

RESOURCES

An aerial photograph of a rural landscape. In the foreground, a large black lattice tower for a power line stands on a dark, shadowed area. Several power lines stretch across the green fields. In the middle ground, there is a cluster of small blue houses, a red barn, a white truck, and a silver tanker truck. In the background, a city skyline is visible under a blue sky with light clouds.

**Regulating the Power Market
Across America**

CONTRIBUTORS

RFF Senior Fellow **Timothy J. Brennan** is a professor of public policy and economics at the University of Maryland, Baltimore County. His work focuses on public policies regarding monopolies and market power.

RFF Fellow **Carolyn Fischer** studies policy mechanisms and modeling tools that cut across environmental issues, including natural resources management. Wildlife conservation and trade in endangered species are two areas of special interest.

RFF Senior Fellow **Ramanan Laxminarayan's** work deals with the integration of epidemiological models of infectious disease transmission and economic analysis of public health problems. He has evaluated malaria treatment policies in Africa for the World Health Organization.

Michael J. Bean is an attorney and chair of the wildlife program at Environmental Defense and a member of the RFF Board of Directors. He has become a leader in designing economic incentive programs to complement regulatory tools for wildlife conservation.

Jan K. Brueckner is a professor of economics and a member of the Institute of Transportation Studies and the Institute for Mathematical Behavioral Sciences at the University of California, Irvine. He concentrates his research on urban and public economics, industrial organization, and housing finance.

Jeffrey Chow is a former research associate at RFF. He is currently pursuing a doctoral degree in natural resource economics the Yale University School of Forestry and Environmental Studies.

Kurt Van Dender is an associate professor of economics at the University of California, Irvine. His research focuses on transportation economics, urban economics, and public finance.

Eili Klein is an RFF senior research assistant and a visiting associate professional specialist in the ecology and evolutionary biology department at Princeton University. He works on preventative polices for, and the ecology and epidemiology of, resistance to antimicrobial drugs.

Paula Tarnapol Whitacre is a freelance writer based in the Washington, DC area. She works on health, environmental, education, and business issues.

RESOURCE LINKS

Selecting a scholar's name above will open a new window in your web browser, displaying their detailed profile and credentials from the RFF website. To learn more about the feature stories in this issue, please enter these links listed below in you web browser or, if reading from our PDF edition, simply select an active link and a new window will open.

▶ This triangular symbol seen throughout *Resources* indicates an active link.

Electricity Markets and Energy Security: Friends or Foes?

▶ www.rff.org/electricitysecurity

Endangered Species: Progress and Pitfalls During Three Decades of Controversy

▶ www.rff.org/endangeredspecies

A Recipe to Fight Vitamin A Deficiency in India: Add Mustard and Stir?

▶ www.rff.org/vitaminAdeficiency

RESOURCES

FALL/WINTER 2008 • ISSUE NUMBER 167



RESOURCES FOR THE FUTURE

1616 P Street, NW
Washington, DC 20036-1400
202-328-5000
www.rff.org

Resources is available to individuals and institutions at no cost. To subscribe, contact Scott Hase at RFF (hase@rff.org) or 202-328-5006. The publication is also available on the RFF website ▶ www.rff.org.

OFFICERS

President, Philip R. Sharp
Vice President—Finance & Administration, Edward F. Hand

BOARD OF DIRECTORS

Lawrence H. Linden, Chair
Frank E. Loy, Vice-Chair
Vicky A. Bailey, Michael J. Bean, Preston Chiaro, Norman L. Christensen, Jr., Maureen L. Cropper, W. Bowman Cutter, E. Linn Draper, Jr., Mohamed T. El-Ashry, Daniel C. Esty, Linda J. Fisher, Dod A. Fraser, Kathryn S. Fuller, David G. Hawkins, R. Glenn Hubbard, Charles F. Kalmbach, Michael A. Mantell, Steven W. Percy, Peter J. Robertson, Matthew R. Simmons, Robert N. Stavins, Joseph E. Stiglitz

RESOURCES

Stanley N. Wellborn, Director of Communications
Felicia Day, Managing Editor
Adrienne Foerster, Assistant Editor
Marc Alain Meadows, Art Director

Published quarterly since 1959, *Resources* (ISSN 0048-7376) contains news of research and policy analysis regarding environmental, energy, and natural resources issues. The views offered are those of the contributors and should not be attributed to *Resources for the Future*, its directors, or its officers.

© 2008 Resources for the Future. All rights reserved. No part of this publication may be reproduced by any means, either electronic or mechanical, without permission from the publisher. Contact Felicia Day at RFF (email: day@rff.org).

Cover illustration by Randy Lyhus
Design and production: Meadows Design Office, Inc.

♻️ Printed with soy-based inks on 50% recycled (and recyclable) paper containing 15% post-consumer fiber, processed chlorine free, in an FSC-certified plant.

