winning chemist Paul Crutzen speculating on the methods, practicalities, and costs of deliberately injecting particulates into the atmosphere to reduce global warming.[21] (Crutzen won his Nobel Prize for his work in the 1980s on stratospheric ozone depletion, which was a crucial scientific step in the road to the Montreal Protocol.) Crutzen now believes that it would be technically easy and relatively inexpensive to place a layer of sulfate particles 10 miles up in the atmosphere, either through giant cannons or balloons; other advocates suggest that high-altitude aircraft would be sufficient. He concludes that as little as one million tons might be adequate; by comparison, coal-burning power plants in the United States emit more than six million tons per year of sulfur dioxide. His ideas have found support from other leading climate scientists.

Tom Wigley of the National Center for Atmospheric Research (NCAR) wrote favorably of the idea in *Science*.[22] And Stanford climate scientist Ken Caldeira, while "philosophically opposed" to the idea of geoen-

gineering, conducted an extensive computer-climate-model run that generally backed up Crutzen's ideas. NASA held a two-day closed-door workshop on the subject in November, and the EPA's National Center for Environmental Economics published a working paper discussing the subject.[23]

Caldeira's "philosophical opposition" to geoengineering is widely shared. At the Aspen meeting, Yale's William Nordhaus reportedly objected that geoengineering would enable more fossil-fuel use, which would be like giving methadone to a heroin addict. (This seems odd coming from the economist whose work has done more than anyone else's to highlight the adverse cost–benefit outcome of near-term emission reductions.) And *Climatic Change* took the highly unusual step of publishing *five* separate editorial commentaries on how Crutzen's article should be understood.[24] This is likely unprecedented in the history of scientific publishing. Ralph Cicerone, president of NAS, explained in his editorial contribution why the reaction had been so unusual: "Various individuals have opposed the publication of Crutzen's paper, *even after peer review and revisions,* for various and sincere reasons *that are not wholly scientific.*" (Emphasis added.) Mark Lawrence of the Max Planck Institute in Germany concurred in his own *Climatic Change* editorial comment: "There was a passionate outcry by several prominent scientists claiming that it is irresponsible to publish such an article focused on a particular geoengineering proposal."

This kind of environmental correctness should be genuinely disturbing, as a pre-existing policy agenda or preference should not be used as a reason to prevent research, let alone to stop scientific speculation from a Nobel laureate from being published. It is an example of exactly the kind of politicization of the subject that has led to so much popular distrust of climate science and so much policy gridlock over the last 20 years. There are numerous political problems with Crutzen's idea, to be sure. Implementing it might require changes in international law (a UN treaty forbids "manipulation of the environment" for military purposes). Does Russia really want its northern reaches to cool off again? (Of course, that is just as good a reason for Russia to decline to join a serious emission-reduction regime.) Still, it appears that ideological resistance to the idea is breaking down. "People used to say, 'Shut up, the world isn't ready for this,'" Wallace S. Broecker, a geoengineering advocate at Columbia University, told the *New York Times*. "Maybe the world has changed."

Backlash Brewing?

The kind of hyper-politicization of climate change that can be seen in the resistance to consideration of geoengineering may be provoking a backlash in the scientific community. One straw in the wind was the bracing comments made by Mike Hulme, director of the Tyndall Centre for Climate Change Research and one of Britain's leading climate-science figures.

"I have found myself increasingly chastised by climate change campaigners when my public statements and lectures on climate change have not satisfied their thirst for environmental drama and exaggerated rhetoric," Hulme told the BBC in November. "It seems that it is we, the professional climate scientists, who are now the [catastrophe] skeptics. How the wheel turns. Why is it not just campaigners, but politicians and scientists too, who are openly confusing the language of fear, terror, and disaster with the observable physical

reality of climate change, actively ignoring the careful hedging which surrounds science's predictions? To state that climate change will be 'catastrophic' hides a cascade of value-laden assumptions which do not emerge from empirical or theoretical science."[25]

Then in December, Kevin Vranes of the University of Colorado, by no means a climate-change skeptic, commented on a widely read science blog about his sense of the mood of the most recent meeting of the American Geophysical Union, where Al Gore had made his standard climate presentation.

"To sum the state of [the climate-science world] in one word, as I see it right now, it is this: *tension*," Vranes wrote. "What I am starting to hear is *internal backlash*.... None of this is to say that the risk of climate change is being questioned or downplayed by our community; it's not. It is to say that I think some people feel that we've created a monster by limiting the ability of people in our community to question results that say *'climate change is right here!'*"[26]

Notes

1 Marc Kaufman, "Climate Experts Worry as 2006 Is Hottest Year on Record in U.S.," *Washington Post*, January 10, 2007. See also http://www.ncdc.noaa.gov/oa/climate/research/2006/ann/global.html.

