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The Costs of Regulation

I write this letter on the 31st anniversary of Earth Day—and nearly 100 days into the presidency of George W. Bush. What a three months it has been! The new administration's environmental policies—which, in some cases, amount to an outright rejection of those it inherited from President Clinton—have ignited controversies, inflamed passions, and made news. Big news.

One reason for these controversial policies is that the new administration came to town convinced that the scientific basis for many federal environmental regulations is shaky at best, and the benefits they would provide do not justify the costs that they would engender.

This issue of *Resources* addresses the administration's concerns in a variety of ways. Ramanan Laxminarayan takes a look at an issue that may, at first glance, seem a strange one for an RFF researcher to be exploring—antibiotic resistance. But he shows quite clearly that antibiotic efficacy is a common property resource in much the same way as a fishery or grazing commons—and that it can be exploited inefficiently, as the latter sometimes are. He then goes on to show how economic incentives can help avert this “tragedy of the commons,” as Garrett Hardin called it—and minimize the cost of regulations designed to maintain the efficacy of an important class of drugs.

Heather Ross discusses the Supreme Court's recent landmark decision in a case about the possible role of costs in setting national ambient air quality standards. As she makes clear, if our new president wishes to see the beneficial effects of tighter air quality standards balanced against the economic dislocations they can cause, he had better not look to the courts. Without new legislation to change the way these standards are set, there will be no benefit-cost balancing under the Clean Air Act.

David Simpson and Paul Ferraro examine the best ways to conserve threatened habitat. Perhaps surprisingly, they conclude that these methods might not be the approaches that are most in favor today. Finally, Roger Sedjo suggests that, in the short term, it might be cheaper—perhaps far cheaper—to grow forests that will absorb carbon dioxide from the atmosphere rather than attempt to reduce emissions from cars, power plants, factories, and other sources.

Finally, with all this talk about minimizing the costs of regulation, it is impossible not to note the passing of one of RFF's true giants, Allen Kneese, who is memorialized within. During his nearly 40-year association with RFF, Allen Kneese pioneered the use of pollution taxes, deposit-refund systems, and marketable discharge permits as ways to meet ambitious environmental goals at least cost to society. Ignored for many years, these approaches are now the mainstays of environmental policy in many parts of the world. If any researcher ever demonstrated that ideas can really change the world, it was Allen Kneese.

Paul Portney

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RFF Scholar Testifies Before House Science Committee On Role of Renewable Resources in Power Generation

In recent testimony before House Science Committee, RFF Senior Fellow Joel Darmstadter sounded a note of caution about the potential role of renewable energy sources in addressing the nation's power generation needs. "Despite widespread optimism, dating from the energy market upheavals of the 1970s, and considerable policy support over the years, the reality is sobering: nearly 30 years later, renewable energy systems have not emerged as a significant factor in the country's electricity infrastructure," he said. "Nor is this picture likely to change appreciably over the next several decades."

The exception is hydropower, currently the dominant renewable resource, accounting for roughly 10% of the nation's electricity generation, Darmstadter said, who focused his remarks on other renewable energy sources. "Hydropower is a mature, low-cost technology that raises different policy issues than those raised by other renewable energy sources. Those other sources involve emerging technologies that face barriers which are primarily economic in nature."

Darmstadter spoke before the House Committee on Science, as part of a panel hearing on the role of renewable energy and energy efficiency in addressing the nation's energy future. The hearing was conducted by committee chairman, Rep. Sherwood Boehlert (R-NY), to look at what he called the "real energy crisis," this country's "irresponsible and probably unsustainable" energy profile.

Renewable Energy's Role in the Marketplace

The failure of renewables to play a more prominent role is intimately linked to the concurrent decline in the cost of conventional generation, Darmstadter said. Several

factors have contributed to this, including the emergence of more competitive energy supply markets, productivity improvements in oil and gas exploration and coal production, the successful deregulation of the railroads (a major factor in reducing the cost of coal shipping), and technological progress in conventional generation itself (such as gas-fired, combined-cycle power plant systems). Notwithstanding the current problems facing California, the ongoing restructuring of the electricity industry also has put downward pressure on generation costs, he said.*

While all of these changes have been mostly beneficial for electricity consumers, they have hindered the development of technologies for renewable energy resources, which have had to compete in this changing environment, Darmstadter said. "In other words, supporters of renewables have had to fix their sights on what has so far been a steadily receding target. Nor is that competitive tension likely to abate in the years ahead."

Future gas prices will play a critical role in setting the bar for renewables, he said. Unlike the situation for other generation technologies, where capital costs are the dominant component in the cost of generation, fuel costs drive the cost of power from gas-fired units. The current high price of gas is an important contributor to California's costly electricity purchases.

Some Lessons To Be Learned

Still, the renewables experience cannot be termed bleak, according to Darmstadter. The relative cost of power generated by renewable sources has come down over the years. For example, there have been significant improvements in the size and

technological sophistication of wind turbines. Such cost reductions occurred without the benefits of large private investments and significant output volume and represent a genuine accomplishment that can be a springboard for future progress, he said. Moreover, the reductions are at least partial testimony to the efficacy of public support for renewable energy.

Over the years, the federal government's promotion of renewable energy—both through research and development (R&D) support and a variety of financial incentives—has hardly been negligible, Darmstadter said. Whether the extent of this policy support could be justified by the environmental virtues of renewables compared to conventional energy sources is not clear, he said. In any case, during the same period that the federal government was supporting R&D efforts and offering tax credits for wind power applications and the price per kilowatt hour for wind power was falling, the concurrent fall in the price of conventional energy meant that the competitive edge favoring the latter remained substantial.

"Although the marketplace remains the ultimate arbiter of successful outcomes, the complementary role of government in representing the broad public interest is scarcely trivial," Darmstadter said. Looking ahead, conventional and renewable energy sources both have a place in the wide-ranging energy portfolio that is in the nation's best interest." The federal government should consider a prudently targeted, economically efficient program of support for renewables, centering on R&D and, in particular, on the basic research part of that duality, he said.

* The performance of renewables over the past 30 years was more fully discussed in "Renewable Energy: Winner, Loser, or Innocent Victim?" by Dallas Burtraw, Joel Darmstadter, Karen Palmer, and James McVeigh, *Resources*, spring 1999 (www.rff.org/resources_archive/pdf_files/135_burtraw.pdf).

RFF ANNOUNCES FIRST ENDOWED CHAIRS

Resources for the Future (RFF) is honored to announce the establishment of the Thomas J. Klutznick Chair and the Linda and Ken Lay Family Chair at RFF, the first endowed senior fellowships in the institution's history. Darius Gaskins, chairman of the RFF Board of Directors, says that the endowed chairs will "significantly enhance RFF's ability to support timely and objective research by the country's foremost thinkers on environmental policy. We are truly indebted to Tom and to Ken and Linda for their generosity and commitment to securing RFF's future well into the 21st century."

The Thomas J. Klutznick Chair

"Americans are fed up with urban sprawl, disappearing farmland, and congestion. But what we do about it is still open for debate. I think there is a real need for independent analysis on how to prevent and alleviate the negative impacts of unfettered urban growth. RFF is one organization that we can count

on to bring research, reason, and common sense to this highly contentious debate."

With those words, Thomas J. Klutznick pledged to endow one of the first chairs at Resources for the Future. Klutznick, a philanthropist and civic activist, is president of Thomas J. Klutznick Company, a Chicago-based real estate investment and development firm. Since the 1970s,

Klutznick has been involved in the development of office, retail, hotel, resort, and residential properties nationwide. He has been responsible for such landmark properties as Chicago's Water Tower Place, Los Angeles's Fox Plaza, and Boston's Copley Place. In the 1980s and 1990s, Klutznick was co-managing partner of Miller-Klutznick-Davis-Gray, whose portfolio included the Pebble Beach Company and the Aspen Skiing Company. His concern for an appropriate balance between growth and environmental protection is reflected in these projects—and throughout his career.

"By establishing this chair, I am planting the seeds for research that will help policymakers in particular, and society in general, understand the complex relationship among urban development, land-use planning, transportation, and the environment," says Klutznick. In addition to urban affairs and the environment, his interests and involvements include economic policy, education, and social policy. Klutznick is currently the chairman of the board of trustees of Oberlin College and a trustee of the Committee for Economic Development. He has also served on the boards of Chicago's Roosevelt University, where he founded the Institute for Metropolitan Affairs, the Yosemite Restoration Trust, and the National Building Museum, among others.

Klutznick's gift also symbolizes his longtime commitment to Resources for the Future. From 1985 to 1994, he was a member of the RFF Board of Directors. Under his leadership as the first development committee chairman, RFF launched its individual giving program. Today, over 200 donors from around the world contribute to RFF, providing vital financial support to the organization.

He also played an instrumental role in establishing RFF's real estate portfolio. Ted Hand, RFF Vice President—Finance and Administration, credits Klutznick with "laying the foundation for the development of the Resources and Conservation Center (RCC). Tom provided invaluable guidance as we worked our way through the process from conceptualization through construc-



tion to financing and leasing. Today the equity in RCC represents one-third of RFF's endowment. Tom has long been a good friend to Resources for the Future. This chair is just another example of his commitment and generosity."

The Linda and Ken Lay Family Chair

"In his role as chairman of Enron Corp., Ken Lay has almost singlehandedly made the world rethink what it means to be a modern energy company. With his and Linda's very generous gift, I hope RFF can force a rethinking of the role that objective analysis can play in energy and environmental policymaking," says Paul Portney, president of Resources for the Future, upon the establishment of the Linda and Ken Lay Family Chair at RFF.

