FALL 1999
ISSUE 137

RESOURCES

RESOURCES FOR THE FUTURE RESEARCH THAT MAKES A DIFFERENCE

3 **Goings On**
Clean tanneries in Mexico ≋ Reducing greenhouse gas emissions ≋ Using economics to cut pollution ≋ Climate change and water ≋

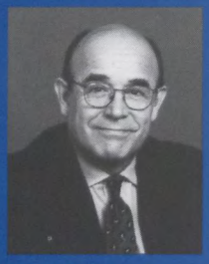
FEATURE
5 **A Dilemma Downwind**
Ozone Blows Across State Lines, Raising a Tangle of Regulatory Issues
Alan Krupnick and John Anderson
RFF research is shedding new light on a thorny issue for regulators: what to do about pollution that is generated in one state, but blows into another.

FEATURE
8 **Forty Years in an Emerging Field**
Economics and Environmental Policy in Retrospect
Wallace E. Oates
It took years for economics to be viewed as an agent of change in environmental policy. It emerged eventually through some groundbreaking research, and even a little serendipity.

FEATURE
12 **The Forest Service at a Crossroads**
Dan Quinn
By adopting ecological sustainability as its primary mission, the U.S. Forest Service is making a major break from its legislated mission to be all things to all people. With 191 million acres at stake, such a decision should reflect the will of the American people, an RFF researcher believes.

FROM THE PRESIDENT 2 ■ INSIDE RFF 14 ■ DEVELOPMENT 18

Wisdom In Middle Age



Paul R. Portney

I have been doing a lot of writing and speaking lately about what the future may hold for environmental quality and environmental policy, both domestically and globally. I do so with a concern bordering on terror. We all have examples of "experts" who have had to explain predictions that were dead wrong!

Perhaps most usefully, this exercise has given me a chance to review how much progress the nation has made in recent decades cleaning up the environment. Since 1970, air quality has improved markedly in almost all of the nation's cities, and many of the most-polluted rivers are substantially improved as well. I see this favorable trend continuing unabated.

At the same time, we have made tremendous progress in developing the tools of progressive environmental policy. As Wally Oates points out in his retrospective on the use of economics in environmental policy (see p. 8), much of the foundation for this progress has been laid here at RFF, and much of it has been highlighted in the pages of *Resources*. This year, *Resources* celebrated an important milestone—40 years of uninterrupted publication—of which we all are proud.

RESOURCES

Some findings and conjectures from recent research into resource development and use

Published three times a year by RESOURCES FOR THE FUTURE, INC.

Every discovery that has extended the circle of the known has enlarged the perimeter of the unknown. —FOREST RAY MOULTON

NUMBER ONE — WASHINGTON, D. C. — MAY, 1959

The Endless Adventure

GEORGE BEADLE'S opening words at the first of our 1959 Forum series on Science, Resources, and Society provide, it seems to me, a fitting introduction to these seasonal summaries of research. "It is an unending source of wonderment," he said, "that out of minute spheres of jelly-like protoplasm little larger than the point of a dull pin there should develop living beings like you and me." He spoke with awe of "this tiny sphere, the fertilized egg of man," wherein is locked "the secret of man's origin from subhuman ancestors and the nature of his destiny in an evolutionary future now unknown."

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R. G. GUSTAVSON, *President Resources for the Future*

SWEET WATER BY SUNPOWER

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The British foreign aid program in Libya has also been concerned with this problem, and within the last few months it has been responsible for the installation of an electrodialysis system for desalin-

Forty years is a long time–especially in a field as young as the environmental movement. Although we usually assume the passage into middle age makes one wise, *Resources* may have been born so. It quickly grew in the early 1960s from a humble four–page sampler of some of the ideas being investigated at RFF, into a forum that explored the leading edge of environmental policy—at RFF and beyond. Past issues have highlighted advances made here and elsewhere in everything from the economic theory behind environmental and resource economics to the proper design of incentive-based approaches to regulation.

I predict that the current trend toward incentive–based approaches will continue to grow over the next 40 or 50 years, and that even more of our work will be used to influence the policy process. I believe we will be able to protect the environment more effectively, and less expensively, if policymakers continue to adopt the kinds of approaches we have been featuring in *Resources* from the beginning.

Indeed this issue highlights just how applicable this work is to several of the most vexing environmental contemporary problems facing us, from ozone transport, to controlling greenhouse gases, to curbing nonpoint sources of pollution. It seems the best way to commemorate 40 years of *Resources* is to keep looking to the future.

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Editor, Dan Quinn

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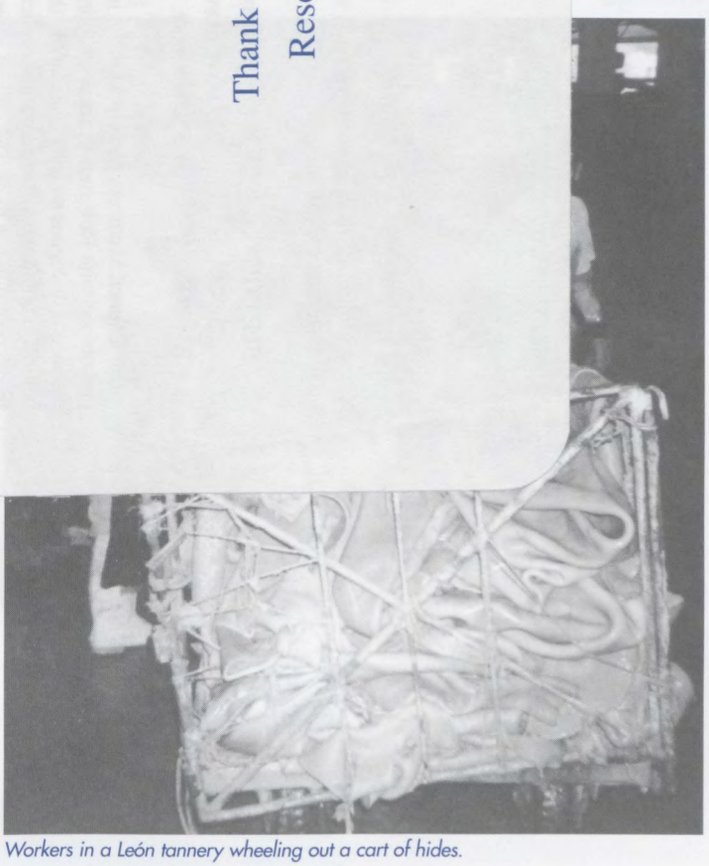

Workers in a León tannery wheeling out a cart of hides.

understanding what has motivated a small but significant percentage of tanneries in León to cut pollution despite a decided lack of conventional regulatory pressure. At least 200 tanneries in León will be surveyed to identify contributing factors, including tanners' awareness of the health impacts of their pollution, the costs of pollution control, changes in production processes, community pressure, and the availability of technical assistance.

The survey data will help to identify means of encouraging other tanners to adopt environmental management practices. In addition, the researchers hope to develop policy recommendations that are applicable to tanneries and other types of small-scale polluters around the globe.

The project is scheduled to be completed in May 2001 and will culminate in a book identifying promising regulatory and other approaches to pollution control. It is a follow-on study of a recently completed RFF project that analyzed efforts to control emissions from small-scale brick kilns in Mexico. Both studies are funded by the Tinker Foundation.

For more information contact RFF Fellow Allen Blackman at (202) 328-5015; *blackman@rff.org*.

Controlling Greenhouse Gas Emissions

Setting targets for emissions limits like those in the Kyoto Protocol may not be the most effective way to reduce greenhouse gas emissions, according to a paper completed recently by RFF Fellow **William Pizer**. Uncertainty surrounding the costs and benefits of emissions limits makes it far more effective to charge sources of carbon dioxide and other greenhouse gases a set price for every ton they emit, the study shows. Such price-based controls could give policymakers a key advantage over the Kyoto protocol—the ability to limit the potential economic costs.

Price-based controls on greenhouse gases have not been pursued vigorously to date because they do not provide the kind of guarantee on total emissions that many environmentalists and policymakers find appealing about quantity-based controls. Both approaches involve considerable uncertainty, however, as it is not clear how much a quantity-based system will cost to implement, or how much a price-based system will reduce emissions.