CONTENTS



DEPARTMENTS

Goings On

RFF Releases Major Climate Policy Report 2

Auction Design for Selling CO₂ Emissions Allowances Put to Inaugural Test 3

At the Intersection of Climate and Deforestation: Can We Solve Two Problems at Once? 4

What Works when It Comes to Planning for Smart Growth? 5

2007 Nobel Peace Prize Recognizes Climate Change Research and Leadership 5

RFF Weekly Policy Commentary Series: What Do the Damages Caused by U.S. Air Pollution Cost? 10

Jan K. Brueckner and Kurt Van Dender

Inside RFF

RFF Establishes a Major Research Initiative on Adaptation to Climate Change 32

RFF Scholar Ian Parry First to Fill Kneese Chair 33

FEATURES

Electricity Markets and Energy Security: Friends or Foes? 6

Timothy J. Brennan

Resources for the Future: 2007 Annual Report 11

Endangered Species: Progress and Pitfalls During Three Decades of Controversy 23

A Conversation with Michael Bean and Carolyn Fischer

A Recipe to Fight Vitamin A Deficiency in India: Add Mustard and Stir? 28

Ramanan Laxminarayan, Jeffrey Chow, Eili Klein, and Paula Tarnapol Whitacre

The RFF Weekly Policy Commentary series, a new feature on our website, provides an accessible way for students, academics, journalists, policymakers, and the general public to learn about important environmental, natural resource, energy, urban, and public health problems. Each week, a leading expert summarizes the current state of analysis or evidence about a particular policy topic, along with recommendations for further reading. These commentaries can be found at ► www.rff.org/weeklycommentary.

RFF Releases Major Climate Policy Report

RFF recently released a major new report, *Assessing U.S. Climate Policy Options: A report summarizing work at RFF as part of the inter-industry U.S. Climate Policy Forum*, informed by a year-long dialogue between RFF researchers and business leaders from 23 companies that represent a broad spectrum of the U.S. economy.

The purpose of the report is to provide decisionmakers and stakeholders with concise and objective information describing and evaluating issues—and options for addressing those issues—related to the design of domestic greenhouse gas (GHG) mitigation policy. Already, the findings helped inform the recent Energy Bill and were presented in Bali, at the Conference of the Parties in December.

RFF Senior Fellows Raymond J. Kopp and William A. Pizer organized the U.S. Climate Policy Forum in May 2006 to analyze and make findings regarding policies to address global climate change. Written entirely by RFF scholars, the report encompasses 15 issue briefs, detailing policy questions and concerns in key areas

related to GHG emissions and legislative proposals to curb them. The structure of the report, which was established before any writing began, was based on needs and priorities identified in consultation with Senate and House members and staff, former staff from relevant executive-branch agencies, NGOs, and corporations.

"The Climate Policy Forum process marks a departure from how research projects are typically carried out at RFF," said Pizer. "We first consulted the end users about what material and format would be most useful. We then spent over a year talking to the folks directly affected by proposed regulations to understand the questions they face. We purposefully sought out companies from a range of industries, from financial services to power generation to automobile manufacturing. We were interested in the breadth of their issues, while the companies in turn were interested in hearing from both their competition as well as their downstream customers and upstream suppliers."

At the report launch, Kopp outlined the five key take-away points in the report:

"First, domestic policy design must balance competing interests of the environment and economy, as well as the desire for clear versus adaptable goals. That is, it must incorporate a reasonably clear long-term vision to aid investment planning, while at the same time being flexible and adaptable as new information becomes available over the next several decades.

Second, carbon pricing is a necessary foundational element of mitigation policy. Whether established through a cap-and-trade program or a carbon tax, carbon pricing is robust over time, adjustable in response to new information, and can provide a smooth adjustment path for the economy.

Third, while carbon pricing makes a reasonable cornerstone for mitigation policy, a properly designed policy that accelerates low-carbon technology R&D can lower mitigation costs. However, technology policies as a substitute for carbon pricing can, in fact, raise mitigation costs.

Fourth, there is no free lunch—GHG mitigation will entail costs. These costs will be higher in some regions of the country, in some industries, and over some periods of time, compared to others.

And finally, it makes little sense to continue to think about the formulation of energy policy and climate policy as separate activities. Energy policy can work to support, as well as inhibit, climate policy."

While these points represent overarching themes in the report, the real contribution of the report is the issue briefs, said Pizer. "The true test of whether this exercise was successful will be whether Congressional staff and other stakeholders go back to these briefs as a reference in the months and years to come. When suddenly someone needs to know what to do about agriculture in the context of climate policy—we hope they'll turn to issue brief #13 in the report—and the same thing for the other 14 briefs." ■

See ► www.rff.org/cpf.

We purposefully sought out companies from a range of industries, from financial services to power generation to automobile manufacturing. We were interested in the breadth of their issues, while the companies in turn were interested in hearing from both their competition as well as their downstream customers and upstream suppliers.

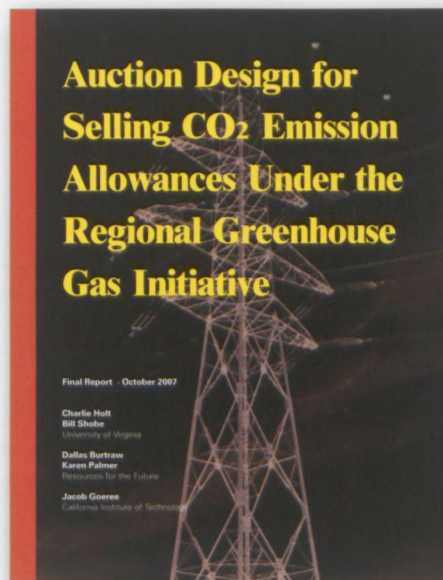
Auction Design for Selling CO₂ Emissions Allowances Put to Inaugural Test

Dallas Burtraw and Karen Palmer

This June, at least five of the 10 northeastern states that comprise the Regional Greenhouse Gas Initiative (RGGI) will carry out the first auction prior to the launch of the cap and-trade program for carbon dioxide (CO₂) emissions in 2009. This program, the first in the United States, covers CO₂ emissions from electricity generators within the region and is the result of a multi-year cooperative effort among states from Maryland to Maine. CO₂ emissions will be capped at levels comparable to those at the beginning of this decade and then reduced to 10 percent below the initial cap levels by 2019. Such architecture could serve as a model for a national program to limit CO₂ emissions and other greenhouse gases (GHGs).