Beginning in 2004, the Chair will be awarded to an outstanding senior fellow at RFF or used to recruit an exceptional scholar to RFF for a three-year term. The Lay family's gift will help underwrite research and communications activities undertaken by the chairholder to improve the way decisionmakers consider important issues on the top of the nation's policy agenda.

Ken Lay is currently serving his second term on the RFF Board of Directors, having previously been a trustee in the early 1980s. He has been with Enron since 1986, following the merger of Houston Natural Gas and InterNorth, Inc. He also served as Enron's chief executive officer from 1985 until February 2001.

Ken received both his bachelor's and master's degrees in economics from the University of Missouri and his Ph.D. in economics from the University of Houston. He has long been a proponent of using eco-

nom ic principles in decisionmaking, especially in the public policy arena, where objective analysis can often be used effectively to bridge the gap between different stakeholder groups.

Among other philanthropic interests and activities, Ken currently serves on the boards of the American Enterprise Institute; the H. John Heinz III Center for Science, Economics and the Environment; and Howard University. He is a member of the Texas Business Hall of Fame, and received the 1998 Horatio Alger Award.

Linda Lay owns a real estate development company and is an active community leader, who has raised millions of dollars for nonprofits such as DePelchin Children's Center, Design Industries Foundation Fighting AIDS, The Rise School of Houston for Children with Down's Syndrome, and United Negro College Fund. She received the Crohn's and Colitis Foundation's 1999 Women of Distinction Award and was a Susan G. Komen Breast Cancer Foundation 2000 Lifetime Member Honoree. Linda is also a business and personal advocate for a large Bolivian community in Houston. The Lays have five married children and six special grandchildren.

"Resources for the Future plays a unique



role as an objective and expert voice in the otherwise quite often emotionally charged debates on energy, resources, and the environment. It is our hope this chair will further enhance Resources for the Future's stature and authority in these most critical discussions," states Ken Lay.

For more information on these chairs or other giving opportunities at Resources for the Future, please contact Lesli A. Creedon, director of development, at (202) 328-5016.



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RFF Studies Suggest Annual NO_x Reductions Would Save Billions of Dollars Compared to Current Seasonal Approach

Emissions of nitrogen oxides (NO_x) contribute to the formation of smog (technically ozone), which is associated with health hazards as well as environmental problems. The U.S. Environmental Protection Agency (EPA) has called on eastern states, where the ozone problem is most pronounced, to formulate state implementation plans (SIPs) for reducing NO_x emissions, a requirement of the 1990 Clean Air Act.

EPA's proposed policy, known as the SIP Call, would implement a five-month, summer-season emissions cap aimed at reducing NO_x and the resulting smog it creates. The reduction in NO_x emissions would also lead to reductions in particulate formation, another pollutant that is different from smog. The proposed policy would primarily affect electricity generators in 19 eastern states plus the District of Columbia. The program would emulate the successful sulfur dioxide (SO₂) program by allowing affected sources to meet the cap through emissions trading.

The electricity industry will make substantial investments over the next few years to come into compliance with the NO_x provisions of CAA. While the extent to which investments for ozone protection yield cost-effective health benefits is controversial, two recent studies by RFF researchers demonstrate conclusively that redesigning the manner in which ozone-mandated emission targets are met can result in sizeable health benefits for virtually no additional capital investment. These benefits (from reduced particulate pollution) can be achieved if the program is simply shifted from being a seasonal program to an annual program. The investment in pollution reduction equipment is altered only

slightly; the equipment simply would be operated across the whole year when it does yield particulate benefits and not just during ozone-sensitive summer months.

In specific, the RFF analyses consider three NO_x reduction scenarios: a summer seasonal cap in the eastern states covered by EPA's NO_x SIP Call, an annual cap in the same SIP Call region, and a national annual cap. All scenarios allow for emissions trading. Both analyses conclude that an annual cap-and-trade policy in the SIP Call region would do far better than a seasonal policy when comparing benefits with costs. The particulate-related health benefits of the annual policy in the SIP Call region are more than double those of a seasonal policy, yet the compliance costs of an annual policy are only slightly greater. The annual policy limited to the SIP region also appears to dominate a national annual policy.

Economic Regulation and Industry Restructuring

The two studies assume that economic regulation in the electricity industry will evolve toward greater competition over the next decade. Economic regulation is the overarching issue currently facing the electricity industry. Electricity generation and supply are regulated at the state level, and roughly half of the states have committed themselves to move away from traditional cost-of-service-based regulation with prices set by a regulator. In its place, these states will adopt competition, with prices determined by market forces. The change also is expected to have an important effect on environmental performance in the industry and on the costs of reducing NO_x emissions.

In one study, the researchers modeled the electricity industry to reflect existing

commitments to restructuring in various states around the country. They calculated particulate-related health effects stemming from NO_x emissions, and compared these to the compliance costs that would be incurred in order to achieve these emissions reductions. The annual policy was found to offer net benefits (benefits minus costs) that exceed those from the other scenarios by at least a billion dollars per year. Perhaps more important than the effect on compliance cost, from a political perspective, is the effect on electricity price. The study found the effect to be only slightly greater in the annual scenario than in the seasonal scenario in the SIP region, and at a national level electricity price is less in the annual scenario.

A second study compared current commitments to restructuring with a nationwide adoption of restructuring across the electricity industry. The study reveals three important additional findings. First, the performance of an annual policy compared to a seasonal one varies significantly with the approach to regulating the electricity industry. Nationwide restructuring is found to increase NO_x emissions substantially, due to increased utilization of coal for electricity generation. An emissions cap on NO_x would eliminate the increase while preserving the majority of the economic benefits from electricity restructuring. However, the NO_x cap would have little effect on the increase in carbon dioxide emissions that would also occur.

A second finding is that compliance costs do not equal economic costs from environmental policy. Compliance costs include out-of-pocket costs for capital investments and operation of emissions control equipment. Economic costs measure what society has to give up to achieve emissions reductions, measured as changes in consumer and producer surpluses. Con-



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sumer surplus is the difference between consumers' willingness to pay for electricity and the price consumers actually must pay. Producer surplus is the difference between revenues and production costs. The sum of consumer and producer surplus is called economic surplus.

In the limited restructuring case, much of the nation sets the price of electricity in an inefficient manner. Consequently, the change in economic surplus due to the NO_x policy was found to be less than compliance costs. However, under nationwide restructuring, electricity is priced efficiently. If some consumers decide to reduce consumption of electricity, the forgone electricity consumption has a value that is at least as great as its price. This makes the cost of emissions reductions appear more expensive, from an economic perspective.

A third finding is that, even when measured in terms of changes in economic surplus, the annual policy dominates a seasonal one. Under limited restructuring, an

annual policy would yield more than \$600 million in net benefits per year measured in this way. Under nationwide restructuring, an annual policy would yield nearly \$1 billion in net benefits per year.

Benefits Exceed Costs

The health-related benefits from reducing particulates are expected to represent the major portion of all benefits, so they provide a meaningful basis to analyze the cost-effectiveness of the policies under consideration. However, a limitation of the two studies is the omission of other expected benefits of NO_x reductions, including reduced nitrogen deposition and reduced ozone concentrations. When these are taken into account, each of the modeled scenarios appears likely to have benefits roughly equal to or in excess of compliance costs. In all cases benefits also are expected to be greater than economic costs, or the change in economic surplus. Under an annual policy, benefits are likely to be sub-

stantially greater than economic costs. In every case, the inclusion of additional benefits boosts the argument in favor of an annual policy in place of a seasonal one, because many of the omitted benefits would accrue on an annual basis.

The additional benefits of extending the proposed seasonal cap on NO_x emissions to an annual basis could be expected to outweigh the additional costs, according to the researchers. EPA and the affected states may want to consider replacing or supplementing the current initiative for the eastern United States—a seasonal program to reduce NO_x emissions—with a new initiative aimed at annual reductions.

This article is based on two recent studies, which can be found on the RFF website: "Cost-Effective Reduction of NO_x Emissions from Electricity Generation" by Dallas Burtraw, Karen Palmer, Ranjit Bharvirkar, and Anthony Paul (www.rff.org/disc_papers/PDF_files/0055.pdf); and "Restructuring and the Cost of Reducing NO_x Emissions in Electricity Generation" by Karen Palmer, Dallas Burtraw, Ranjit Bharvirkar, and Anthony Paul (www.rff.org/disc_papers/PDF_files/0110.pdf).

RFF Researchers Assessing U.S. Efforts to Meet U.N. Goals To Cut World Hunger in Half by 2015

Currently, more than 800 million people around the world are chronically hungry. Most of this "food insecure" population live in developing countries and survive on less than a \$1 a day. Experts estimate that if the status quo continues, there will be an additional 2.5 billion hungry people by 2025.

To combat hunger, the United Nations Food and Agriculture Organization (FAO) convened the World Food Summit (WFS) in 1996 to renew earlier commitments of reducing world hunger. The pledge from member countries was to reduce the number of undernourished people by half by

2015. Following the summit, the FAO and member countries committed to achieving the WFS goal by supporting economic development in developing countries and fostering "sustainable, intensified, and diversified food production" systems. Based on this mandate, each member country was charged with developing an action plan to reduce hunger both domestically and internationally.

In March 1999, the United States issued the *U.S. Action Plan on Food Security*, which details priorities, actions, and commitments for meeting the WFS goals at home

and abroad. A subsequent report was released in November 2000, documenting the progress of implementing the U.S. action plan. The Action Plan was developed by the Interagency Working Group on Food Security, which was co-chaired at the subcommittee level by the U.S. Agency for International Development, the U.S. Department of Agriculture, and the U.S. Department of State.