Research that Pizer has been conducting at RFF shows that the emissions uncertainty associated with price controls is preferable to the cost uncertainty associated with quantity controls. The expected net gains associated with a price-based system are up to five times higher than even the best system based on quantity controls. His results suggest that an even better alternative may be a combination of both price and quantity controls in a "hybrid" approach, in which policymakers would fix the initial emis-

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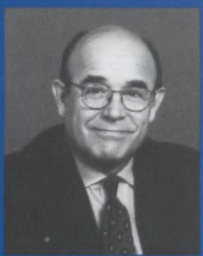

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GOINGS ON

Clean Tanneries

In developing countries, large numbers of unregistered small businesses escape the attention of understaffed and underfinanced environmental regulators. Urban clusters of small-scale polluters like leather tanneries, brick kilns, and metal-working shops cause severe environmental damage, but are difficult for regulators to identify, much less monitor or sanction. Even when identified, these small businesses often do not have the financial or technical resources to adopt pollution-control measures.

León, Mexico is the home of approximately 800 small-scale leather tanneries. Despite the efforts of local environmental authorities, almost all of these tanneries continue to dump toxic effluents and solid wastes directly into the nearby Turbio River. As a result, groundwater has been seriously contaminated, irrigated agricultural land has been destroyed, and health risks have accrued.

Resources for the Future Fellow **Allen Blackman** recently launched a two-year research project in association with the University of Guanajuato in Mexico to guide the design of effective pollution-control policies for small-business polluters in developing countries. He will pay particular attention to understanding what has motivated a small but significant percentage of tanneries in León to cut pollution despite a decided lack of conventional regulatory pressure. At least 200 tanneries in León will be surveyed to identify contributing factors, including tanners' awareness of the health impacts of their pollution, the costs of pollution control, changes in production processes, community pressure, and the availability of technical assistance.

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ALLEN BLACKMAN

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Price-based controls on greenhouse gases have not been pursued vigorously to date because they do not provide the kind of guarantee on total emissions that many environmentalists and policymakers find appealing about quantity-based controls. Both approaches involve considerable uncertainty, however, as it is not clear how much a quantity-based system will cost to implement, or how much a price-based system will reduce emissions.

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GOINGS ON

sion level, but allow emitters to buy additional emissions rights at a fixed price.

Pizer's paper, "Choosing Price or Quantity Controls for Greenhouse Gases," can be downloaded at *http://www.rff.org/issue_briefs/PDF_files/ccbrf17.pdf*. For more information contact William Pizer at (202) 328-5039; *pizer@rff.org*.

Using Economic Instruments to Control Pollution

RFF has been awarded two grants by the state of Michigan to study innovative uses of economic strategies to tackle the state's environmental problems. The projects funded include a year-long study of various methods to combat farm runoff and other "nonpoint" sources of pollution, and an 18-month examination of ways to ensure that firms doing business in the state are financially able to pay for environmental damages they may cause.

In the first study, RFF researchers will examine the effectiveness of using land-use regulation and market-based policies to reduce the amount of nonpoint source pollution coming to lakes and wetlands from farms and city streets. In the past, polluted runoff has received considerably less regulatory attention than pollution that derives from one specific source, such as sewage treatment plants and industrial facilities. As a result, nonpoint source pollution has become the greatest contributor to water quality problems in the Lake Michigan Basin and in the nation's waterways in general.

RFF researchers will examine whether coupling land-use policies with market-based instruments for pollution reduction can produce more cost-effective pollution control options. The study will compare the effectiveness of nutrient trading markets between point and nonpoint sources and land-use instruments such as transferable development rights. The study will be conducted by Senior Fellow **Alan Krupnick** and Fellows **James Sanchirico** and **Jhih-Shyang Shih** and is projected to be completed in the fall of 2000.

The second study explores the effectiveness of laws designed to ensure that firms possess adequate financial resources to pay for environmental damage they might cause during their business operations. These laws would require that firms demonstrate their ability to cover the costs of the most catastrophic hazard their business could create, using either the firm's own assets or insurance through a third party. These laws currently only apply to the operators of large-scale waste generators such as landfills, underground petroleum storage tanks, and offshore rigs.

The RFF project will examine the strengths and weaknesses of such programs currently in use in the United States. In addition, the study will examine whether such financial instruments could be extended to small-scale waste generators such as dry cleaners and photoprocessing facilities. This 18-month study will be conducted by Fellow **James Boyd**.

Both studies are funded by the Office of the Great Lakes, Michigan Department of Environmental Quality through the Michigan Great Lakes Protection Fund.

For more information contact James Sanchirico at (202) 328-5095; *sanchirico@rff.org*.
James Boyd can be reached at (202) 328-5013; *boyd@rff.org*.

Flexible Water Policies in the Face of Climate Change

Policymakers and water resource managers should adopt flexible strategies to combat threats to the water supply brought about by global climate change, says a new report coauthored by Resources for the Future Senior Fellow **Kenneth Frederick** and **Peter H. Gleick** of the Pacific Institute for Studies in Development, Environment and Security. The report, "Water and Global Climate Change," was prepared for the Pew Center on Global Climate Change.

The existing pressures on the water supply—including rising demand and variations in the water cycle—could be compounded by greenhouse gas-induced changes to the climate, the report says. But because climate change models are only capable of simulating change on large scales, it is difficult to pinpoint effects at the local level, where most decisions about the water supply are made. Current general circulation models predict that climate change will significantly affect precipitation, evaporation from the surface and transpired from plants, and runoff. Predicting effects for specific regions introduces new uncertainties.

Despite these uncertainties, the report finds that climate change *may* increase the frequency of intense precipitation days and floods, particularly in northern latitudes and snowmelt-driven basins. Heavy rainfall may also lead to soil erosion and contribute to the leaching of agricultural and urban pollutants into streams and lakes. At the same time, arid regions may become more prone to drought, placing added stress on their limited water resources for irrigation and other uses.

The authors identify four promising areas that policymakers should explore for adapting to future climate variability. Options include establishing incentives for using, conserving, and protecting water supplies; providing opportunities for transferring water among competing uses in response to changing conditions; influencing how water is managed within and among basins; and reevaluating the operations of the existing infrastructure to address potential changes.

For more information contact Senior Fellow Ken Frederick at (202) 328-5063; *frederick@rff.org*.

A Dilemma Downwind

Ozone Blows Across State Lines, Raising a Tangle of Regulatory Issues

by Alan Krupnick and John Anderson

As states, the Environmental Protection Agency, and power companies square off in court, judges and administrators are forced to grapple with the economic implications of clean air policy. Recent research at RFF can help.

Air pollution blows with the wind across state lines, sometimes for hundreds or even thousands of miles. In a federal system, this raises difficult legal and political issues. Recent research at RFF illuminates two of the key questions in the current litigation over the federal Environmental Protection Agency's proposed solutions.[1]

The dispute is over ground-level ozone. While arguably among the least dangerous of the common air pollutants that the EPA struggles to reduce, ozone accounts for the lion's share of violations of the nation's air quality standards. Thirty-two metropolitan areas, with one-third of the country's population, at present exceed the federal health standard for ozone.

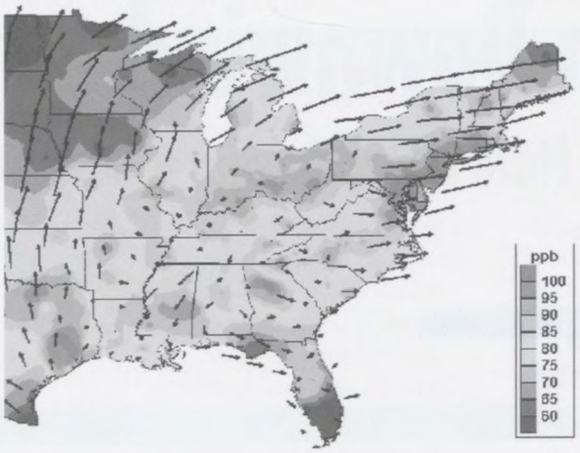
Ozone is produced on hot, bright days when sunlight cooks a mixture of precursor gases, nitrogen oxides (NOx) and volatile organic compounds. The sources of NOx include the combustion of fossil fuels in power plants and automobile engines. One of the EPA's chief weapons in reducing ozone levels has been controls imposed on the emissions from power plants' smokestacks.