The June auction will be path breaking for at least two reasons. One is that it will implement the use of an auction for the first time at an important level within a cap-and-trade program. Previously auctions have been used to distribute only a small portion of the emissions caps. Second, the auction will be the first strong signal giving an indication of what a ton of CO₂ emissions will be worth in the RGGI market.

Many aspects of the final auction design remain to be worked out, but it is expected to draw on work at RFF. Our recent report, *Auction Design for Selling CO₂ Emission Allowances Under the Regional Greenhouse Gas Initiative*, written in collaboration with Charles Holt and William Shobe of the University of Virginia and Jacob Goeree of the California Institute of Technology, was designed to assist with auction design for the initial sale of allowances in RGGI that will meet the program's goals and criteria.



The RGGI proposal represents a substantial break with the past. Rather than give emissions allowances away for free, the RGGI states agreed to allocate at least 25 percent of the allowances to benefit consumers and to support strategic energy investments. Auctioning allowances is the most straightforward way to implement this policy. More recently, several RGGI states have decided to auction 100 percent of their annual CO₂ allowance budgets. As the first GHG cap-and-trade program to start with a substantial auction of allowances, this major regional initiative will have a global impact.

Although auctions are widely used and generally simple to implement, it is important that they be robust and not susceptible to manipulation. We developed an auction design that meets several key criteria, including attaining economic efficiency, so that the auction delivers allowances to those who value them

most; deterring collusive behavior by bidders, and providing good signals about market prices. Auctions also should have low administrative costs, be perceived as fair, be transparent and simple, and help minimize price volatility. In addition, auctions should successfully raise revenue from the sale of a valuable public asset and be compatible with existing electricity and energy markets.

The report findings were developed using experimental economic methods, insights taken from the economics literature, and results from past experience with various types of auctions, including prior allowance auctions. We also examined the effect of reserve prices and allowance banking, analyzed how auctions combine with secondary markets, and studied the effects of allowing participation by brokers or other traders not needing allowances for compliance.

Several recommendations on auction design follow from our research and are detailed in the report. Issues including the auction format, clearing price, reserve prices, transparency, what to do with unsold allowances, and market monitoring efforts are addressed, and the analysis is applicable to a large, region-wide auction that involves the participation of all RGGI states. Part of our report looks at potential opportunities for the auction design to address or mitigate concerns that would exist even in the absence of an auction. Where possible, we also comment on adjusting the program design to address these larger market issues.

The report was funded by the New York State Energy Research Development Authority (NYSERDA) on behalf of RGGI. The statements and recommendations in the report are solely the responsibility of the authors and do not necessarily represent the views of NYSERDA or the RGGI Staff Working Group or others associated with RGGI. ■

► The full report can be downloaded at www.rff.org/rggi.

At the Intersection of Climate and Deforestation: Can We Solve Two Problems at Once?

New scientific evidence is emerging, on an almost daily basis, about the destructive effects of global warming on ecosystems around the world. While tropical deforestation has been a longstanding environmental concern, it is becoming increasingly clear that the effects of heavy logging, development pressures, and agriculture go well beyond habitat loss, for forests "sequester" carbon, removing it from the atmosphere. (See the box for detailed explanation.)

The nexus of these two crises was the subject of a recent seminar at RFF, which drew together representatives from the conservation community, federal agencies, and rainforest nations. For developing countries, building their economies in order to bring about higher living standards has often come at the expense of protecting the environment.

Finding positive incentives to slow the rate of deforestation around the globe emerged as a shared concern among the panelists. As

countries develop, they almost all deforest, and as they gain wealth, they tend to stabilize their forest cover and see that forests have value, said Kevin M. Conrad, special envoy and ambassador for environment and climate change, Papua New Guinea. The primary challenge now is helping countries bypass the deforestation phase, he said.

Bringing about real change will require focusing on the economics of the situation, according to Larry Linden, RFF's board chair and an advisory director and former general partner at Goldman Sachs. When the only way to make money requires cutting down trees, he said, "It's time to align private incentives with social costs and benefits, to find a way to add market value to standing trees."

The first place this is starting to happen is in the voluntary market for carbon credits, Linden said, but there are fundamental problems. The market is "disorganized" at best, with no standards for what you're buying, much less for what you're getting. "This approach will never grow and prosper without sufficient incentives that introduce compliance measures and encourage legal and economic rigor," he said. "There is a clear need for policy measures to make this happen."

Regulatory Impediments

Protecting carbon sequestration in tropical forests could be a crucial bridge to a low-carbon future, but until developing countries are able to be fully "compensated" for their reduc-

tions, progress will be halting, said Annie Peterson, international counsel, Environmental Defense. Again, the issue is a matter of accountability, she said. Under Kyoto, industrialized nations can measure their progress in curbing CO₂ emissions at the national level, while developing countries must tally theirs on a project-by-project basis. And getting an accurate estimate can be challenging: it's hard to measure emissions, determine a realistic baseline, and fairly calculate real results.

Rainforest nations like Papua New Guinea are told that this problem is too hard and can't be fixed, said Conrad. "But we can't afford to move on—we live with this conundrum every day. When deforestation occurs, topsoil flows into our rivers, people get sick, show up in our hospitals, and we can't afford to treat them."

Looking to the future, Ray Kopp, an RFF senior fellow and director of the Climate Technology and Policy Program, outlined the core questions that would have to be addressed about a new policy approach that incorporated credits from reducing emissions, deforestation, and ecosystem destruction.