RFF Senior Fellow Mike Taylor and Research Assistant Jody Tick, in collaboration with Dr. G. Edward Schuh, the Orville and Jane Freeman Professor in International Development and Investment Policy at the University of Minnesota and co-chair of the Food Security Advisory Committee, are in



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the process of a six-month study to analyze the implementation of the *U.S. Action Plan on Food Security*.

The research team will evaluate the action plan's international components as they relate to food aid and agricultural development assistance, focusing on governance, policy, and budget issues within the broader historical context of U.S. inter-

national assistance to developing countries. This approach will provide a frame of reference for differentiating between existing programs and resources to promote international food security and new programs initiated as a result of the renewed U.S. commitment to the WFS goal.

Funded by RFF, the study aims to provide policymakers and stakeholders with a

common factual and analytical base for evaluating the U.S. effort to meet WFS goals. This study is part of a larger effort in the development of a food system program at RFF. This new program takes a multi-disciplinary approach to food system issues with emphasis on food safety, international food security, and the nexus of agriculture and the environment.

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Fighting Antibiotic Resistance: Can Economic Incentives Play a Role?

Ramanan Laxminarayan

Antibiotic resistance is on the rise, imposing enormous costs on society and spurring concerns about the treatment of infectious diseases. The problem can be traced to the widespread overuse of the readily available drugs. Policy-makers should consider creating economic incentives to encourage individuals and drug manufacturers to take into account the societal costs of using antibiotics.

Widespread reliance on antibiotics has spurred an alarming rise in resistant strains of bacteria, complicating the treatment of infectious diseases. Many blame the situation on doctors, patients, and livestock farmers who overuse, and sometimes even misuse antimicrobial agents. The challenge for policymakers is to promote the optimal use of antibiotics by creating economic incentives for individuals and drug manufacturers to consider the costs, as well as the benefits, of using these powerful drugs.

Resistance imposes enormous costs on society in the form of increased hospitalizations, higher mortality rates, and the diversion of resources from other medical needs into the development of new and more powerful antibiotics. Nevertheless, doctors understandably focus on the benefits to the patient, not the risks to society, when they prescribe an antibiotic. Similarly, livestock producers who use antibiotics in animal feed are motivated by the incentive of increased profits, and drug companies that encourage antibiotic use are motivated largely by objective to profit from the antibiotic before expiration of its patent life. Such economic incentives drive the evolution

of antibiotic resistance. As more antibiotics are used, bacterial resistance increases—a cycle that is exacerbated by the failure of antibiotic users to consider the full costs of their activities. Because resistance results from the selective use of drugs on sensitive strains of bacteria, it is likely to remain a pressing issue as long as we rely on antibiotics.

Although no one knows the exact costs that antibiotic resistance imposes on society, the most common estimates range from \$350 million to \$35 billion, depending on how long resistance persists in the bacterial population, and whether or not the cost of deaths is considered. Such assessments are incomplete, however, because they fail to take into account the biological dynamics of resistance and infection. Unfortunately, limited data exist on antibiotic use and bacterial resistance, making it difficult for economists to compare costs when trying to evaluate alternatives to antibiotics.

A number of studies and reports have proposed guidelines for limiting the use of antibiotics in order to reduce resistance. But neither such guidelines nor educational efforts have been successful. Short of directly monitoring clinical practice, which would be extremely

expensive, public health policymakers can do little to enforce restrictions on antibiotic use. And any attempt to admonish doctors for overusing antibiotics is likely to spark strong opposition from the medical community.

If we are to use the drugs more judiciously, it may be necessary to create a system that stresses the economic value of preserving the effectiveness of the drugs. In the language of economists, antibiotic resistance is a negative "externality" associated with antibiotic use, much as pollution is an undesirable externality associated with the generation of power at a thermal power plant. There are no incentives for antibiotic users or power plants to take into account the negative impact of their actions on the rest of society. In the case of power plants, government agencies impose emissions restraints in the form of taxes and quotas to force them to take the cost of pollution into account when determining how much power to generate. Similarly, society should devise mechanisms by which the cost of antibiotic resistance is taken into account—or, in economic terms, "internalized"—in decisions regarding the use of the drugs.

However, the externalities associated with antibiotic use are not all negative. A positive externality associated with antibiotic use is that it may cure infections, thereby reducing the likelihood of the infection being transmitted to uninfected individuals. Therefore, we need to weigh the favorable and unfavorable effects against one another to determine the optimal antibiotic use policy.

Optimal Use

Antibiotic effectiveness may be thought of as an economic or natural resource that is of value to society because it enables doctors to both prevent and treat infections. The current debate over antibiotic resistance centers on whether the current rate of depletion of this resource is greater than optimal.

From an economic perspective, the optimal use of antibiotics depends on whether the drugs are a renewable or a nonrenewable resource. This distinction relies on a biological concept (known as "fitness cost") that measures whether resistant strains of bacteria are placed at an evolutionary disadvantage when antibiotics are removed from the environment. If resistant bacteria were less likely to survive in the absence of antibiotics, one could conceive of temporarily removing an antibiotic from active use to enable it to recover its effectiveness. Antibiotic effectiveness would then be characterized as a renewable resource, much like a stock of fish that is harvested

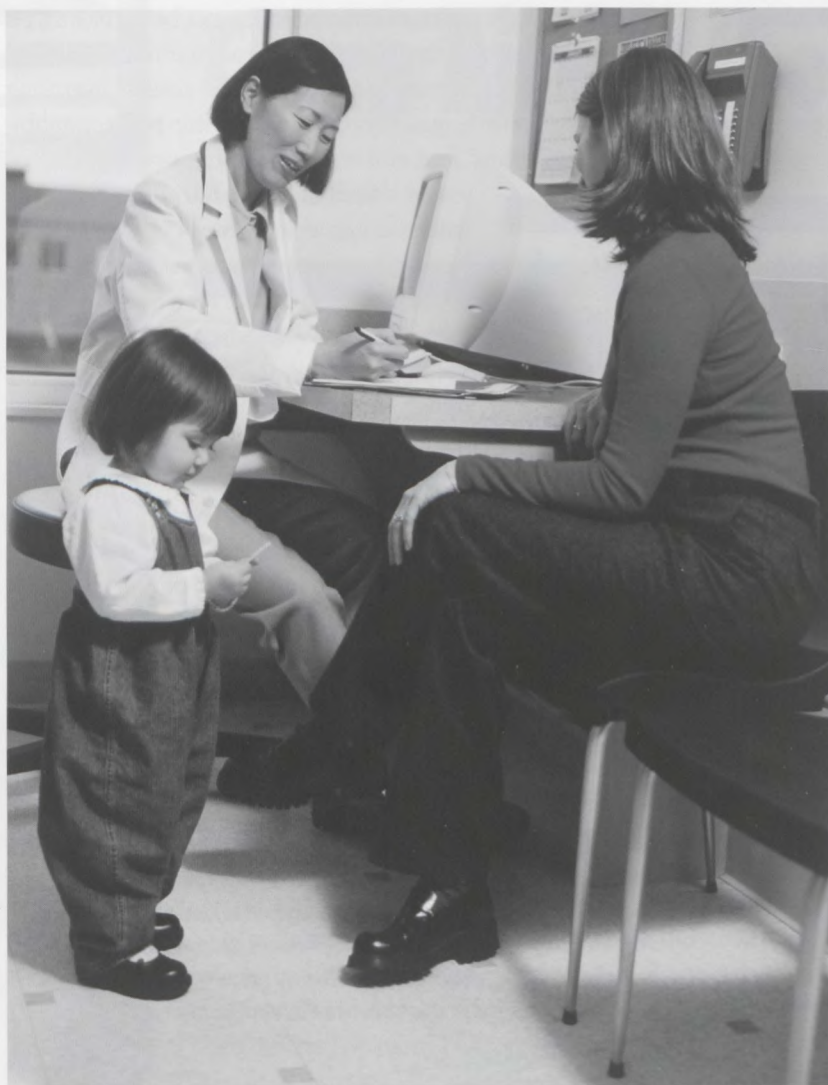
periodically and allowed to regenerate between harvest seasons. On the other hand, if the resistant strain remained prevalent, then an antibiotic would fail to regain its effectiveness even if it were temporarily removed. Effectiveness would be treated as a nonrenewable or exhaustible resource, similar to a mineral deposit. The question of renewable versus nonrenewable is difficult to answer because scientists continue to debate whether resistant bacteria endure in an environment without antibiotics.

In hospitals, where the increased use of antibiotics has contributed to a growing number of infections, officials seek to achieve optimal use by altering the menu of antibiotics available to doctors. How the antibiotics should be used to limit resistance, however, is a difficult question. If two antibiotics are available, for example, should doctors prescribe one, both, or alternate between the two?

Scientists have used mathematical modeling to show that, in the case of two antibiotics that are identical except for their modes of antibacterial activity, the optimal strategy would be to use equal fractions of both on all patients simultaneously. But if the two drugs differ in price, initial effectiveness, or the rate at which resistance develops, the results change dramatically. For example, when the cost of two antibiotics is identical, the optimal approach is to use the more effective antibiotic until resistance increases to the point that the two antibiotics are equally effective, and then to use both drugs. Alternatively, if the two drugs are equally effective, but one costs more than the other, the recommended approach is to use the less costly antibiotic until, due to increased resistance, the cost-effectiveness of the two antibiotics becomes identical. Finally, if one drug produces resistance more slowly, that drug should be used to treat more of the patients.