The controls are expensive and can affect the price of electricity. Since the degree of control required varies from one jurisdiction to another, the EPA's rules touch on the competition among the states for economic growth. With deregulation, the electric utilities are no longer protected monopolies but are fighting actively for customers—accordingly, they would like to spend as little on environmental controls as possible while still complying with the laws.

For years cities in the Northeast have complained bitterly that, regardless of their own increasingly expensive efforts to control ozone, they are pushed into violation of the standard by pollution carried in from the west and southwest by the prevailing summer winds.

In 1995 the EPA set up an elaborate venture in federal-state cooperation called OTAG—the Ozone Transport Assessment Group—in which it would work with the governments of the 37 states from Nebraska eastward, plus the District of Columbia and any corporations and environmental organizations that wanted to participate. Using meteorological modeling they would quantify the amounts of pollution crossing from one region to another and offer recommendations. That work took two years.

Based on it, the EPA announced a rule designed to reduce the imported pollution to negligible amounts. The rule was to cover 22 states, a region reaching from New England as far south as Georgia and as far west as Missouri. EPA's proposed limit on emissions was more stringent in some cases than the OTAG's recommendations but, the EPA explained, "it provides



Winds and Ozone on High Ozone Days. Ozone Transport Assessment Group, Executive Report 1997.

the most improvement in air quality while staying within the bounds of the most highly cost-effective technology available."

The Clean Air Act leaves to each state the choice of methods to comply with the federal standard. But EPA's method here was to give each state a pollution ceiling that it could meet by imposing restrictions that the EPA suggested. One such restriction was a uniform limit on electric utilities throughout the 22-state region of 0.15 pounds of NOx emissions per million BTU of energy generated.

To the downwind states, the rule seemed eminently fair. All power plants would bear the same burden, and the result would be that the whole region would be greatly helped in complying with the standard.

But to most of the upwind states in the Midwest and the South, the rule seemed outrageous. Distant plants that contributed only trivial amounts to downwind ozone would bear the same regulatory burden as plants much closer to the urban Northeast that had a significant impact on ozone levels there.

Eight of the upwind states sued. The EPA, they argued, has no authority under the Clean Air Act to take into account the kind of fairness or cost-effectiveness on which it was basing its proposed rule. An appellate court in Washington suspended the rule until it could hear the case. (It was the same court that, a few days earlier in a separate case, had overturned the EPA's proposed new air quality standard for ozone and sent it back to the agency for revision.)

Legal issues also arose from the proposed emissions-trading plan that the EPA had coupled with the new emissions limit. A utility that found it expensive to bring a plant within that limit would be allowed to buy emissions permits from a more efficient plant that was able to stay below the limit. The effect of the trading system would be to cut the utilities' cost of compliance by nearly one-half, relative to a uniform emissions limit that did not allow trading. But it meant that a ton of NOx emissions from a distant plant, with little effect on the urban Northeast, could be traded for a ton from a much closer plant.

Research at RFF has addressed two of the central issues in this controversy. One is the trading system and whether it needs to be redesigned to take into account powerplant location or, more precisely, the varying effects of different plants' contributions to human exposure to ozone. An exposure-based emissions trading system would be more complex, since the value of each ton of emissions would depend on the locations of the two plants trading it.

To investigate the consequences, RFF researchers constructed a model using EPA's own database, including more than 9,000 point sources of pollution, as well as mobile sources. Then, using runs of the EPA's approved Urban Airshed Model-V produced by its creator, ICF Kaiser, the research team developed relationships between emissions at their point of origin and pollution exposures to people living in downwind regions for each of three types of meteorological episodes that produced significant concentrations of ozone. The RFF model showed that even during weather conditions leading to major ozone violations in the Northeast, utilities in southern Michigan, Ohio, West Virginia and western Pennsylvania have relatively small effects, per ton of NOx emissions, on New York and New England, with larger effects locally and in eastern Pennsylvania and New Jersey. In contrast, New York utilities have much larger effects, per ton of emissions, on New England and locally. In spite of these spatial differences, when viewed across the entire study region, RFF concluded that there was no clear benefit to an exposure-based trading system, compared with simple ton-for-ton NOx trading. Public health benefits would be approximately the same, and there would be no significant difference in costs to the utilities.

The second issue, and an even broader one, is

whether the EPA has set its aggregate limits for NOx at the right level in terms of the health benefits that they can be expected to produce. It turns out that the EPA's proposed limit on power plant emissions of NOx, with the ton-for-ton trading program, would give an ozone level that is just about right—but only if one assumes that exposure to ozone in the air can hasten mortality.

That assumption is crucial, yet most do not embrace it. The EPA itself has been reluctant to conclude that ozone increases mortality risks, in view of the few studies showing such an effect and the many showing no significant effect. If one assumes that ozone does not cause deaths, the EPA's proposal is much too restrictive, incurring costs far out of proportion with the benefits it would bring.

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The Clean Air Act also allows states themselves to take the initiative against interstate pollution by petitioning the EPA to tighten the controls on upwind sources outside their borders. Eleven states have filed such petitions, and last April the EPA issued a rule responding to eight of them. The rule was based on the new air quality standard, and assumed that the EPA's program to control ozone transport would shortly go into effect. When the court overturned the new air quality standard and then stayed the ozone transport program, the EPA was forced to withdraw its rule. A revision, the EPA has said, will appear later this year.

Adding another layer of complication to the legal maneuvering, New York state has announced that it intends to sue 17 Midwestern power plants that, it claims, are illegally treating increases in generating capacity as plant maintenance—thereby avoiding costly requirements for NOx controls on new sources. In effect, the state has decided not to wait for the EPA to try to work out a compromise.

An economic question hangs over this complex series of related legal cases: at what level do the efforts to reduce ozone produce benefits that equal their costs? The courts have so far held that the Clean Air Act does not permit economic factors to be considered in setting standards. But the current litigation will force judges, administrators, and perhaps eventually legislators to deal with the economic implications of clean air policy. Consumers will notice the consequences in their power bills.

Alan Krupnick is a senior fellow and director of the Quality of the Environment Division at RFF. John Anderson is RFF's journalist in residence.

Note

1. Krupnick, Alan, and Virginia McConnell with Matt Cannon, Terrell Stoessell, and Michael Batz, "Cost-Effective NOx Control in the Eastern U.S.," 1999.

Forty Years in an Emerging Field

Economics and Environmental Policy in Retrospect

By Wallace E. Oates

Economics was missing in action during the environmental revolution of the late 1960s, but eventually made its mark on policy. How the discipline became an agent of change in environmental law is a story that isn't over yet.

We have seen a remarkable transformation in the role of economics in environmental policymaking over the past three decades. Coming out of the environmental revolution of the 1960s, the early federal legislation—notably the Clean Air Act Amendments of 1970 and the Clean Water Act Amendments of 1972—essentially ignored economics. In the "command-and-control" (CAC) tradition, this legislation directed environmental agencies to set air and water quality standards with little regard to their economic consequences and then to issue directives to firms for the control of their waste emissions into the environment, often specifying the technologies that were to be used.

Since those early days, however, things have changed in some quite dramatic ways. To take one example, the U.S. Congress under the 1990 CAA Amendments has adopted a wholly different regulatory strategy to tackle the troubling acid-rain problem: a market for tradable sulfur-emissions allowances. Sources throughout the nation are buying and selling entitlements to a limited quantity of sulfur discharges into the atmosphere. This approach is achieving our objective of cutting aggregate emissions in half, but it does so in a way that gives emitters discretion to determine their own levels of both emissions and abatement technology.