- At the in-country level, which policies would work best on the ground? Are policies scalable and do they account for the very real differences between countries as diverse as Papua New Guinea, Brazil, and Indonesia?
- What do we know about the supply curve for forest carbon credits? How would these credits affect the global carbon market, as well as the U.S. domestic market?
- What would these mechanisms look like? Are there aspects of credit design that will be attractive to private investors?

Current RFF activities are centered on modeling how U.S. carbon markets will work and designing offsets that can be integrated into the UN Framework Convention on Climate Change and the EU Emissions Trading System. ■

The presentations from this seminar and additional background materials are available at:
▶ www.rff.org/rff/Events/IntersectionClimateDeforestation.cfm.

HOW CARBON SINKS WORK

Global carbon is held in a variety of different "stocks," including oceans, fossil-fuel deposits, the terrestrial system, and the atmosphere. In the terrestrial system, carbon is sequestered in rocks and sediments; in swamps, wetlands, and forests; and in the soils of forests, grasslands, and farmland. About two-thirds of the globe's terrestrial carbon, exclusive of that sequestered in rocks and sediments, is sequestered in the standing forests, forest understory plants, leaf and forest debris, and forest soils.

A stock that is taking up carbon is called a "sink" and one that is releasing carbon is called a "source." Over time, carbon may be transferred from one stock to another. Fossil-fuel burning, for example, shifts carbon from fossil-fuel deposits to the atmospheric stock. Biological growth involves the shifting of carbon from one stock to another; for example, plants fix atmospheric carbon in cell tissues as they grow, thereby transforming carbon from the atmosphere to the biotic system.

What Works when It Comes to Planning for Smart Growth?

In 1997, Maryland caught the attention of urban planners and city officials across the country with the passage of its Smart Growth and Neighborhood Conservation initiative. As this incentive-based approach to managing growth reaches its 10th anniversary, Maryland and states across the country continue to wrestle with the challenges of community development and land conservation.

To examine the program's impact and effectiveness, land-use researchers joined state legislators, local government officials, home builders, environmentalists, and academicians in early October for a three-day conference entitled "Smart Growth @ 10: A Critical Examination of Maryland's Landmark Land Use Program." It was organized by the University of Maryland's National Center for Smart Growth Research and Education and RFF.

"The trade-offs we face in urban planning, the competition between open space and sprawl, the tensions between population density and traffic congestion—all these issues have only intensified over the past 10 years, in Maryland and many other parts of the country," said Margaret Walls, RFF senior fellow and co-organizer of the conference.

Although Maryland's Smart Growth legislation is often held up as a model for other states, most conference participants conceded that

the initiative has not been as successful in controlling urban sprawl as they had hoped.

"As we face a booming population, rising sea levels, a warming planet, escalating gas prices, and a troubled housing market, the need for aggressive action is urgent," said former Maryland governor and Smart Growth visionary Parris Glendening in his keynote speech.

The cornerstone of the Maryland program is the concept of "priority funding areas" (PFAs), or town centers and urbanized regions of the state that receive priority for state infrastructure dollars. Because it eschews the "stick" approach of urban growth boundaries in favor of offering the "carrot" of state funding,



Maryland's program has always been seen as more incentive-based than regulatory.

Several papers presented at the conference, however, suggest that PFAs may be failing as means for containing new development and need to be revised and strengthened. For example, the amount of money earmarked as incentives under the Smart Growth law represents only about five percent of the overall state budget, according to Gerrit-Jan Knaap, director, National Center for Smart Growth, Jungyul Sohn of Seoul National University, and Rebecca Lewis, a University of Maryland graduate research assistant.

Most participants agreed that increasing density in PFAs is essential to achieving Smart Growth goals. Reaching this outcome may be easier said than done, however. Elizabeth Koptis, EPA; Virginia McConnell, RFF and the University of Maryland, Baltimore County; and Daniel Miles, University of Maryland, Baltimore County; looked at the density of development across different regions of eight Maryland counties, along with the density limits allowed in those regions. They found that the density limits established in zoning laws have typically

only constrained development in the more rural, large-lot zoning areas.

Despite Smart Growth's shortcomings, the opportunity now exists to embrace fundamental changes, according to workshop participants. Decisionmakers must confront the current challenges in order to drive change and support Smart Growth as an important mechanism for influencing development patterns in Maryland and nationwide. ■

► To learn more, visit www.rff.org/rff/Events/SmartGrowthat10.cfm.

► 2007 Nobel Peace Prize Recognizes Climate Change Research and Leadership

In October 2007, the Nobel Peace Prize was awarded jointly to the Intergovernmental Panel on Climate Change (► IPCC) and former Vice President Al Gore for their efforts, according to the citation, "to build up and disseminate greater knowledge about manmade climate change, and lay the foundations for measures that are needed to counteract such change."

The award to the IPCC gives new recognition to a scientific process that RFF researchers have contributed to for many years. The IPCC is a structure of working groups involving hundreds of experts who periodically report on the status of knowledge in the many fields that describe the science of climate change, its impacts, and possible responses to it.

Successive IPCC assessments have marked the growth of the scientific consensus that the planet's climate is warming, and that the principal cause is the rising prevalence of gases generated by human activity, primarily carbon dioxide created by burning fossil fuels.

Among the RFF researchers who have participated in drafting IPCC reports in the nearly two decades since it was founded are Senior Fellows Alan Krupnick, Roger Sedjo, William Pizer, and Richard Morgenstern.

Electricity Markets and Energy Security: Friends or Foes?