Another issue for hospitals is the tradeoff between the costs of strengthening infection control measures and reducing antibiotic use. Infection control measures, such as sequestering nursing staff to a limited number of patients, can be effective in reducing the spread of infections in hospitals. One recent study has shown that these policies also can reduce microbial resistance in hospital settings. Further studies are required to develop the optimal mix of strategies to reduce resistance in an economically efficient manner.

Efforts to restrict antibiotic use in outpatient settings have been much less successful than in hospitals because no central agent (such as a hospital administrator or infection control committee) can enforce an antibiotic policy. Also, the high cost of malprac-



tice lawsuits may induce doctors to err on the side of using stronger and broader spectrum antibiotics than may be called for. This tendency has the effect of increasing the level of resistance throughout the community, but the impact of each individual prescription is so small that the benefit perceived by the doctor of prescribing antibiotics often outweighs the small uncertain costs associated with increasing resistance. One solution would be to design guidelines that use community data to minimize the overall total cost of treatment and future resistance.

From a patient's perspective, the decision to request an antibiotic is based on two factors: the benefit of quickly recovering from an infection and the cost (minimized by insurance coverage) of

taking the medication. But patients may not be aware of studies that have demonstrated conclusively that prior use of antibiotics increases a person's risk of acquiring a resistant infection.

Patients who are educated about the risks of antibiotics may be more careful about demanding such medication from the doctor. In addition, policymakers may want to consider such economic instruments as taxes, subsidies, and redesigned prescription drug insurance programs to ensure that incentives faced by both doctors and patients are aligned with the interests of society.

Livestock producers, like doctors and patients, have few incentives to consider the risks of antibiotic use. But the practice of adding antibiotics to livestock feed in order to promote growth in cattle and poultry has spurred warnings that such drugs may increase the level of bacterial resistance to antibiotics used in humans. In 1997, the World Health Organization recommended that farmers refrain from using drugs that are prescribed for humans or that can increase resistance to human medications. Policymakers need to balance the social costs of using antibiotics in animal feed against the benefits (namely more efficient livestock operations) in order to arrive at a rational policy regarding such use of antibiotics.

The Role of Patents

Firms that manufacture antibiotics face conflicting incentives with respect to resistance. On the one hand, bacterial resistance to a product can reduce the demand for that product. On the other hand, the resistance makes old drugs obsolete and can therefore encourage investment in new antibiotics.

Pharmaceutical firms are driven to maximize profits during the course of the drug's effective patent life—the period of time between obtaining regulatory approval for the antibiotic and the expiration of product and process patents to manufacture the drug. Given the paucity of tools at the policymaker's disposal, the use of patents to influence antibiotic use may be worth considering. A longer effective patent life could increase incentives for a company to minimize resistance, since the company would

enjoy a longer period of monopoly benefits from its antibiotic's effectiveness.

Patent breadth is another critical consideration. When resistance is significant, other things being equal, it may be prudent to assign broad patents that cover an entire class of antibiotics rather than a single antibiotic. In such a situation, the benefits of preserving effectiveness could outweigh the cost to society of greater monopoly power associated with broader patents. Broad patents may prevent many firms from competing inefficiently for the same pool of effectiveness embodied in a class of antibiotics, while providing an incentive to develop new antibiotics.

Patent policies must take into account the global reach of antibiotic resistance. The 1999 Agreement on Trade-related Aspects of Intellectual Property Rights, sponsored by the World Trade Organization, provides for stricter enforcement of patent rights worldwide, while creating a phase-in period for developing countries that lack certain patent protections. Once antibiotic patents are enforced worldwide, pharmaceutical firms will have more incentive to research new and more effective antibiotics. Such patent rights could also have the potential to reduce the inefficient use of antibiotics by providing incentives to a single agent to conserve antibiotic effectiveness.

Future Research

The importance of scientific research in providing a reliable

foundation for sound economic policy cannot be overstated. As we learn more about the relationship between antibiotic use and resistance, we can better quantify the social costs of overusing the drugs. Similarly, quantifying the relationship between antibiotic use in animal feed and resistance in humans will help us assess the economic tradeoffs involved in using the agents in livestock operations.

Further economic and scientific research could provide guidance for a number of policy issues. Such research could investigate the optimal antibiotic use in community settings, design incentives to promote the judicious use of antibiotics, and analyze the behavior of drug firms in investing in the development of new antibiotics. Finally, much research remains to be done to evaluate the costs of antibiotics in light of the biological dynamics of resistance. These efforts can help policy-

makers ensure that antibiotics remain a valuable resource for society.

Given the paucity of tools at the policy-maker's disposal, the use of patents to influence antibiotic use may be worth considering.

Ramanan Laxminarayan is a fellow in RFF's Energy and Natural Resources Division. This article is based on a longer, more technical paper he coauthored with Gardner M. Brown, "Economics of Antibiotic Resistance: A Theory of Optimal Use," which can be found on the RFF website, at www.rff.org/disc_papers/PDF_files/0036.pdf. RFF recently sponsored a conference on resistance economics, focusing on antimicrobial resistance and pest resistance in agriculture. Look in the next issue of *Resources* for coverage of the conference proceedings.



Clean Air—Is the Sky the Limit?

Heather L. Ross

Society is inclined to see clean air as a priceless amenity, and the U.S. Supreme Court recently ruled that Congress held that view when it wrote the Clean Air Act—that costs should not be considered in setting air quality standards. How disproportionate a burden are we willing to bear to keep this appealing, and expensive, faith?

On February 27, 2001, the U. S. Supreme Court ruled in *Whitman v. American Trucking Associations (ATA)* that only health factors can be considered in setting national ambient air quality standards (NAAQS). Media accounts called the opinion, which upheld an interpretation of the Clean Air Act (CAA) that had been in place for decades, “the dog that didn’t bark.”

Was this a nonevent? When the Supreme Court ruled against cost-benefit analysis for NAAQS, did society dodge a bullet or take one? This article will argue that: as a matter of law, reasonable people can differ with the two different opinions filed on this point, and as a matter of policy, society now faces greater risks to its well-being from keeping the no-cost rule than it would have from overturning it.

Taken at its word, the Supreme Court ruling requires the U.S. Environmental Protection Agency (EPA) to set air quality standards that are by definition too pristine to be in the public interest, and it requires the courts to make sure that they do. How did we get here?

The Clean Air Act

The costs and benefits of CAA are both enormous, but they are moving in opposite directions. As the air gets cleaner over time, the benefits of further improvement in air quality decline while the costs increase. EPA esti-

mates that from 1970 to 1990, the first 20 years of CAA, society devoted \$1.6 trillion to reducing air pollution, about 40% in compliance costs borne by businesses, consumers, and governments and 60% in aggregate gross national product losses. Under the strengthened CAA Amendments of 1990, EPA estimates that society will spend \$45.8 billion on compliance costs alone in 2010, a 140% increase from such costs in 1990. EPA’s separate estimate of the additional costs of its 1997 ozone and particulate standards, the rulemaking action that set in motion the Supreme Court’s recent decision, comes to \$48 billion per year.

Is this money well spent? This is a challenging question since both the benefits and the costs are hard to measure. Challenges include the difficulty of assessing ever-smaller health risks, valuing improvements in human health that have no direct market price, and anticipating the cost and performance of as-yet-unidentified mitigation technologies. But we know that the rising marginal costs of cleaner air will eventually exceed the declining marginal benefits, and that society will be worse off once they do. Weighing costs and benefits is essential to finding a stopping point before we pursue a degree of purity that lowers the quality of human life in favor of advancing the quality of air. Did Congress really intend to make this illegal?

The Court Case

Four years ago, in July 1997, EPA published new NAAQS for ozone and small particulate matter. In the case of ozone, the new standard replaces a previous one established in 1979. That standard is well overdue in its originally scheduled achievement—one fifth of the U.S. population still lives in nonattainment counties. But it has produced a significant improvement in air quality—urban ozone concentrations have fallen 25% since 1980. The new tighter standard will require additional emissions reductions that, in the case of Los Angeles, exceed total current motor vehicle emissions. Reductions of this magnitude will require unprecedented technological change of a nature we can't currently identify and at a sustained pace we have never experienced.

A large group of plaintiffs—consisting of manufacturing, electric utility and transportation companies along with three midwestern states—filed suit against EPA's regulation in the U.S. Court of Appeals for the District of Columbia, which ruled on their petition in May 1999. The Appeals Court found that EPA's regulation "effected an unconstitutional delegation of authority" that went beyond the discretion that Congress could grant the agency. The remedy imposed by the court was not that the law should be changed, but that EPA should enunciate an "intelligible principle" to explain how it was going to limit its own discretion by determining how much protection was enough. There is only one way to make this determination properly, and that is by weighing costs and benefits. By definition, protection that costs us more than we think it is worth is too much.

However back in 1980, this same Appeals Court, affirming a position advanced by EPA, had declared this cost-benefit decision rule unlawful. The Court was now facing up to the fact that its no-cost rule—coupled with advancing science capable of detecting or inferring health benefits down to zero concentrations—had delegated to EPA essentially unlimited power over human activity. The Appeals Court solved the problem of having attributed to Congress an open-ended decision rule by declaring that rule as exercised by EPA unconstitutional. This solution was arguably a bigger reach legally, and definitely more significant in policy potential, than reversing the no-cost rule would have been.

EPA appealed to the Supreme Court, which took the case, and then also accepted a cross-filing from the opposite side seeking further review of the no-cost rule. For both advocates and opponents of cost-benefit analysis, the stage was set for an historic decision.