More generally, benefit-cost analyses of proposed environmental standards have become a routine part of the regulatory process. Although their role in the establishment of regulatory standards is, in some cases, rigidly circumscribed by existing statutes, such benefit-cost studies figure in important ways in the debate over proposed measures (and in *ex post* reviews of policy as well).

How has environmental policymaking evolved from a process in which economics had so little relevance into one in which it plays a significant role? And what did economists have to do with this transformation? These are fascinating questions, if not easy ones to answer. But let me at least offer some reflections.

Environmental Economics Early-On

If we didn't know better, it would be natural to suppose that economics had been important in the design of environmental policy from the outset. After all, economists were, it might seem, well positioned upon the arrival of the environmental revolution. They had a coherent view of the problem of environmental degradation, one that indicated clearly the nature of

the "market failure" that takes place when economic agents have free access to our scarce environmental resources. Such free access leads quite naturally to an excessive use of resources, resulting in a polluted environment. Moreover, this view of the environmental problem carries with it a direct policy prescription: government needs to introduce the correct "price" in the form of a tax on polluting waste emissions. Such a tax would represent the surrogate price that would induce polluters to cut back their emissions to the socially desired levels.

This perspective on environmental regulation, developed in the first half of the century by A.C. Pigou and others, was embedded in the academic literature by the time the amendments to the Clean Air and Water Acts were under consideration. Basic textbooks provided a standard description of the smoky factory spewing fumes over nearby residences and went on to prescribe taxes on the emissions of the offending pollutants as a corrective measure.

But this approach was completely ignored in the initial round of environmental legislation both in the United States and abroad. Why? My answer to this question comes in three parts. First, there was no constituency for whom the economist's view and policy proposal had much appeal. Environmentalists were decidedly hostile. The market system was the reason we had pollution in the first place, they said. The idea of putting a price on the environment was morally repugnant. Moreover, they argued, it wouldn't work: polluters would simply pay the tax and go on polluting. Environmentalists thus flatly rejected an economic approach (as I learned personally and painfully on several occasions) and called for direct controls on polluting activities.

Industry was not very sympathetic either. The idea of a new tax was, of course, not very appealing. Beyond that, some firms found that environmental controls could actually work to their advantage, because such controls were often much stricter on new industry. Many established firms welcomed the barriers to entry that command–and–control regulation was creating.

Finally, the fraternity of regulators was less than enthusiastic about discarding traditional methods of regulatory control for a largely untried system of taxes on pollution. There really was no one to champion the cause of the economic approach to environmental policy.

The second part to my answer turns to the state of environmental economics itself in the late 1960s and early 1970s. Economics had a view of the pollution problem, but it did not go much beyond a general conceptual level. It is a long way from an equation on the blackboard stating that a tax on each firm's emissions should be set equal to "marginal social damages" to the design and implementation of a workable system of pollution taxes. And few economists were working on these issues. Today there exists an active Association of Environmental and Resource Economists (AERE) with a membership approaching one thousand and with a large and energetic sister organization in Europe. But thirty years ago, only a small number of economists were seriously addressing the hard issues of policy design.

Several of them were at Resources for the Future. Allen Kneese and Blair Bower, for example, published a pathbreaking study of water quality management in 1968 that explored the scientific character of water pollution, studied the actual institutions for regulating water quality, and then turned to the design of a feasible system of fees for the control of waste emissions. But these studies were exceptions. Economists really were not in a position at that time to offer much guidance on the actual design and implementation of systems of environmental taxes.

The third part of my answer (closely related to the second) is the pervasive ignorance of the economic approach to environmental policy outside the economics profession itself. Even as late as 1981, Steven Kelman's survey of the environmental policymaking community turned up virtually no one who could even explain the basic rationale for incentive-based policy measures! Finally, it is probably a fair criticism to say that few of those who did understand the power of incentive–based approaches were willing to make the effort to educate legislators, regulators, and their staffs about this radical alternative.

Economics and the Evolution of Environmental Policy

The story of the growing role of economics in environmental policymaking is a complicated one, only imperfectly understood. Indeed, its chapters contain both serendipitous and more purposeful elements.

One important facet of this story in the United States (but not in Europe) is the emergence of an

alternative incentive-based policy instrument. Economists surely knew that, in principle, it is possible to attain the objective of cutting back waste emissions either by a tax or by a system of tradable emissions permits (TEP). It is straightforward to show that emissions can be reduced to the target level either by setting a sufficiently high tax on emissions or by issuing the requisite number of emissions permits and allowing trading activity to establish the market-clearing price. The outcome in the two cases is, in principle, identical.

But in the early dialogue, discussion focused primarily on the tax approach. My recollection is that most of us in our assessments of the prospects for various policy measures assumed that the so-called quantity approach involving a TEP system would encounter overwhelming opposition inasmuch as it involved literally putting the environment up for sale. Polluters would buy and sell "rights to pollute." There seemed to be little hope for such an audacious proposal.

We were wrong of course, partly, I believe, by reason of historical accident and partly because of a failure to understand the political economy of instrument choice. With the prospect of a tumultuous political confrontation in the mid-1970s over nonattainment of clean air goals in many regions of the country, the U.S. Congress introduced in 1977 a provision for "pollution offsets." Under this provision, new sources of pollution could enter nonattainment areas if existing sources cut back their emissions by more than those of the entrants. Somewhat unwittingly, I suspect, federal legislators had opened the door to what eventually became the Emissions Trading Program, under which trading of emissions allowances for air pollutants has been taking place in many areas.

Tradeable emission permit (TEP) systems turn out to have much more appeal than their tax counterpart in the policy arena. Environmentalists are much more sympathetic to them since, by restricting the number of available permits, the environmental authority can directly and unambiguously achieve its objective. Industry is also receptive. Instead of paying a tax, firms typically receive (under some kind of grandfathering provision) a valuable asset: emissions permits, which they can use either to validate their own emissions or sell for a profit. Regulators much prefer TEP systems to taxes. They can achieve their goal simply by issuing the requisite number of permits; they don't have to worry about setting and then adjusting tax rates to induce the needed reductions in pollution. It is interesting that the TEP approach has not caught on in Europe; there the use of incentive-based instruments has primarily taken the form of taxes on pollution.

The work of environmental economists has, I think, been important in this evolution. Ideas can be a powerful force in the policy arena, and economists were able to provide a compelling conceptual rationale for the new tradable-permit approach. In addition, they carried out a substantial number of careful empirical studies that documented the large cost savings available through the use of incentive-based policy instruments. Over the last thirty years, the educational void has been filled. In response to environmental concerns, courses in environmental economics have sprung up across the country. At the graduate level, the field of "Environmental and Natural Resource Economics" has emerged; Ph.D. students have written dissertations and gone on to teach, carry out research, and take positions in environmental agencies. As mentioned earlier, there now exists a large and energetic organization of environmental economists; the Association of Environmental and Resource Economics has its own journal and holds frequent conferences to help organize research efforts and disseminate the findings. At least as important has been the growing presence of economists in law schools and schools of public policy. Here, many future policymakers have received a firm grounding in the economics of environmental policy.

Resources for the Future has played an important role in this evolution. From the beginning, RFF reached the policymaking community not only through research, but through determined and patient efforts to make available and accessible to the general public not only research findings but, more generally, the basic economic principles of policy analysis and design. Indeed, this very publication, *Resources*, has a long history of doing precisely that (see "Forty Years and a Book").

Lest we go overboard with self-congratulation, however, it is important to recognize that there has been a growing receptivity in the Western world to market-based forms of regulation. The advent of Reaganomics in the United States and Thatcherism in

Britain signaled the arrival of what John Kay has called a new "faith in market forces." Over this period, we have seen a basic change in the intellectual setting for social and economic policy—one that is at least as concerned with "government failure" as with "market failure." From this perspective, the evolution of environmental policy is best seen as part of a larger movement for the fundamental reform of regulatory policies, a movement that actively seeks to employ market incentives for social programs.