Timothy J. Brennan

U.S. energy policy has taken center stage, driven by the growing threat of climate change and rising oil prices. Less prominent perhaps, but also important is the security of our electricity generation capacity. As consumers, we are regularly reminded to conserve energy by turning the thermostat down and buying compact fluorescent light bulbs, but such admonitions sidestep a larger issue.

Since the mid-1990s, the federal government and many of the states have attempted to transform a vertically integrated, top-to-bottom regulated electricity sector into one in which competition among independent energy suppliers determines the prices charged to local utilities and, eventually, commercial, industrial, and residential users.

The path has not been smooth. Its most prominent sinkhole was the implosion of the California electricity market from the fall of 2000 through the spring of 2001. In addition, much of the Northeast suffered a massive blackout in August 2003. At the residential level, customers have generally not taken advantage of opportunities to choose among residential suppliers. More recently, price controls imposed as part of the political bargain for opening markets have expired, and some customers now face rate increases of 50 percent or more.

These developments give rise to the question: to what extent is overall energy security affected by competition in the electricity sector? Letting the markets set prices should improve security, but competition has proven difficult to institute and may exacerbate some concerns, particularly reliability of supply. Opening electricity markets is easier said than done, but here we explore reasons for why this is so.

Different Meanings to Different People. Even when restricted to electricity, the term “energy security” can take on a number of different dimensions.

THE SHORT TERM

From a short-run perspective—taking as given the productive capacity in place—energy security in electricity has two manifestations. One has to do with sheer availability: Will outages be short, rare, and localized, or long, frequent, and widespread? The other has to do with peaks in the price of electricity, assuming that it is available. Blackouts are harmful, but so are high energy prices, particularly for those with low incomes for whom utility bills constitute a significant fraction of their monthly spending.

Importantly, and unfortunately, mitigating one of these security interests can exacerbate the other. The cost of preventing blackouts is quite high. Because electricity cannot be stored, it must be produced when it is demanded. And energy demand is far from constant; it can hit very high peaks for short

periods of time. The generation capacity needed to meet that demand, then, is in service for only a small fraction of time, perhaps $\frac{1}{200}$ of a year (a year = 8,760 hours), and maybe less. Recovering the costs of that capacity in such a short time makes that generation very expensive. If prices reflect costs—usually one of the benefits of adopting markets—making the system more reliable will increase insecurity arising from price fluctuations.

THE LONG TERM

In markets with growing demand, the viability of the electricity system depends on expansion of capacity to generate, transmit, and distribute electricity. Numerous political and policy factors come into play. Construction of power plants and transmission lines is often hampered by the NIMBY (“not in my back yard”) effect, in that everyone wants electricity generated as long as they do not see it. Some recent controversies include the Cape Wind installation off Cape Cod in Massachusetts and proposals to build new transmission lines through wealthy “horse country” in northern Virginia.

A related problem affecting transmission is that a line needed to improve electricity delivery between generators in one state and customers in another may have to traverse other states in between. States along the path might resist having lines built, figuring that they are bearing costs and reaping none of the benefits. Recent federal legislation has given the secretary of energy the authority to order states to allow transmission construction, specifically to counteract this potential problem.

THE ENVIRONMENT

Environmental security plays a role in electricity for two reasons. First, most electricity in the United States (and much of it elsewhere) is produced by burning fossil fuels—primarily coal and natural gas—that emit carbon dioxide (CO₂) as a by-product. In 2005, fossil fuels burned to generate electricity produced 2,363 million metric tons of CO₂, about 40 percent of the U.S. total. Second, unlike automotive use of gasoline—the other major contributor to greenhouse gas emissions, producing about 32 percent in 2005—there are comparatively few electric power plants.

This makes the math much simpler: with so many fewer “actors” (hundreds of power plants versus millions of cars), it becomes easier to implement efficient and effective policies to control emissions, such as carbon taxes or permit trading, based on the quantities that polluters actually emit. Just as power plants were the initial participants in trading sulfur dioxide emissions permits, they are likely to be leading players in market-based policies to address CO₂ emissions. Increasing the role of markets in electricity overall is likely to improve the effectiveness of taxes or permits in providing incentives to limit emissions.

NATIONAL SECURITY

A final security dimension is threats from external enemies, most prominently terrorist threats to the public—either directly or to its infrastructure. The interstate transmission system is the part of the electricity sector where an attack would probably wreak the most havoc. Because the system is so interconnected, it would remain regulated even if wholesale and retail markets for electricity became open. That continuing regulation suggests that the transmission sector is not affected by opening other markets, and so national security is not directly affected. To the extent that expanding competition among generators increases their propensity to sell to distant users, however, the transmission grid becomes an ever more crucial component of the electricity infrastructure.

Global Energy and U.S. Electricity

The main global energy security concern involves oil. In the short term, concerns about oil arise from the fact that a large share of the supply comes from parts of the world that are subject to considerable political instability. Moreover, this supply is concentrated in a few countries that, in the past, have been

The interstate transmission system is the part of the electricity sector where an attack would probably wreak the most havoc.

Electricity is vulnerable to imbalances between supply and demand: too little supply relative to loads can cause outages and too much can cause failures in the grid.

able to “cartelize” the supply of oil as well as subject world oil markets to shocks from wars and boycotts. More important and certain is global growth in demand, as China and India race toward the developing world in terms of per-capita wealth and, as a result, much greater use of automobiles and other goods and services that rely on petroleum.

The relationship between electricity and global energy security would be more significant if oil were an important part of electricity generation. At least in the United States, though, this effect is likely to be minor. When oil was less expensive, it generated a significant fraction of electricity in the United States, as much as 17 percent as recently as the 1970s. By 2005, however only about 3 percent of U.S. electricity was generated by oil.