The Supreme Court Ruling

In two separate opinions, the Supreme Court unanimously reaffirmed the Appeals Court ruling that costs could not be considered in setting air quality standards. In the majority opinion, Justice Antonin Scalia argues that costs are too important to be read into NAAQS. Because of their significance, costs must be "expressly mentioned" in the NAAQS language or they are "unambiguously" barred. Only Justice Stephen Breyer eschews this ominous "silence is prohibition" argument. In a separate opinion concurring with the judgement of the majority he says:

In order to better achieve regulatory goals—for example, to allocate resources so that they save more lives or produce a cleaner environment—regulators must often take account of all of a proposed regulation's adverse effects, at least where those adverse effects clearly threaten serious and disproportionate public harm. Hence, I believe that, other things being equal, we should read silences or ambiguities in the language of regulatory statutes as permitting, not forbidding, this type of rational regulation.

In this case, however, other things are not equal. Here, legislative history, along with the statute's structure, indicates that [section] 109's language reflects a congressional decision not to delegate to the agency the legal authority to consider economic costs of compliance.

The record Justice Breyer cites shows a Congress driven by health concerns and convinced that forcing action to clean up the air in 1970 was clearly warranted. But did that Congress go on to lay down a rule that, no matter how clean the air might become over time, EPA could never consider whether additional reductions would be a net gain or net loss to society? This plunge into the irrational is an awfully big leap.

In support of this leap, Justice Breyer argues that a no-cost decision rule is not necessarily irrational, since "[t]echnology-forcing hopes can prove realistic." He cites the impressive performance of catalytic converter technology in achieving the 90% auto emissions reductions called for in the 1970 Act, despite dire industry warnings that such a standard could force them out of business.

But technological change is uncertain, and things that are uncertain need more thought to get a handle on, not less. Justice Breyer, who wrote the book on risk regulation, understands this, but he's not so sure about Congress. "[E]fforts to take costs

into account can breed time-consuming and potentially unresolvable arguments about the accuracy and significance of cost estimates. Congress could have thought such efforts not worth the delays and uncertainties that would accompany them." While he does not say that this would have been a reasonable thought, Justice Breyer's use of this language in an argument supporting Congress' rationality seems to say as much.

As a matter of law then, cost-benefit analysis has taken a considerable hit in *Whitman v. ATA*. It has again been read out of the most expensive and expansive regulatory statute of our time and characterized as arguably too complicated, time-consuming, and subject to misuse to be worthwhile. Those who doubt the merit of either of these verdicts will just have to lick their wounds.

The Policy Consequences

What will be the practical effect of this cost-benefit ruling? One line of reasoning says not much. In this view EPA would have coped handily with a cost-benefit mandate, much like industry figures speaking alarmingly of ruinous costs and then surviving with new capabilities. The agency would have handled the economists and their cost conundrums with the same skill it has shown with health scientists and their epidemiology statistics, bringing NAAQS out pretty much where it wanted to. Conversely, without costs, EPA will probably carry on as it always has, cleaning up the air and imposing severe excess burdens in the process, but not enough to force the hand of others to intervene. EPA's chosen path may be costly, but it is invariant to the Court's opinion.

Under a different line of reasoning, the Court ruling does matter. One alternative scenario could be called "decision forcing," an analogy to "technology forcing"—that is, applying long-term pressure to improve. In this view, EPA's decision trajectory under cost-benefit analysis would tend over time to bend away from minimizing health effects toward maximizing net social benefits, a very different and superior path. Critics of EPA may doubt that any such voluntary bending would occur, while opponents of cost-benefit analysis express fear that it would go too far. Based on the record to date, the latter group has the harder argument. Under a provision of the 1990 CAA Amendments as well as President Clinton's 1993 Executive Order on Regulatory Planning and Review, EPA has had years of experience doing cost-benefit analyses that support its clean-air decisions, although not using those results to set NAAQS. Were such analyses to



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become part of the decision record, they would enjoy the same deference that courts give to all agency deliberations. So EPA would not be deflected from its preferred path in this scenario, but its preferences might change for the better.

A third scenario does involve perturbation of EPA's preferred path. This story starts with the old chestnut that costs are not considered in setting NAAQS because they are taken into account at the implementation stage—the stage of deciding who must reduce emissions and how in order to meet the standard. The introductory summary to *Whitman v. ATA* says "[o]ther CAA provisions, which do require cost data, have no bearing upon whether costs are to be taken into account in setting the NAAQS." The fact that economic considerations play a role in implementing the standards does not explain why they are excluded in setting the standards, nor does it ameliorate that exclusion. Relief from economic burdens comes not from implementing the standards but from staying their effect—through provisions like exemptions, variances, and deadline extensions.

This is the big tradeoff in ozone regulation—unmeetable standards mitigated by unmet deadlines. What happens if EPA can't maintain the flexibility in timing and penalties it needs to keep too-difficult standards from becoming untenable? Litigation currently is under way to block EPA's attempt to extend deadlines for its existing (1979) ozone standard. Earthjustice Legal Defense Fund, on behalf of the Sierra Club, has sued to prevent EPA from extending that deadline for metropolitan areas of Washington, DC, Connecticut, and Massachusetts without reclassifying those areas to greater nonattainment status. Such

reclassification would mean a significant step-up in emissions reduction requirements, with major effects on production, transportation, and electric generation. The 1990 CAA Amendments also reduce administrative flexibility as to when and how ozone standards are to be met, and EPA's efforts to sidestep those confining effects in its 1997 ozone rule were struck down as unreasonable in another part of *Whitman v. ATA*.

So the Supreme Court ruling comes at a time when EPA's effort to temper standards with discretion is becoming more difficult, and it increases that difficulty. Justice Scalia seems almost cheery about this, at one point warning the administrator that if any allegation that EPA "is secretly considering the costs of attainment without telling anyone . . . could be proved, it would be grounds for vacating the NAAQS because she had not followed the law." It is Justice Breyer who wants to avoid a train wreck. He says that the CAA's words allow the administrator to "take account of context when determining the acceptability of small risks to health. And they give her considerable discretion when she does so." This broad language gives EPA major running room for accepting nonzero residual health effects, if it chooses to do so. The tradeoff Justice Breyer will not grant in costs he partially restores in acceptability of small risks, although the statute is equally silent on both.

When the rock of impossible standards does meet the hard place of unavoidable enforcement, the only relief is congressional action. This may help EPA hold its course or, less likely, blow it out of the water. The one thing that does seem improbable, after 30 years in the air wars, is Congress's adopting a straightforward public-interest standard for NAAQS.

As a matter of policy then, a noticeable change in EPA's regulatory path seems unlikely, although this will probably require a greater resort to congressional dispensation as time goes on. In addition to mounting costs, this raises the prospect of federal policy being made as a series of discretionary responses to affected parties petitioning for relief from the law. As CAA is

opened up to these extenuating amendments, there is always the chance that some genuine harm could befall the statute. None of these prospects is attractive.

Conclusion

Law and policy notwithstanding, clean air is not a free good. As the air has become cleaner over the last 30 years, the costs of further cleanup have risen substantially, even as technology has improved. Meanwhile the benefits of further cleanup have fallen. EPA's Clean Air Science Advisory Committee, tasked with developing the health science on which to base the 1997 ozone standard, advised the agency that health would be adequately protected at the equivalent of the existing standard, and that science did not provide a basis for recommending that the standard be tightened. But EPA did tighten. Its estimate of the incremental annual compliance cost of the new standard, while implausibly low, is still 3.5 times the federal FY 2000 budget for the Centers for Disease Control and Prevention. We could buy a lot of health improvement for that money, but we won't.

Saying that costs don't count in deciding how clean we want the air to be sounds good to people accustomed to viewing environmental policy as a struggle between the black hats and the white hats. But beyond the interest group struggle, there is an objective public interest in beneficial regulation and in good analysis to support it. Failure to find a place for that interest in setting air quality standards is a loss for society, for good government, and for sound environmental policy. With all three branches of government accepting the no-cost rule, none of the usual checks and balances is in place to protect the public from its worst effects. For now, there is no limit to the sky-high costs of clean air.

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Cost-Effective Conservation:

A Review of What Works to Preserve Biodiversity

Paul J. Ferraro and R. David Simpson

The need to preserve biodiversity is urgent, but the financial stakes are high and the debate is heated. There has never been a greater need for both a clear understanding of the principles involved and a careful investigation of the facts.

Humanity has never had a greater impact on the world's land use than we do at the present. As a result, some natural scientists predict that a third or more of the species on earth could become extinct in this century. Such losses are encountered in the geological record only at times of astronomical cataclysm. Half of all terrestrial species can be found in the 6% of the world's land area covered by tropical forests, and these species face the gravest risk. In developing tropical countries, the social agenda is dominated by the pressing needs of poor and growing populations.

Despite the difficulties inherent in influencing behavior in other countries, international efforts to preserve biodiversity have been under way for many years. Aggregate statistics are difficult to come by, but some numbers are indicative of the commitment. The World Bank has dedicated well over a billion dollars toward biodiversity conservation. A number of donors have allocated the same amount toward retiring developing country debt under debt-for-nature swaps. A recent study of conservation spending in Latin America reported approximately \$3.3 billion in expenditures. Private foundations have contributed more than \$10 million per year to conservation in developing countries.

Over the past two decades, conservation funding has shifted away from the "parks and fences" approach toward one attempting to integrate conservation and development projects. This new approach has been harshly criticized. "Integrated conservation and development projects," as they are called, have been labeled as little more than wishful, and generally ineffectual, thinking in works such as John Terborgh's *Requiem for Nature* (Island Press, 1999). Calls to return to a parks and fences approach have sparked another backlash from critics who regard it as little better than stealing indigenous peoples' land at gunpoint. While these debates are raging, other groups are cataloguing, extolling, or sometimes lambasting a variety of innovative approaches to conservation finance.