Much Left to Accomplish

The role of economics in environmental policy has clearly come a long way over the past thirty years. Prospective environmental programs are routinely subjected to benefit-cost assessments, and at least some attention is often given to the use of incentive-based instruments for the attainment of our prescribed standards for environmental quality. But this progress should not be exaggerated. Most of our regulatory measures, for example, are still of the command-and-control variety. Often it is not easy to design a workable and effective incentive-based mechanism. In fact, the design and implementation of such measures for different kinds of environmental problems are real challenges. An especially fascinating and difficult case is how to design a system of tradable carbon allowances on an international scale to address global climate change. This problem is the subject of widespread interest and current research. Meanwhile plenty of more mundane and localized cases of environmental management need to addressed. We have a long way to go!

While we economists can take some real satisfaction in our contributions to environmental policymaking, we must retain a certain humility. Benefit-cost analyses are a valuable component of program assessment, but we should never base decisions on environmental standards *solely* on the bottom line of a benefit-cost study. Likewise, command-and-control programs will continue to be a fundamental part of our regulatory landscape. But even here there is plenty of room for economic analysis aimed at making such CAC programs more effective in attaining their environmental targets at relatively low cost.

Wallace E. Oates is an RFF university fellow and a professor of economics at the University of Maryland.

Forty Years and a Book

Appearing regularly since its first issue in May 1959, *Resources* has offered a variety of provocative articles on research findings, briefings on policy issues, and general overviews of analytical methods. As a teacher, I have found many of these articles so useful that for many years I incorporated them into the reading list for my undergraduate course in environmental economics. But since many of these articles are of broad interest, it seemed desirable to make a collection of them more widely available.

Earlier this year, I edited *The RFF Reader in Environmental and Resource Management*, a compilation containing 43 papers from various issues of *Resources* organized around ten topics. The book is intended to serve both as a teaching resource for classroom use and for the edification of a more general audience. It is fitting that the book also marks the 40th anniversary year of *Resources*. The *RFF Reader* is available in a paper cover from RFF. (To order a copy, see page 16.)

The U.S. Forest Service at a Crossroads

By Dan Quinn

For 900 million visitors a year, the 191 million acres of forest and grasslands controlled by the U.S. Forest Service are a vast playground for camping, hiking, and other outdoor activities. For conservationists, these lands are home to dozens of species of endangered plants and wildlife, as well as the headwaters for one-fifth of the country's fresh water. And for industry, the Forest Service's holdings contain a vast bounty of oil, minerals, timber, and land for grazing.

The U.S. Forest Service has long tried to maintain an uneasy truce among these competing interests. Its central mission, according to legislation passed in the mid-1970s, is protection of "the multiple use and sustained yield of the products and services obtained [on Forest Service land]"... and "the coordination of outdoor recreation, range, timber, watershed, wildlife and fish, and wilderness."

In other words, the Forest Service is required to be all things to all people.

That daunting mission would change substantially if the recommendations of a recent advisory committee, appointed to review the Forest Service mission, are adopted. The report of the 13-member "Committee of Scientists"—which included RFF Senior Fellow Roger Sedjo—says that "ecological sustainability should be the guiding star for the stewardship of the national forests." Upon its release last spring it was immediately hailed as "a new planning framework for the management of our forests for the 21st century" by Agriculture Secretary Dan Glickman, whose department oversees the Forest Service.

But Sedjo believes the committee has overstepped its charge. By giving preeminence to preservation of biodiversity, the committee tips the scales away from mining, grazing, logging, or other commercial activities in a way that is directly counter to the Forest Service's legislative mandate.

In a dissenting appendix to the report, Sedjo says that such a shift, if warranted, should not be decided by the committee of scientists but by the will of the American people, either through new legislation or some other means. And given the level of dissatisfaction on all sides about the agency's mission and performance, Sedjo believes Congress and the President should begin a dialogue that can help determine the public's will about the future direction of the Forest Service.

Competing Interests

Originally hailed as a breakthrough in progressive legislation, the National Forest Management Act (NFMA) of 1976 was designed to provide a venue for conflicting parties to air their differences and come to consensus over management of the forests. Armed with such a consensus plan for each forest, the agency could make a budget request to Congress for funding them. In practice, however, this planning process quickly got off track. Consensus was hard to find at many forests, and the ability to tie up implementation of a plan through a lengthy appeals process has left some areas without a management strategy for more than a decade.

Further complicating the agency's job has been a series of court rulings over enforcement of the Endangered Species Act, which have in many cases curtailed the commercial use of Forest Service property. The courts and recent federal policy hold that the requirements of the Endangered Species Act are overriding, so that if conflicts arise between the Endangered Species Act and an agency's other governmental statutes, the act must dominate.

Although it has not been formally articulated, Former Forest Service Chief Jack Ward Thomas says that the mission of the Forest Service has evolved over time to the point where "public land managers now have one overriding objective for management—the preservation of biodiversity." This has created a gap between the Forest Service's statutory mandate and the nature of its actual management and activities. Underscoring this contention is the fact that the amount of timber harvested from national forests is about one-fourth of what it was at its peak in the late 1980s.

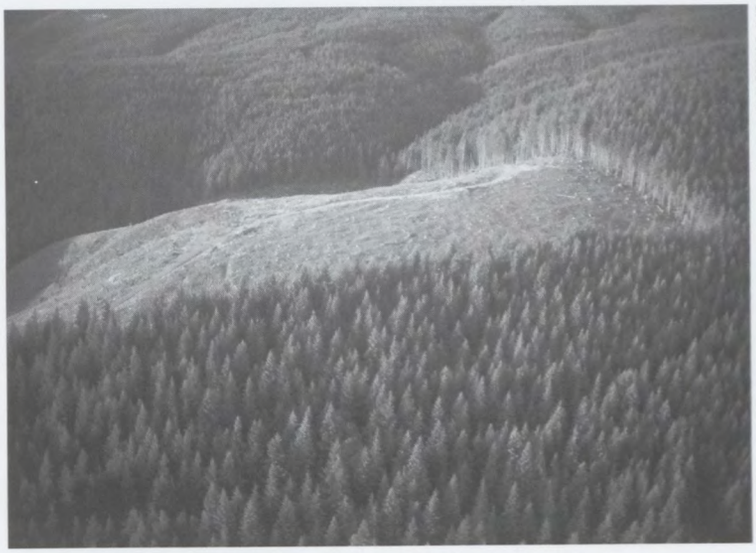
Agriculture Secretary Dan Glickman appointed the committee of scientists in late 1997 and charged them with helping guide USDA's revision of its 155 forest plans, as is required every 10 to 15 years. This is a critical time in that process, as more than 150 million acres are scheduled for plan revisions within the next five years.

The committee called for the Forest Service to develop more collaborative relationships with local communities and interest groups throughout the planning process; to use scientific assessments to inform the public and land managers in making decisions; to strengthen the connection between science and management by adapting land management practices in response to results from scientific monitoring of land conditions; and to integrate the budget more fully into forest plan implementation.

But beyond these specific issues, Sedjo believes the Forest Service needs a new, better-defined mission and an answer to long-term budget questions that were not addressed in the committee's report.

A new mission?

An overriding emphasis on biological preservation may signal the end for the Forest Service, Sedjo believes. Without a role to support the tangible industry that is now part of its mandate, the Forest Service's budget may lose some of its support in Congress. It is doubtful that the goal of biological preservation could command the kinds of budgets that the Committee of Scientists' report calls for to manage such a program. If the budget erodes, the Forest Service may be forced to scale back from active management to custodial management and protection, Sedjo says.



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One promising area is recreation, however. With a more aggressive program of user fees in place, recreational users of the national forests could provide major revenue support for management of the forests. A successful user fee program may allow Congress to reduce its support for forest programs, however, and there is no guarantee that emphasizing recreation will quell the arguments over the agency's role. Some recreational uses may not mesh with other objectives for the forests, including preservation of biodiversity.

Another option may be to combine enhanced user fees with a system that cedes more responsibility for managing national forests to local officials. Such an approach could give greater voice to local residents in making management decisions. Some national environmental groups oppose such a plan, however, believing that decisions about the use of such national assets rightly reside in Washington.

Although the right direction is not crystal clear, "it is clearly time to rethink the role and mission of the Forest Service," Sedjo says. Congress and the Administration should begin a national dialogue that engages the public in helping to provide a future direction for the national forests.