A less direct but potentially significant relationship between oil markets and electricity use arises because of substitutions in other markets, particularly involving heating. For example, if the price of oil goes up, more consumers, offices, or factories might switch to electricity for heating and other power uses. This would have a significant effect on the price of electricity because the marginal unit needed to supply electricity, particularly when demand is at its greatest, is generally a plant powered by natural gas.

Markets Generally Boost Security

In the short run, markets allow for efficient resource allocation. Absent significant market power or substantial nonmarket effects—both of which are important in electricity—competition among suppliers will result in prices approximating the marginal cost of producing a good. Buyers, as “end users” or “final consumers,” decide how much to buy based on whether the price they have to pay is more or less than the item’s worth. Ideally, these decentralized decisions lead to allocations where the marginal benefit to consumers of producing more of something is about the same as the marginal cost of that production. There is neither too little—measured by being able to produce benefits greater than those costs—nor too much—as when those marginal benefits are less than those costs.

When it comes to security, markets should help, not hurt. Opening markets to new competitors and, over time, to new entrepreneurs and innovators should result in redundancy. And a region or nation should be less vulnerable to disruptions if it is not depending on the facilities and services of a single monopoly provider. The Internet offers an excellent example: with packet switching and routing available over multiple backbone networks, removing one company’s facilities should not bring the entire system down.

More directly, markets can actually help to provide security. Security of service, like any other product feature is one of the attributes that suppliers will offer in an open market, as long as the consumer’s willingness to pay exceeds the cost of furnishing it. Security can be viewed in the same way, from the protection against physical invasion of buildings by burglars to the electronic invasion of data by hackers. Not every service will have the same level of reliability. Some cars will have more air bags or engines less likely to need repair than others; some buildings will have more elaborate security systems than others; some data sites will have more elaborate firewalls than others. But to the extent that markets are open to entrepreneurship and innovation, security need not be a matter of public policy.

The Central Security Issue: Reliability

The overarching energy security issue arising in electricity involves reliability of the grid. We all want our cars to start, our furnaces to come on, and our computers to boot up. With that noted, reliability is particularly acute in this context because as a commodity, electricity has three distinct attributes:

First, it is crucial to the economy and to society at large. Virtually every sector on which we depend cannot function without electricity to power lighting, heating, cooling, computing, and communicating,

In
sup
on

along
Se
mand
ures i
also e
cally s
TH
the el
more
servic
high e
TH
“colle
are on
suppl
Nu
ity. O
Augu
hand,
rate e
to ma
so do
tion n
and ac
variou
TH
icy Ac
bility
ability
In
such
neuria
exerci
tition
need t
to ens
while
the le
their

In economic terms, electricity is a critical “collective good.” If my supplier fails to meet my demand, it is not just my problem; everyone on the grid is blacked out as well.

along with all types of commercial and industrial equipment.

Second, because it cannot be stored, electricity is vulnerable to imbalances between supply and demand. Too little electricity relative to loads can cause outages; too much relative to loads can cause failures in the grid. Together, these require that supply equal demand virtually minute by minute. They also explain why it is so expensive to meet extreme demand peaks. Electricity cannot be economically stored to get over a hump; it must be produced in real time.

This vulnerability becomes a general reliability problem only when combined with a third feature of the electricity sector—interconnection. The grid is interconnected to promote efficiency and reliability; more links increase the means by which energy can reach consumers. But unlike other interconnected services, such as telecommunications where routing traffic can be accomplished through switches, the high energy levels in electricity transmission preclude directing energy along particular pathways.

These three factors combine to create a situation in which reliability is, in economic terms, a critical “collective good.” Failures of my car, furnace, or computer to start may be serious problems, but they are ones largely between me and the firms I choose to supply and repair those items. If my electricity supplier fails to meet my demand, it is not just my problem; everyone on the grid is blacked out as well.

Numerous factors make it difficult to assess the need for investment and policy to enhance reliability. One such example is deciding how much we should spend to ensure reliability. In the wake of the August 2003 blackout, some called for spending up to \$60 billion on new transmission lines. On the other hand, DOE and others estimated the cost of this massive blackout at about \$6 billion. If this is an accurate estimate, we might still need to avoid roughly one blackout of this magnitude every year or two to make such an investment worthwhile. Most fundamentally, the cost of a blackout is not unlimited and so does not warrant unlimited expense to eliminate any possibility of a power outage. Careful attention needs to be given to estimating the cost of blackouts because they differ in location, duration, scope, and advance notice, and in the effect of expenditures on reducing the likelihood of blackouts along those various dimensions.

The nature of reliability as a collective good implies some degree of central control. The Energy Policy Act of 2005 authorized the Federal Energy Regulatory Commission to delegate control over reliability to “electricity reliability organizations” that would certify, in this case, the North American Reliability Council.

In considering the effect of electricity markets on security, the key question is the degree to which such centralized control is consistent with the decentralized decision processes essential to entrepreneurial competition. At one extreme, we might need no more central planning than air-traffic controllers exercise in the airline industry. Air space can be policed to avoid collisions without precluding competition among carriers to transport passengers and freight. At the other extreme, a central controller may need to control dispatch of generators in the short run and investment in generation over the long run to ensure reliability as well as efficiency. If so, there may be little left over to make competition worthwhile, particularly if the restructuring necessary to ensure competition is itself costly. Looking through the lens of energy security reveals another perspective on the question of whether “markets have met their match” when it comes to electricity. ■

Using the Price System to Reduce Airport Congestion

Jan K. Brueckner and Kurt Van Dender

Driven by the growth in demand, flight volumes at many major U.S. airports have increased sharply in recent years. Since airport flight capacity has hardly changed, the increase in traffic volumes has led to more and longer delays. In 2007, 24 percent of flights arrived late, up from 15 percent in 2003.