The conservation need is urgent, the stakes are high, and the debate is heated. There has never been a greater need for both a clear understanding of the principles involved and a careful investigation of the facts.

Direct vs. Indirect Approaches

Biodiversity conservation is largely a matter of preserving the habitats sheltering imperiled species. Effective conservation requires that people who would destroy

Box 1. A Taxonomy of Habitat Conservation Policy Options

Direct approaches pay for land to be protected. Examples include:

- Purchase or lease—Land is acquired for parks or reserves.
- Easement—Owners agree to restrict land use in exchange for a payment.
- Concessions—Conservation organizations bid against timber companies or developers for the right to use government-owned land.

Indirect approaches support economic activities that yield habitat protection as a by-product. Examples include:

- Payments to encourage land use activities that protect habitat and supply biodiversity as joint products. These payments can take several forms:
 - Subsidies to ecofriendly commercial ventures: Subsidies assist ecotourism, bioprospecting, and nontimber forest product entrepreneurs with facility construction, staff training, or marketing and distribution.
 - Payments for other ecosystem services: Payments for carbon sequestration, flood and erosion protection, or water purification provide incentives to maintain the habitats that both provide these services and shelter biodiversity.
- Payments to encourage economic activities that direct human resources away from activities that degrade habitats. This "conservation by distraction" approach provides assistance for activities such as intensive agriculture or off-farm employment. These activities may not be eco-friendly, but their expansion can reduce local incentives to exploit native ecosystems.

such habitats be provided with incentives to preserve them. Equitable conservation requires that we identify the people who have a rightful claim to such habitats and compensate them. People who do *not* have rightful claims must be prevented from destroying imperiled habitats.

People will generally do what is in their own interest. If they can receive more benefits from protecting an area of habitat than they could from clearing it for other uses, they will preserve it.

Box 1 identifies a number of conservation policy options. We've grouped them into *direct* and *indirect* approaches. Direct approaches are straightforward. The conservation organization pays for conservation. Payments may be in the form of outright purchases or purchases of "partial interests" such as easements or concessions, but the basic idea is to pay for actual conservation.

Indirect approaches are more complicated. Subsidies are provided to activities that are felt to be conducive to conservation. A conservation organization might, for example, assist a local entrepreneur in constructing a hotel for ecotourists, or training people to evaluate native organisms for their pharmaceutical potential. Indirect approaches raise two questions:

- If the activities local people undertake are profitable, why is assistance from conservation organizations necessary?
- If the activities are not profitable, might direct approaches be more effective in motivating conservation?

Ecofriendly enterprises have proved profitable in many parts of the world (see Box 2), so subsidies are not always required. Many millions, if not billions, of dollars have been devoted to assisting ecofriendly enterprises, however. The wisdom of these subsidies is suspect for a number of reasons.

First, such subsidies are generally an inefficient way of accomplishing a *conservation* objective. Consider two options facing an organization that wishes to preserve a certain area of land. First, it could pay for land conservation. If an ecofriendly enterprise can profitably be operated on the land, the conservation organization could sell a concession to operate the enterprise. The *net* cost of conservation under this option would be the cost of buying the land less the income received from the concession.

Under the second option, the conservation donor would subsidize the ecoentrepreneur by, for example, investing in hotel facilities to be used by tourists. The ecoentrepreneur would then acquire land for the ecotourism facility. The conservation donor may be able to motivate the protection of more land by providing a higher subsidy. The conservation organization's net cost of conservation under this option would be the value of the subsidy it offers.

The second approach is more expensive. The basic principle at work is that "you get what you pay for," and the cheapest way to get something you want is to pay for it, rather than things indirectly related to it. While it is extremely difficult to estimate reliably the earnings of ecofriendly projects, we have been able to construct a number of examples that demonstrate dramatic differences in costs under the alternative approaches. The cost

of the direct approach can be no greater than the forgone earnings that would have arisen from land conversion. If any earnings can be generated from ecofriendly activities, they can be subtracted from the cost of protection in computing the net cost of conservation. The cost of the indirect approach can, on the other hand, be several times higher than the cost of outright purchase or lease.

A number of other considerations also weigh against indirect approaches:

- There is no guarantee that subsidizing ecofriendly activities will motivate more conservation. Organizations offering such subsidies often assume that their effects will be positive, but if, for example, nicer hotel facilities induce would-be ecotourists to spend more time in their rooms than outdoors, the investments would prove counterproductive.
- Activities intended to be ecofriendly can have unintended consequences. Careless tourists may damage the sites they visit. Projects to commercialize local collection of forest products may induce overharvesting, or encourage local people to cultivate particular plants at the expense of their region's broader biodiversity.
- Integrated conservation and development projects may fail to achieve development objectives. Many developing nations would be better served by broader investments. Spending on public health or primary education is likely to pay greater dividends than training specialists in taxonomy or hotel management.

What Works in Practice?

Theory and practice can, of course, be very different things. It's one thing to advise conservation organizations to pay to preserve imperiled habitats, but it can be quite another thing for them to implement such a policy. One of the problems often observed in implementing conservation policy in developing countries is that the legal institutions for establishing and defending property rights are absent. Nevertheless, there is evidence that direct approaches are working at least as well as the alternatives:

- A recent paper in the respected journal *Science* by a group of researchers from Conservation International and the University of British Columbia demonstrates that many areas derided as "paper parks" are, in fact, effective in protecting imperiled habitat.
- Organizations in several tropical countries have initiated

Box 2. Profitable Ecofriendly Enterprises

Landowners in many parts of the world are "doing well by doing good."

- Some ranchers in Zimbabwe and other African nations earn more money managing native species than they would from cattle.
- Scores of landowners in Costa Rica choose to maintain their land as private nature reserves.
- Earth Sanctuaries Limited, a private firm operating game reserves in Australia, became the first conservation-related enterprise to be publicly traded when it was listed on the Australian Stock Exchange.

These developments are to be applauded. The question remains, though, "What should we do when local landowners do not perceive biodiversity conservation to be in their own interest?"

apparently successful programs to provide direct payments for habitat protection.

- There is no reason to suppose that indirect approaches will be any more effective than direct ones when property rights cannot be enforced. Whether it is an ecoentrepreneur or a park ranger, *someone* needs to guard against incursion.
- Payments for habitat conservation can create incentives for institutional change. When local people stand to gain from instituting clear property rights, they are likely to respond by doing so.

Conservation Finance

Just as there are a number of approaches to spending money for conservation, there are also a number of ways to raise money to spend. It is important to think clearly about each. While innovative approaches are to be applauded, one must also maintain realistic expectations because "if it sounds too good to be true, it probably is." A number of options have been suggested (see Box 3). Some financing approaches that have received considerable recent attention may be no more effective than existing options, or could even perpetuate inefficiencies.

- A debt-for-nature swap may be no more effective than simply allocating money for conservation directly. Exactly the same outcome would be achieved if the conservation organ-

Box 3. Financial Instruments for Habitat Conservation

Financial Instruments may be used to fund either direct or indirect approaches. Examples include:

- Debt-for-nature swaps—A conservation organization purchases and retires the loan of an indebted nation in exchange for the country's promise to conserve more biodiversity.
- Environmental funds—Public or private investors provide debt or equity financing for conservation projects.
- Securitization—Debt or equity issued to support conservation-related activities is bought and sold in organized financial markets.

ization paid the indebted government to preserve habitat. The government could then, if it chose, use the money to retire its debt.

- Ecofriendly enterprises might "securitize" their financial obligations by combining them in negotiable stocks or bonds. In order to do so, they must meet the standards of the organized financial exchanges on which they hope to list them.
- A number of investment companies already offer their clients socially responsible options. When conservation donors subsidize funds for eco-friendly investment, it raises the questions regarding the efficacy of indirect approaches that we addressed above.

Risky Bargains

Conservation donors are intrigued by programs that would afford them leverage: small investments with big payoffs. There is, however, an irreducible cost of conservation. If people are to preserve the habitats under their control, they must receive benefits as least as large as they would have from converting them to other uses. Some conservation donors find these costs daunting, although we have found that they are often surprisingly affordable.

The costs of conservation would only be lower if local people misunderstand the benefits conservation would afford them or cannot organize to realize them. These possibilities hold out a glimmer of hope to those who would achieve conservation on

the cheap. There might be "demonstration effects." For example, one landowner might devote holdings to tourism rather than farming after observing that another has done so successfully. Or there might be "spillovers," if, for example, one landowner's property is a more attractive tourist destination if a neighbor chooses to keep his or her land in its natural state as well.

Is wagering the success of conservation policy on demonstration effects and spillovers wise? Perhaps it is, if one truly believes that only a spectacular reduction in conservation costs will suffice to assure the meaningful preservation of biodiversity. If one is not quite so pessimistic, though, three considerations argue against seeking such risky bargains.

- The simplest explanation of a phenomenon is not always right, but it should be the first considered. The simplest explanation for why local peoples do not maintain biodiversity is that they find destructive options are more attractive.
- The track record is not good. A number of programs have failed to achieve exactly these demonstration and spillover effects.
- Conservation is often not as expensive as it seems. Over vast areas of the developing world, people can be dissuaded from converting natural habitats for a pittance.

The world's biodiversity is at risk and we ignore this fact at our own peril. Desperate times may, however, call for *thoughtful* measures. Different strategies may work in different circumstances, and there are exceptions to every rule. Mounting evidence suggests, however, that direct conservation measures are generally most effective.