Dan Quinn is the public affairs manager at RFF, and editor of this issue of *Resources*.

INSIDE RFF

PUTTING PEOPLE IN THE PICTURE

Working to Change the Debate

Resources talks occasionally to RFF researchers about their personal goals, outlooks, and expectations as they go about their work day to day. This profile features Katherine Probst, a senior fellow in the Center for Risk Management.

Stroll the halls of the Capitol or scan the daily slew of press releases from advocacy organizations, and you'll find no shortage of opinions in Washington about environmental issues. Reliable, unbiased analyses are far rarer, however.

The paucity of reliable information creates a void in the policymaking process that Resources for the Future can fill, according to Senior Fellow Kate Probst. Precisely because it is free from the baggage of advocacy, RFF's work can help policymakers navigate a confusing maze of opinion.

Probst has worked at the intersection of policy and analysis for nine years at RFF and, prior to that, in stints at the U.S. Environmental Protection Agency, Clean Sites, the Environmental and Energy Study Institute, and the New York City Department of Environmental Protection.

Like many of her colleagues at the Center for Risk Management, Probst is not an economist, but rather the graduate of a public policy program. All of RFF's research portfolio ultimately is related to policy questions, but the issues that Probst and others tackle at the Center for Risk Management are focused on "the more immediate hues and cries" of policy questions, as RFF President Paul Portney puts it.

Her projects have dealt with topics ranging from the future of the Superfund program to environmental problems at Department of Energy sites. In

THERESA SOTTO

a field cluttered with strident views, Probst judges her success not by some kind of win-loss legislative scorecard, but by a more subtle mark. She knows she has succeeded when she is able to help change the debate—to get people to start asking new questions.

It comes from her belief that "in the policy arena, there is no right or wrong answer. Decisions are largely a matter of philosophy." RFF's value is "that we provide an independent view of things in an area where there is often a dearth of analysis."

Take Superfund. Before Probst completed her first project at RFF in the early 1990s—a look at the liability standards of the Superfund law that was co-authored by now-president Paul Portney—a growing debate centered on the high transactions costs that resulted from assigning retroactive liability for contamination to potentially responsible parties. Into this environment came an almost painfully nonprescriptive report from RFF. Like all of Probst's work, it was carefully disseminated to hundreds of key decisionmakers. And unlike the work everyone else was doing at the time, it was the first to delve dispassionately into the more subtle financial implications of changing the liability scheme. Ultimately, it helped usher in a more sophisticated debate on Capitol Hill and elsewhere.

Much of the impact of Probst's work comes from "its careful, empirical grounding," Portney believes. "A hallmark of Kate's work is the emphasis she places on data, facts, and quantitative back-up," he said.

Terry Davies, director of the Center for Risk Management, says, "Kate has contributed immensely to the public debate in a variety of areas, and she has contributed by providing new insights based on careful research."

On the strength of her work at RFF, Probst has been asked to testify at Senate and House hearings on Superfund and other issues, and has served on key national committees, including the Superfund Evaluation Committee convened in 1993 by EPA Administrator Carol Browner to recommend improvements to the national Superfund law.

Probst has moved from an initial focus on Superfund—including ways to improve the remedy selection process for Superfund sites, the pros and cons of alternative liability and financing schemes for Superfund cleanups, and the rationale for linking future land use to cleanup plans—to a series of studies on the Department of Energy's environmental management program. Her work on the cleanup of sites in the nuclear weapons complex has made RFF a key actor in debate over issues related to the future of these sites.

Establishing a name in national environmental policy circles is a time-consuming process, and each year Probst vows to spend more time with her five-year-old daughter and her husband. This fall she is working from home some days to be able to see her daughter to the bus stop when she goes off to kindergarten, and to be home when the bus returns. She admits it is a struggle to find the right balance between work and family, but she is working at it.

At the same time, she has launched a new study to address innovative ways of funding the long-term environmental needs at contaminated sites that are being cleaned up under Superfund and other laws, but which still harbor contamination that restricts their future use. And she is close to completing an investigation with Terry Davies into how well government agencies—who are without question among the biggest polluters in the country—comply with the nation's environmental rules.

As is typical for her work, government-as-polluter is a vitally important topic that has mostly escaped the attention of other researchers in the field. And it leads to a complicated set of issues, including what happens when one government agency is in the position of regulating another.

"I like to think that if you can get people to ask new questions, you can help them find solutions," she says.

Macauley appointed to NASA Advisory Committee

Senior Fellow **Molly Macauley** has been one of the pioneers in applying economic principles to outer space. This work led to her appointment to NASA's Space Science Advisory Committee (SScAC) Board earlier this year.

Comprised of twenty members recognized for their expertise in scientific, technological, and programmatic fields relevant to space science, the SScAC acts as an advisory board for the NASA Administrator through the NASA Advisory Council (NAC). Macauley is one of a diverse group of experts in industry, academia, and government from across the country who advise on agency programs, policies, plans, and other matters pertinent to space science. Their advice spans research topics concerning the Sun-Earth connection, solar system exploration, origins of planetary systems, and the structure and evolution of the Universe.

Macauley directs RFF's research program on space economics and policy and has extensive experience consulting with law, engineering, and government entities. She has published two books and more than forty articles and has worked with NASA in other advisory and research-oriented capacities as well. In 1996, she was elected to Corresponding Membership in the International Academy of Astronautics.

Macauley believes that the fairly recent use of economics in the space industry has improved public policymaking, especially as it relates to "the allocation of resources, space regulatory policies, and a public understanding of the commercial potential of space."

New Fellow for CRM

Carl J. Bauer has joined RFF as the Center for Risk Management's newest fellow. Bauer's interests lie in the law and political economy of natural resources and the environment. More specifically, he is interested in comparative studies of water rights, water markets and river basin management around the world, and he is the author of a recent book on water management in Chile.

PATRICK DEASON PHOTOGRAPHY

At RFF, he will continue to work in the area of water law, policies, and institutions in the Americas. He plans to focus on hydroelectricity and on the relations between water and energy policies, and he is looking forward to returning to research on these issues in the western United States.

Before joining RFF, Bauer was a visiting scholar in the University of California–Berkeley Department of Environmental Science, Policy, and Management. He was also an adjunct professor in water law at the Chilean University of Atacama.

Bauer received his doctorate from the Jurisprudence and Social Policy Program, School of Law, at UC–Berkeley in 1995. He holds a master's degree from the same program as well as another in geography from the University of Wisconsin–Madison.

Improving the Science of Regulatory Decisions

New RFF Book Describes Science at EPA

The U.S. Environmental Protection Agency (EPA) has drawn sharp criticism in recent years for the scientific basis underlying its regulations covering everything from airborne particulate matter to arsenic in drinking water. Critics of all persuasions have complained that EPA either bases some of its decisions on weak scientific footing, or that the agency has ignored key scientific breakthroughs that could allow it to better protect the public's health.

A new book from Resources for the Future provides the first comprehensive look at exactly *how* scientific decisions are made at EPA. *Science at EPA: Information in the Regulatory Process*, written by former RFF staffer Mark Powell, concludes that the process is at its core a human one. Terry Davies, senior fellow and director of the Center for Risk Management, writes in the book's foreword that "the process … does not look like something from a public administration textbook. It is frequently messy, the actors are often motivated by dedication to the public interest (as they perceive it) but also succumb to less elevated motives of pride and ambition … Dr. Powell finds a very human world, strongly affected by individual perspectives and personalities."

Through a series of case studies, the book outlines myriad factors that combine to weaken the scientific basis of decisions at EPA, several of which—naïve statutes written by Congress for example—are not EPA's fault. Other factors include the agency's need for clarity and precision in crafting enforceable guidelines, and the persistence of major scientific uncertainties in important areas.

Science is an important component in EPA's decisionmaking, but it is not the only—or even the most important—factor. Instead, decisions are the result of a complicated mix of legal, political, economic, and scientific concerns, which in some cases led EPA to downplay the ambiguity and imprecision inherent in science. The agency's 1987 rule on standards for airborne particles, for example, was issued amid considerable uncertainty about the appropriate size of particles being regulated and about the levels of exposure at which adverse health effects might occur, according to several people interviewed for the book.