What measures are appropriate for handling airport congestion? Building more capacity is one option, and some expansion will surely be needed despite its high cost. Another is to cut flight volumes through direct government intervention in airline scheduling decisions. A more systematic approach relies on a "slot" system, where airlines cannot schedule flights as they please but must instead acquire landing or take-off slots, issued by the airport. "Slot constraints" have been used at four major U.S. airports and are de rigueur in Europe.

Quantity controls, however, do not guarantee that available slots are used effectively. For example, airlines may use peak-hour slots to operate smaller aircraft than would be desirable. While slot trading helps to achieve the highest and best use of slots, frictions in the trading process may still leave room for inefficiencies.

A better way to ensure efficient use of scarce runway capacity is to rely on the most basic economic pricing principle: make airlines pay the marginal cost of using a congested airport. If an airline decides to land under congested conditions, it incurs extra operating costs while subjecting its passengers to additional time costs, and it will take both of these costs into account. But the presence of congestion means the extra flight also increases operating and time costs for all other flights using the airport, and these impacts are also part of marginal cost. A condition for efficient use of congested runway capacity is that the full marginal cost, including the cost imposed on other airlines, must be internalized (taken into account) by the carriers.

But would an airline in fact internalize these costs in deciding whether to operate an extra flight? This question has been much debated among airline economists, leading to the usual answer: "it depends." If each airline serving the airport has a relatively large presence, operating a substantial number of flights, then each carrier will

understand that its scheduling decisions affect the overall level of congestion. Moreover, carriers will play a scheduling game, with each airline setting its flight volumes to maximize profit, taking account of airport congestion as well as scheduling choices of the other carriers. In this situation, each airline will partially internalize congestion, taking into account the congestion it imposes on itself (additional delays for all its other flights) in deciding whether to schedule an extra flight. However, since the airline will ignore the congestion imposed on other carriers, marginal costs are only partially internalized.

The answer to the internalization question is even less favorable when the big players at the congested airport coexist with a competitive fringe, namely, airlines that operate only a few flights. Rather than being equal players, the fringe carriers follow the lead of the big airlines, adjusting to their behavior while having no individual impact on the overall level of congestion.

In the presence of a competitive fringe, partial internalization of congestion is eliminated. If large carriers restrict their flight volumes, the fringe carriers would simply fill the gap. Therefore, each big carrier's incentive to take account of self-imposed congestion is neutralized. The Federal Aviation Administration observed exactly this kind of "gap-filling" behavior after convincing United and American Airlines to cut their flight volumes at O'Hare Airport.

Since internalization of congestion is either partial or nonexistent in these two cases, policy intervention is required. Congestion pricing, which makes airlines pay for the congestion they fail to internalize, is an attractive option. Joseph Daniel (1995) calculated congestion charges for the Minneapolis-St. Paul airport, assuming that the competitive fringe model is realistic. He found that the congestion charge for each flight should equal about \$1,000 (in 2007 dollars)

on average during the day. But once the charges have spurred airlines to shift flights to off-peak hours, the average charge would fall to about \$360. With partial internaliza-

tion, congestion charges would have somewhat smaller magnitudes. Regardless of which case applies, some level of congestion pricing would be required at most large airports.

Unlike pouring concrete for more runways, congestion pricing is virtually costless to implement, and by reducing peak traffic volumes, it will make our airports seem magically larger. While airlines strongly oppose congestion pricing, the industry seems not to recognize that congestion charges can replace the current weight-based system of landing fees. With fees dropping to zero in off-peak hours, reflecting the absence of congestion, the carriers' overall costs need not rise by much. In any case, peak-hour congestion charges are likely to be passed on to passengers, widening the current differential between peak and off-peak fares and generating the traffic shift toward less-congested hours. ■

See ► www.rff.org/weeklycommentary



**RFF WEEKLY POLICY
COMMENTARY**

Resources for the Future Annual Report

07



In 2007, scholars at Resources for the Future were in great demand by policymakers at the state and federal levels as they grappled with the compelling questions of climate and environmental change.

In the northeast, for example, states looked to RFF to help design auctions for emissions allowances. In California, the Market Advisory Committee relied heavily on the contributions of one of its members, an RFF senior fellow, in deciding where in the electricity market to place the burden of regulation. In Washington, several researchers testified before Congress and produced *Assessing U.S. Climate Policy Options*, a report that has garnered high praise in many circles. The Environmental Protection Agency, after the Supreme Court declared it has authority to regulate CO₂ emissions, has turned to RFF to run a series of public workshops on key economic questions associated with emissions control.

Why is RFF able to have such impact? Because for years, it has invested in high-caliber researchers working on these issues—issues that recently have jumped higher on the public agenda; because supporters of RFF have faithfully provided financing for our work; and because RFF consistently aspires to do research of the highest quality—independent of ideology, or shifting political winds, or financial pressures.

Reporting on RFF's Successes and . . .



PHILLIP R. SHARP, PRESIDENT

We are, of course, having impact on many policy fronts. The first report of the Extending the Cure project provided feasible solutions to the growing threat of antibiotic resistance. RFF scholars produced a major report on the national implications of Smart Growth programs encompassing land use and urban planning. And we are collaborating with researchers in developing countries who are seeking to incorporate environmental values in economically depressed and often politically unstable nations.

RFF also used its potent convening power to explore, in public exchanges, such crucial topics as global deforestation, food safety, the value of conservation, nanotechnology, and the future of coal. In a special conference focused on the Frontiers of Environmental Economics, we assembled hundreds of America's leading resource economists to explore the most exciting new ideas in the field.