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Suggested Readings

- Paul J. Ferrara, *Global Habitat Protection: Limitations Of Development Interventions And A Role For Conservation Performance Payments*. *Conservation Biology* (August, 2001). In Press.
- Paul J. Ferrara and R. David Simpson, "The Cost-Effectiveness of Conservation Payments," RFF Discussion Paper 00-31, which can be found on the RFF website, at www.rff.org/disc_papers/PDF_files/0031.pdf



Forest 'Sinks' as a Tool for Climate-Change Policymaking:

A Look at the Advantages and Challenges

by Roger A. Sedjo

Forests can trap or "sink" large amounts of atmospheric carbon, believed to be a primary cause of global warming. Scientists are now looking at this natural process as a low-cost mitigation strategy that will buy humanity a few decades to make more fundamental changes. But as a policy tool, forest sinks pose implementation challenges that will require planning and diplomacy to resolve.

The degree to which natural processes can mitigate the build-up of atmospheric carbon has generated considerable debate among the countries that have been drafting the detailed rules to implement the Kyoto Protocol, the international climate-change treaty. While the Kyoto process may now collapse following the withdrawal of support by the United States, the concept of forest "sinks" offers advantages that are likely to make it important in any successor policy to address climate change. Since President Bush has also moved away from support of caps on carbon dioxide (CO₂) emissions because of his concerns about energy supply, while acknowledging that climate change is a "real problem," this could mean that sinks are all the more important, particularly in the early phases of any long-term comprehensive carbon mitigation plan.

The fundamental science of carbon sinks is well understood—biological growth binds carbon in the cells of trees and other plants while releasing oxygen into the atmosphere, through the process of photosynthesis.

Ecosystems with greater biomass divert more CO₂ from Earth's atmosphere and sequester it; forests in particular can absorb large amounts of carbon. Under the Kyoto Protocol, a forest is a carbon sink and a new or expanded (through human effort) forest is allowed to generate credits for removing carbon from the atmosphere.

The most recent round of Kyoto Protocol negotiations, held last November in The Hague, came to a standstill in part because a compromise over carbon sinks failed. American and European negotiators could not reach agreement on the extent to which carbon captured in biological sinks, would be given credit in meeting country carbon-reduction targets as agreed to earlier at Kyoto.

At first glance, the idea of providing carbon credits for forest sinks sounds easy to implement, but a number of questions have been raised:

- Should existing forests count?
- Is there an agreed measure of absorption?
- How long will it take for a newly planted forest to start absorbing CO₂ and at what rate?

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- Should a country receive CO₂ credits if it develops forests in a country other than its own?
- What are the politics of sinks?
- What are the economics of sinks?

Some experts claim that there seem to be no precise answers to these and other questions about forest sinks. (It's important to point out that a substantial amount of carbon is sequestered in the oceans as well as modest amounts in soil.) So, in the context of strategy to control climate change, how important is the sink issue and what compromises may be necessary to prevent sinks from fouling up the grand design?

Let us address these questions one at a time.

Should existing forests count?

In general, the view is that existing forests have inadvertently served as sinks and thus should not count under the Kyoto Protocol. However, there may be some exceptions to this rule. For example, it may be sensible to provide carbon credits for protecting forests that would otherwise be converted to other uses, such as agriculture. In many cases, the value of the carbon credits would exceed the value of the land in nonforest uses. In addition, if existing forests continue to grow and sequester additional carbon, particularly as a result of forest management, then one can argue that credits should be provided for the additional carbon. This is sometimes referred to as a "baseline" problem—deciding which measures are considered over and above what would have happened anyway.

Is there an agreed measure of absorption?

Yes. The amount of carbon held in the forest depends on the amount of dry biomass there. Most developed countries have accurate forest inventories that can provide the baseline for estimating forest biomass. About 50% of the dry weight of the biomass will be carbon. Different tree and plant species have different densities, but these differences are well known, and forest biomass is easy to estimate by using sampling techniques.

How long will it take for a newly planted forest to start absorbing CO₂ and at what rate?

The rate of carbon absorption depends on the amount of dry biomass in the forest. Trees typically grow slowly at first, then at an increasing rate until growth begins to level off as they approach maturity. The growth pattern depends on species, climatic conditions, soil fertility, and other factors. In some parts

of the world, certain species grow quickly and can accumulate substantial biomass in less than a decade.

Should a country receive CO₂ credits if it develops forests in a country other than its own?

Forest growth is much more rapid in some regions than in others. Resource conservation would dictate that most of the carbon-sequestering forests should be located in regions where carbon can be absorbed efficiently. Thus, it is sensible for one country to invest in the forests of another—with permission, of course—as a way to earn carbon credits. Additionally, such an approach may transfer large amounts of capital from developed countries to developing countries, thus promoting their economic development.

What are the politics of sinks?

Forest sinks appear to offer the potential of low-cost carbon absorption. However, not all countries are equally blessed with these resources. Much of Europe consists of even-aged growth in what are called "regulated" forests. The expected potential for additional forest growth there to absorb carbon is limited. In fact, many observers argue that European forests are likely to experience some decline over the early decades of the twenty-first century. Thus, it is not surprising that European countries would resist the inclusion of forest sinks for carbon monitoring under the Kyoto Protocol.

By contrast, many countries outside of Europe, including the United States, expect their stock of managed forests to increase during the first decades of the twenty-first century. The United States, Australia, Canada, and Japan are keen to use forest sinks to meet any climate treaty obligations. Many environmental groups appear to believe that meeting carbon targets should be painful and thus view forest sinks as insufficiently austere. However, other environmental groups view carbon credits from forests as offering the potential to help protect tropical forests from destruction and from forestland conversion to agricultural and other uses.

What are the economics of forest sinks?

Most studies indicate that the costs associated with sinks appear to be modest compared with the costs of making the necessary changes in the energy sector. Forest sinks often have other associated benefits, such as erosion reduction, watershed protection, and biodiversity protection of existing native forests.

RESOURCES FOR THE FUTURE

However, their potential to offset carbon emissions is limited. At best, the potential of forests and other terrestrial systems that act as carbon sinks to offset emissions is probably not more than one-third of current net emissions.

Additionally, as the volume of forest sinks increases across the globe, their costs will rise and their additional potential will decline. Thus, perhaps the best way to view sinks is as a temporary low-cost mitigation strategy that can buy humanity three to five decades to make more fundamental adjustments.

Looking Ahead

Carbon sinks appear to offer substantial potential to assist humankind in addressing the challenge posed by climate change but they are more than just forest ecosystems. Grasslands, wetlands, and agriculture all offer the potential to absorb carbon. Although grasslands do not build up a large above-ground mass like forests do, they are effective in the sequestration of carbon into the soil. Wetlands, too, hold large amounts of carbon in storage. Agricultural lands can contribute to carbon absorption if proper management is followed. No-tillage agriculture offers the potential to restore large volumes of carbon to agricultural soils and contribute to the absorption of carbon from the atmosphere.

Forests appear to offer the greatest potential because they can absorb large volumes of carbon both above and below the ground. Furthermore, the measurement and monitoring of aboveground forest carbon is reasonably simple. The condition of the forest can readily be ascertained visually and with standard forest inventorying procedures, which have been used for decades—indeed, centuries. Carbon can be estimated from the standard forest inventories with only modest additional data requirements. Furthermore, if payments are made for carbon absorbed in the forest biomass, they typically do not reflect the true values because the forest soils also sequester carbon.

As a policy tool, forest sinks pose some distinct challenges. Suppose that a huge reforestation effort is driven by the desire to absorb carbon and that many of these trees would also be suitable as timber. Timber producers, which annually plant an estimated several million hectares of trees for industrial wood purposes, are going to reconsider their tree-growing investments. After all, with all of these new forests being created, the outlook for future timber prices must appear to be bleak. Thus, many timber producers may decide to reduce their own investments in timber growing. The net effect will be to offset some

of the increased planting for carbon purposes with the reduction in industrial forest-growing investments. This reduction—that is, the impacts that are precipitated by carbon-absorbing forest projects but are external to those projects—is called *leakage*.

A second form of leakage is associated with protecting threatened forests, as often is proposed for the tropics. Suppose that a particularly valuable forest is threatened with conversion to agriculture. Intervention may be able to save this forest and thus claim credits for the carbon that is prevented from being emitted. However, such an action might simply deflect the deforestation pressure from one forest to another, with no net reduction in carbon emissions.

It should be noted that leakage is not unique to forest sinks. Potential leakage is pervasive throughout many of the proposed climate remedies. Consider the proposal to tax carbon emissions from fossil fuels in developed countries as a way to provide financial incentives to assist developed countries in meeting their emissions reduction targets. Such a policy would increase energy prices in the developed world and energy-intensive industries would have incentives to move to the developing world, where no emissions targets or carbon taxes exist, and hence energy is cheaper. The net effect could be the transfer of emissions from developed countries to developing countries without a significant reduction in global emissions. This leakage in the energy sector could be substantial and could have significant implications for the world economy.

Can such an outcome be avoided for both carbon sinks and energy? Yes, but it would require implementing similar rules across countries so that leakage is not created through circumvention outside a project or outside a particular country. One step would be to allow sink credits only on a country's net carbon sink increases, and debits for net sink reduction.

Overall, forest sinks have the potential to play a valuable role in carbon sequestration. Although sinks are only a partial solution to anticipated global warming, they do appear to have the potential to sequester 10 to 20% of the anticipated build-up of atmospheric carbon over the next 50 years. Furthermore, sinks can accomplish the task at relatively low costs compared to many other approaches.

Roger A. Sedjo is a senior fellow in RFF's Energy and Natural Resources Division, director of RFF's Forest Economics and Policy Program.

Putting People in the Picture

Roger Sedjo, a senior fellow in the Energy and Natural Resources Division, is the director of RFF's Forest Economics and Policy Program, which, in addition to doing research, brings visiting researchers and consultants to RFF. The program's principal goal is to support and disseminate public policy research in forestry and related areas.