As a discipline, environmental science is particularly weak in understanding how and whether various pollutants regulated by EPA may affect health at low levels of exposure. The failure of environmental science to identify "safe" levels of pollutants (required by the Clean Air Act, for instance) invites policymakers to base their decisions on other criteria, such as engineering feasibility, economic impacts, or political feasibility, according to the book. And because EPA has not successfully linked its research and regulatory agendas, it seldom initiates research in anticipation of regulatory decisions, often leaving the agency to rely on its ability to interpret research conducted by others. Presently, the EPA commands just 15% of the federal environmental research budget, and is far outspent in this area by NASA, the Department of Energy, and the Department of Defense.

The RFF book spells out a series of policy options for improving the use of science at EPA. It says agency decisionmakers should be trained to better understand the application of science to policy decisions. Presently, most of EPA's leaders are trained in law, not science. EPA decisionmakers also need to do a better job in distinguishing between the scientific and policy bases for their decisions.

Further, EPA and Congress should take steps to ensure that the agency is focused on issues beyond its immediate policy priorities. By increasing EPA's research budget—and earmarking a greater share of funds for the regulatory needs of the future—the agency can reduce uncertainty and improve the contribution made by science. The research portion of the agency's budget should grow from approximately 8 percent presently to at least 15 percent. And spending decisions should be guided by a strategic planning process that identifies short-, medium-, and long-term priorities and strategically applies funds to investigate them.

EPA also should reinstitute and strengthen its internal scientific review processes to ensure transparency, account for scientific uncertainty, and improve the analytical bases for its policy decisions.

The book's author, Mark R. Powell, is an American Association for the Advancement of Science risk fellow with the U.S. Department of Agriculture. He is a former researcher with the Center for Risk Management. The study was funded by the EPA and RFF.

Ordering books

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ANNOUNCEMENTS

1999 Awards and Internships

Joseph L. Fisher Dissertation Awards

In honor of the late president of RFF, the following students will receive support during their final year of doctoral study.

Juan-Camilo Cardenas, Department of Resource Economics, University of Massachusetts. Cardenas is studying people's willingness to pay to preserve biodiversity, based on data from his own survey in rural Colombia.

Anne-Juliane Hunnemeyer, Department of Agricultural Economics and Business, University of Guelph. Hunnemeyer is exploring how to give the private sector financial incentives to preserve biodiversity in Canada.

Becky Mansfield, Department of Geography, University of Oregon. Mansfield is analyzing the economic and political factors that influence the sustainability of the global market for Alaskan pollack.

Mahesh Sankaran, Department of Biology, Syracuse University. Sankaran is studying the effects of humans on tropical ecosystems in southern India, using the tools of biology but also drawing out management and economic policy implications.

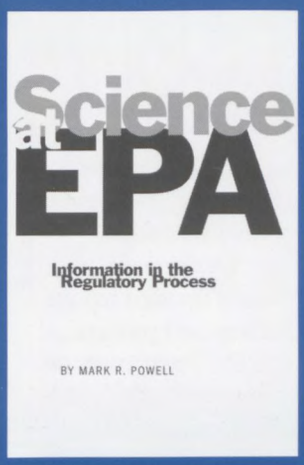
Michelle Villinski, Department of Applied Economics, University of Minnesota. Villinski is studying the pros and cons of option pricing to manage water resources in California.

Walter O. Spofford Jr. Memorial Internships

To honor the late RFF researcher who helped launch RFF's China Program—and to continue the work that he started—**Grace Yun Bai** and **Lubiao Zhang** have received internships in his name.

Now a graduate student in public policy analysis at the University of Rochester, Bai worked for nine years at China's National Environmental Protection Agency. Her interests include energy and natural resources, and market-based approaches to resource management.

Zhang received a Ph.D. in resource economics from Nanjing Agricultural University in 1992. Currently, he is an associate professor and deputy division director at the Institute of Agricultural Economics within the Chinese Academy of Agricultural Sciences. Sustainable water management and rural pollution are the focal points of his present work.



July 1999
ISBN 1–891853–00–7
433 pages
$49.95, paper

Science at EPA
Information in the Regulatory Process

Mark R. Powell

In this frank, provocative assessment of EPA, Mark Powell contends that environmental policy must be perceived to have a sound basis in science to be credible with the public and policymakers. The obstacles to that perception, he writes, include large scientific uncertainties, increasing workloads, time constraints, short-term political demands, and EPA's staff patterns and legalistic culture.

As the most comprehensive examination available of the acquisition and use of science in environmental regulation, *Science at EPA* includes detailed case studies of eight EPA decisions, involving each of the major statutory programs. Powell also draws on extensive personal interviews with key people to offer an overall evaluation and prescriptions for how the agency can improve in this area.

Mark R. Powell is an American Association for the Advancement of Science risk fellow with the U.S. Department of Agriculture. He is a former researcher with RFF's Center for Risk Management.

Ordering discussion papers

Discussion papers may be ordered through RFF. The price per paper covers production and postage costs and is based on delivery preference: domestic, $6 for book rate and $10 for first class; international, US$8 for surface and US$15 for air mail. Canadian and overseas payments must be in U.S. dollars payable through a U.S. bank.

Please send a written request and a check payable to Resources for the Future to: Discussion Papers, External Affairs, Resources for the Future, 1616 P Street, NW, Washington, DC 20036–1400. Recent discussion papers are accessible electronically for no charge at *http://www.rff.org*.

DEVELOPMENT

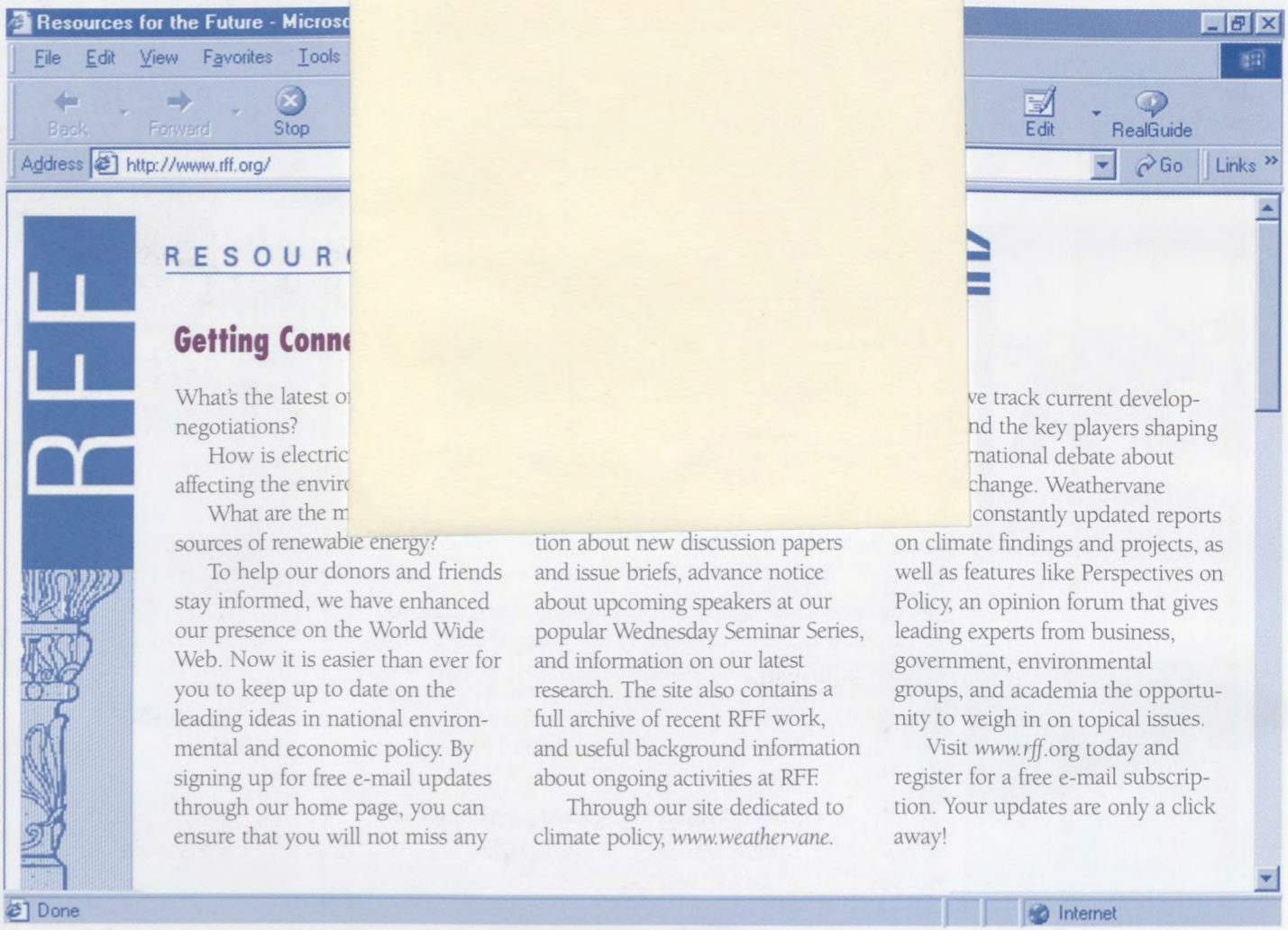
Help RFF While You Reduce Your Tax Burden