2 Lin Zhen-Shan and Sun Xian, "Multi-Scale Analysis of Global Temperature Changes and Trend of a Drop in Temperature in the Next 20 Years," *Meteorology & Atmospheric Physics* 95 (2007), pp. 115–121. The authors sum up, "our primary conclusion [is] that atmospheric CO_2 concentration is not a key determinant of periodic variation of the global temperature. The global climate warming is not solely affected by the CO_2 greenhouse effect."

3 http://www.ncdc.noaa.gov/oa/climate/research/2006/ann/ann06.html.

4 John M. Lyman, John K. Willis, and Gregory C. Johnson, "Recent Cooling of the Upper Ocean," in press, *Geophysical Research Letters*. The authors argue that "the recent and previous global cooling events are significant and unlikely to be artifacts of inadequate ocean sampling."

5 http://www.nhc.noaa.gov/pastprofile.shtml.

6 http://www.aoml.noaa.gov/hrd/Landsea/deadly/Table5.htm.

7 http://www.aoml.noaa.gov/hrd/Landsea/deadly/index.html; http://www.nhc.noaa.gov/gifs/table13a.gif.

8 S.J. Holgate, "On the Decadal Rates of Sea Level Change During the Twentieth Century," *Geophysical Research Letters*, No. 34 (2007), L01602, doi: 10:1029/2006GL028492.

9 http://www.acia.uaf.edu/.

10 See Brian Hartmann and Gerd Wendler, "The Significance of the 1976 Pacific Climate Shift in the Climatology of Alaska," *Journal of Climate*, Vol. 18 (2005), pp. 4,824–4,839.

11 Ian M. Howat, Ian R. Joughin, and Ted A. Scambos, "Rapid Changes in Ice Discharge from Greenland Outlet Glaciers," *Science*, February 8, 2007. (http://www.sciencemag.org/cgi/content/abstract/1138478v1).

12 http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm.

13 Tol's paper can be downloaded from: http://sciencepolicy.colorado.edu/prometheus/archives/climate_change/000974the_stern_review_on_.html. In an online comment, Tol is even more blunt: "The Stern Review violates the guidelines of HM Treasury. This is most peculiar, as the Stern Review was written by civil servants of HM Treasury. This is bad procedure."

14 http://www.econ.yale.edu/~nordhaus/homepage/SternReviewD2.pdf.

15 http://www.econ.cam.ac.uk/faculty/dasgupta/STERN.pdf.

16 *Surface Temperature Reconstructions for the Last 2,000 Years*, available at: http://www.nap.edu/catalog/11676.html.

17 Henning Steinfeld et al., *Livestock's Long Shadow: Environmental Issues and Options* (UNFAO; Rome, 2006), available at www.virtualcentre.org.

18 National Academy of Sciences, *Policy Implications of Greenhouse Warming: Mitigation, Adaptation, and the Science Base* (Washington D.C.: National Academies Press, 1992).

19 Jeff Goodell, "Can Dr. Evil Save the World?", *Rolling Stone*, December 2006: http://www.rollingstone.com/news/story/12343892/can_dr_evil_save_the_world.
20 William J. Broad, "How to Cool a Planet (Maybe)," *New York Times*, June 26, 2006.
21 P.J. Crutzen, "Albedo Enhancement by Stratospheric Sulfur Injections: A Contribution to Resolve a Policy Dilemma?", *Climatic Change* (August, 2006); DOI: 10.1007/s10584-006-9101-y.
22 T.M.L. Wigley, "A Combined Mitigation/Geoengineering Approach to Climate Stabilization," *ScienceExpress*, September 14, 2006.
23 Alan Carlin, "If Geoengineering Is the Best First Step Towards Global Climate Change Control, How Could It Best Be Implemented?", NCEE Working Paper Series, #07-04, January 2007. See also Carlin, "Global Climate Change Control: Is There a Better Strategy than Reducing Greenhouse Gas Emissions?", 155 *Penn Law Review*, No. 6, forthcoming June 2007.
24 The five editorials were by: Mark Lawrence (Max Planck Institute), Lennart Bengtsson (Max Planck Institute), Ralph Cicerone (NAS), Michael MacCracken (Climate Institute), and Jeffrey Kiehl (NCAR).
25 http://news.bbc.co.uk/go/pr/fr/-/1/hi/sci/tech/6115644.stm.
26 http://sciencepolicy.colorado.edu/prometheus/archives/climate_change/001030so_what_happened_at_.html.

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