Sedjo's research interests include forests and global environmental problems, climate change and biodiversity, public lands issues, long-term sustainability of forests, industrial forestry and timber supply and demand, global forest trade, forest biotechnology, and land use change.

"Forests have always been viewed as a source of fiber and other local outputs, such as watersheds and recreational opportunities," Sedjo said. "It is now clear, however, that forests also play an important role in both stabilizing global climate and sustaining global biodiversity, which needs to be better understood."

Sedjo currently serves as the co-convenor of a team of scientists, including economists, from around the world who are writing a chapter on forest sinks for the International Panel on Climate Change's (IPCC) Third Assessment Report, which will be issued early this fall. The IPCC was established by the United Nations in response to the rise in the global average temperature in recent decades.

The Third Assessment Report—which will consist of three sections, on the state of the science, adaptation options, and mitigation possibilities, each prepared by a separate Working Group—is being prepared by several writing teams. Representatives of Working Group III, which is compiling a broad review and update of the current states of science regarding climate

mitigation possibilities and options, recently met in Accra, Ghana, with delegates of 85 countries to finalize the document summary. This document will be used to inform the discussion and negotiations regarding appropriate actions and responses by government and others.

Sedjo was recently a member of the Committee of Scientists, which was created by the Secretary of Agriculture to make recommendations about the planning of the National Forest System, which is managed by the Forest Service. Their report was submitted to the Secretary in 1999.

Sedjo has also been a consultant to the World Bank, the Asian Development Bank, the U.S. Agency for International Development, and other international organizations in more than a dozen countries, including Argentina, Indonesia, New Zealand, Russia, and Thailand. He also serves as the president of the Environmental Literacy Council.

Sedjo has written or edited 13 books related to forestry and natural resources, in addition to scores of journal articles. His most recent publication, *A Vision for the U.S. Forest Service: Goals for Its Next Century*, was published last fall by RFF Press.

With contributions from scholars, policymakers, and forestry officials, this volume provides broad reflections on the agency's past and future, contemporary perspectives about the use and stewardship of public lands, and analyses of the science involved in the practice of "scientific management." As the lead editor, he recently received the Best Book Award for 2000 from the Section for Environmental and Natural Resources Administration of the American Society of Public Administration.



Roger Sedjo, RFF (left), and Robert Watson, IPCC Chairman, at the Third Assessment Report meeting in Accra, Ghana, March 2001.



In Appreciation – Allen V. Kneese

Allen Victor Kneese, 70, a pioneer in environmental economics, died of cancer in mid-March. A senior fellow at RFF, Kneese played a crucial role in developing the economic principles that have become increasingly influential in environmental policy worldwide over the past 40 years.

When he came to RFF in 1961, economists were beginning to conclude that shortages of natural resources would not stop economic growth—and the greater threat was the rising pollution that growth was creating.

People had started “to raise the idea that you have all these waste materials coming along and maybe that’s where the more important problems lie—in those quality problems rather than the quantity problems,” Kneese said in a 1999 interview.

“Allen was the first to integrate in a truly meaningful way in environmental analysis the physical, natural, and social sciences, anticipating by at least 25 years the development of ecological economics,” said Paul Portney, RFF president.

“He was the first to recognize and then model empirically the interrelatedness of air, water, and other forms of pollution. And he was the person who, in the early years of environmental economics, virtually single-handedly kept alive the idea of using economic incentives to encourage environmental improvements—a true giant upon whose shoulders we all stand.”

In 1990, Kneese and John V. Krutilla jointly won the first Volvo Environment Prize. The citation said that they “founded resource and environmental economics as a research discipline” and that they “lead the field in combining the sciences of economics and ecology.”

In a series of books and articles Kneese laid out several crucial ideas.

He showed that economic incentives in the form of pollution fees were more effective than conventional regulation, under which a public agency tries to find each source of pollution and then tells the polluter which technology to use to get down to the allowed standard. He demonstrated that it was possible to calculate the fees, or “green taxes,” that would push pollution down to the standard while leaving it up



to each polluter to find the cheapest and easiest way to do it.

This idea, which ran counter to the American tradition of regulation, encountered stiff resistance for many years. But it won a victory when it was embodied in the 1990 amendments to the Clean Air Act, setting up a system of permit trading for sulfur dioxide, which causes acid rain. Over the past decade, permit trading has reduced the costs of sulfur dioxide compliance far below earlier forecasts.

Kneese made crucial contributions to the methods for designing least-cost paths to reaching water and air quality standards. In an influential study of the lower Delaware River, he and his colleagues put the theory to work and showed that they

could calculate the effluent charges required to reach the water standard at the least cost to the economy. That meant shifting the focus of pollution policy away from policing separate sources to developing systems that could bring maximum social and economic benefits to the whole river basin.

Some of these ideas were picked up more quickly in Europe than in this country. Kneese did a case study of the heavily polluted Ruhr River, which became one of Germany’s earliest and most dramatic examples of environmental cleanup.

“Our research showed that in many instances it was possible to manage water quality—and air quality too—through measures that did not require treatment at the source,” he said in the 1999 interview. “For example, you would have the possibility of several industries and municipalities being put together in such a way that the waste materials cancel each other or were recoverable, or whatever, rather than just trying to treat it and throw it away.”

Unbalanced policy, Kneese pointed out, often meant merely substituting one kind of pollution for another. Tight rules on water pollution alone, to prevent the dumping of waste into streams, could result in the waste being burned instead, increasing air pollution, or thrown into landfills. In his emphasis on treating a river basin as a whole, he developed techniques for dealing with water, air, and land pollution comprehensively.

His Many Contributions

In the 1999 interview, Kneese was asked about his vision for RFF as it approaches its fiftieth anniversary, which will take place



in 2002. He said that he would like to see RFF programs developed that will yield insights into how to benefit humanity. "So much of our work has been on efficiency questions in the past and yet so much of humanity is poor and miserable," he said. This inequity is hidden in many cases, because the general international statistics look pretty good, he said. "But there are large parts of humanity that benefit hardly at all from the developments that take place in the developed world."

The United States is not without severe distributional problems, Kneese said. The U.S. economy has become so highly technical in nature "that it offers almost unlimited opportunity for those who are motivated, educated, and can go and make a fine life. But it offers less and less opportunity for the ones that aren't so motivated

or have not had so many advantages at home where educational opportunities are limited."

Along with his long-standing commitment to RFF, Kneese also served as the first president of the Association of Environmental and Resource Economists, and was founding editor, with Ralph d'Arge, of the *Journal of Environmental Economics and Management*. With Walter Langbein, he was also the founding editor of the quarterly journal *Water Resources Research*.

In 1962, the year after he joined RFF, he published *Water Pollution: Economic Aspects and Resource Needs*. It was followed by, among other books, *Quality of the Environment*, written with Orris C. Herfindahl in 1965; *Managing Water Quality: Economics, Technology, Institutions*, written with Blair T. Bower in 1968; and *Pollution, Prices, and*

Public Policy, written with Charles C. Schultze in 1975.

Kneese was born on a ranch in Fredericksburg, Texas, a town settled by German liberals fleeing European repression, and he spoke German at home. He went to Southwest Texas State College with no idea what he was going to do, he later recalled, but with a strong interest in nature. A professor who became a mentor turned him toward economics, he said.

He earned a master's degree from the University of Colorado, and a Ph.D. in 1956 from Indiana University. He taught for two years at the University of New Mexico and was a researcher on the staff of the Federal Reserve Bank of Kansas City for three years before joining RFF.

Allen Kneese—An Extraordinary Scholar, A Generous Mentor, A Valued Friend

RFF recently held a memorial service to honor Allen Kneese, one of the founders of the field of environmental economics and a long-time member of the research staff. Colleagues from a career that spanned several decades came to honor his professional acknowledgements and his generous spirit.

V. Kerry Smith, a former member of the RFF research staff and a professor of economics at North Carolina State University, said that one of Kneese's important contributions was to locate production in a context, to give it a physical place. In neoclassical economics, no one actually describes how production works or how markets occur, Smith said. "But for Allen, the most important part of production was what the conventional models left out—

energy and materials. In the real world, you can't ignore the physical realities of the production process."

Emery Castle, former RFF president and a member of the University Graduate Faculty of Economics at Oregon State University, sent a letter that was read at the service. In it, he said, "Allen collaborated with physicists, lawyers, philosophers, engineers, and sociologists. By doing so, he was able to enrich environmental economics beyond what it would have otherwise been."

"Allen was a kind person and petty matters did not distract him," Castle said. "He behaved as though he knew he would be better off if all those around him were as good as they could be and he helped

them become so. In the jargon of economics, he acted as though expansion effects outweighed substitution effects in his professional work. It was a joy to be his colleague."

Wallace Oates, an RFF visiting scholar and professor of economics at the University of Maryland—College Park, recalled his first meeting with Kneese at an RFF seminar in the late 1960s. The infectious character of Kneese's intellectual insights and his enthusiasm "taught me that economists have something important to say about the design and implementation of environmental policy," Oates said. "It was a career-altering moment that started my work in environmental economics."



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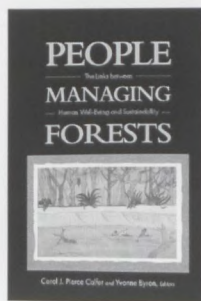
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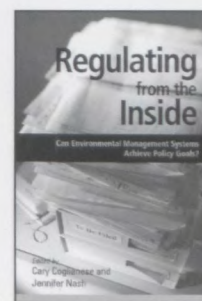
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