As you consider your year-end tax planning, we hope you will consider making good use of the charitable income tax deduction by remembering Resources for the Future with a gift. There is no easier way to help RFF continue its work—and no easier way to garner a charitable deduction for 1999—than by writing us a check.

If you right gift deduct tax yo Gi sto in

any capital gains tax on the increase in the value of your

lar situation. For your convenience, this issue of *Resources* contains an envelope for mailing your gift. For more information on ways to give to RFF, please call Lesli A. Creedon, director of development, (202) 328-5016.



Recent Grants to RFF

German Marshall Fund
$14,000 to support North American participation in an international workshop on key economic instruments of the current global climate change negotiations

G. Unger Vetlesen Foundation
$100,000 to fund RFF's Climate Economics and Policy Program over a two-year period

Michigan Great Lakes Protection Fund
$100,000 to fund a study on promoting environmental compliance through financial responsibility requirements; and $60,000 to fund a study on market-based instruments for pollution reduction *(for more details, see "Goings On" item on p. 4).*

New RFF Council Member

International Paper

Welcome and thank you

Clean Air and Regulatory Policy Featured at the RFF Council Meeting

KEITH KREGER

Judge Stephen Williams, D.C. Circuit of the U.S. Court of Appeals

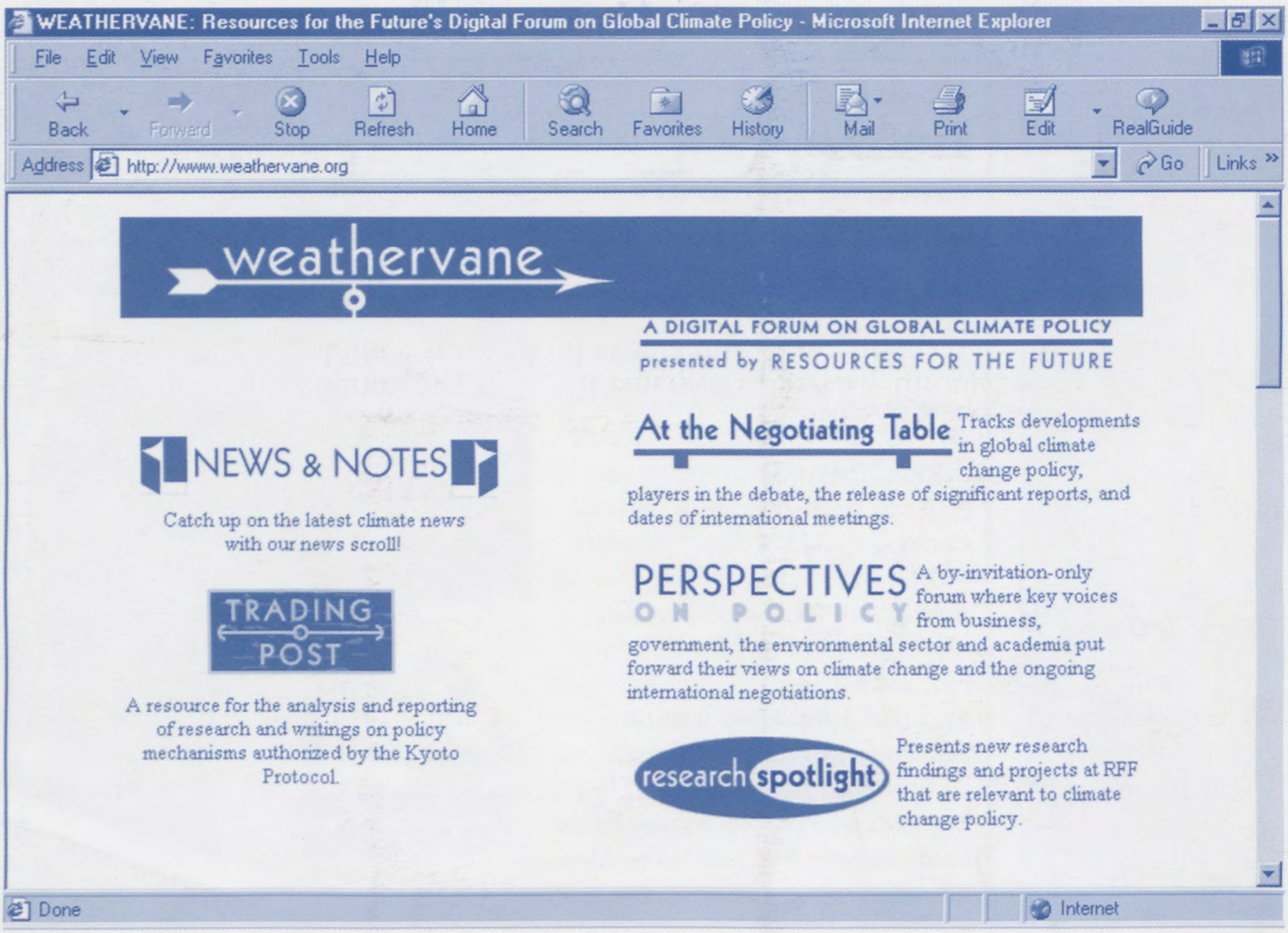
The future of the Clean Air Act was on the minds of members of the RFF Council and Board of Directors when they met in Washington D.C. in early October. The meeting came on the heels of a recent decision of the D.C. Circuit of the U.S. Court of Appeals which invalidated new federal clean air standards on the grounds that they were based on no "intelligible principle," and that they represent an unconstitutional delegation of legislative authority to the executive branch.

Two expert panels assembled by RFF addressed key issues raised by the court's decision. The first, led by **Alan Krupnick**, director of the Quality of the Environment Division at RFF, examined the setting of air quality standards in the wake of the court's ruling. Panelists included **David Hawkins,** senior attorney, Air & Energy Program, Natural Resources Defense Council; **Robert Brenner,** director, Office of Policy Analysis and Review, EPA and C. **Boyden Gray,** partner, Wilmer, Cutler & Pickering. The second panel addressed alternative approaches to current air quality policy. Speakers included **Edward Helme,** executive director of the Center for Clean Air Policy; **Mary Gade,** partner, Sonnenschein, Nath & Rosenthal, and former director of the Illinois EPA; **Jimmie Powell,** staff director with the Committee on Environment & Public Works of the U.S. Senate; and **Paul Bailey,** vice president for the environment at the Edison Electric Institute.

Judge **Stephen Williams** (pictured), one of the two judges on the Appeals Court Panel which decided the clean air case, delivered the keynote address at the dinner that followed the panel discussions.

RESOURCES FOR THE FUTURE

Keep Up With the Latest News on Climate Change—
www.weathervane.rff.org



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