Our scholars continue to do vital work in the intellectual boiler room, energizing serious thought and discourse about how to more effectively analyze problems. This work shows up in top academic journals and in workshops for the technical staff of agencies like the Office of Management and Budget, National Aeronautics and Space Administration, and Food and Drug Administration. While many senior policymakers may not be directly aware of this work, they clearly depend on it.

Our Board of Directors, our management team, and most importantly our scholars, are more determined than ever to maintain our commitment to high quality, independent research that can contribute in the short run or the long run to meeting the challenges our society faces.

To those of you interested in our work, and especially to those of you who make it possible, my sincerest thanks.

A handwritten signature in cursive script that reads "Phil Sharp". The signature is written in a dark ink on a dark blue background.

As Phil outlines in his letter, 2007 proved to be a pivotal year for RFF. The body of work that our researchers delivered has never been more timely or had greater impact on the crucial environmental and natural resource issues facing our nation and the planet today. I have chosen to invest a significant amount of my time volunteering with RFF and am a financial supporter, and I would like to encourage you to become more involved in supporting its work. And here is why:

I have always been an avid environmentalist. My passion is experiencing the diversity of life and reflecting upon the eons of evolution that have created the magnificent diversity of species on this planet and shaped its oceans, atmosphere, and land. To that end, I have been personally involved with several large-scale conservation efforts over the years including protection of the wildlife of Tierra del Fuego and Patagonia and the Brazilian rainforests, and am supporting several more.

On-the-ground habitat and species conservation may seem far removed from the development and application of environmental economics, but, to me, they are both essential investments in the stewardship of the planet. As decisionmakers determine whether to tax carbon emissions or set up a cap-and-trade program to slow the changes that mankind is making to the chemistry of the atmosphere, the planet continues to warm—threatening majestic creatures like the polar bear, interrupting rainfall patterns essential to crop production, providing advantages to invasive species over native ones, and causing the oceans to acidify, threatening marine ecosystems.

So for me, slowing greenhouse gas emissions is much more than a set of policy decisions that will have major implications for our economy. Climate change is impacting our natural world now. The policy decisions being made today will determine whether we act in time to preserve the magnificent habitats and species that are in peril, and sustain the basic geophysical balances that have evolved over time. RFF has stepped up to this challenge and is playing an instrumental role. That is why I support the organization and am proud to be affiliated with its many researchers who strive to influence the policy process.

If you want to see RFF continue its premier work, please consider giving or increasing your financial support. Whether it is energy policy, antibiotic resistance, land-use policies, or myriad other natural resource issues, decisionmakers are seeking out the unbiased analyses and policy recommendations of RFF's research staff. We believe that we have hit a new level of policy impact and have launched several initiatives to significantly build our capacity for more. With your help, we will continue to gain strength, to advocate that environmental policies be based upon sound research and analysis, and to deliver that work. I hope you will join me in helping support RFF at this most exciting time.

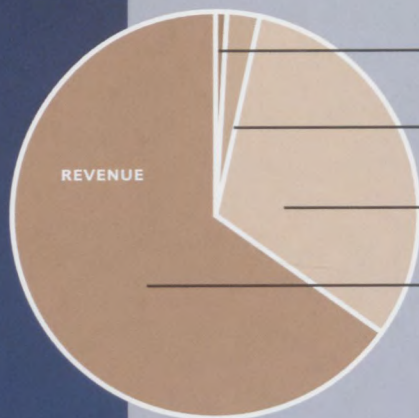
Looking Ahead to 2008



LAWRENCE H. LINDEN, CHAIR

Lawrence H. Linden

In fiscal year 2007, RFF's operating revenue was \$12.2 million, 65.2 percent of which came from individual contributions, foundation grants, corporate contributions, and government grants. RFF augments its income by an annual withdrawal from its reserve fund to support operations. At the end of fiscal year 2007, the reserve fund was valued at \$38.4 million.



TELEPHONE REVENUE 0.9%

BOOK SALES 2.6%

INVESTMENT & RENTAL INCOME 31.3%

GIFTS AND GRANTS 65.2%

Financial Statements

ASSETS	YEAR ENDED SEPTEMBER 30	2007	2006
CURRENT ASSETS			
Cash and cash equivalents		\$ 178,596	\$ 115,506
Grants and contract revenue receivable		1,221,083	657,714
Contributions receivable		548,698	1,182,363
Receivable from RCC		—	37,602
Other receivables		954,102	688,456
Other assets		392,658	442,205
Total current assets		\$ 3,295,137	\$ 3,123,846
Contributions receivable, net of current portion		\$ 586,228	\$ 441,043
INVESTMENTS			
Investments at fair value		38,379,193	35,572,987
Investment in land		8,900,000	8,900,000
Investment in RCC		3,472,639	3,900,152
Total investments		\$ 50,751,832	\$ 48,373,139
Fixed assets—net of accumulated depreciation		6,754,152	6,959,954
Assets held under charitable trust agreements		523,198	462,830
TOTAL ASSETS		\$ 61,910,547	\$ 59,360,812

LIABILITIES AND NET ASSETS	YEAR ENDED SEPTEMBER 30	2007	2006
CURRENT LIABILITIES			
Tax-exempt bond financing, current portion		\$ 200,000	\$ 190,000
Grants and awards payable		33,750	33,750
Accounts payable and accrued liabilities		1,592,069	1,603,031
Deferred revenue		140,411	179,324
Total current liabilities		\$ 1,966,230	\$ 2,006,105
Tax-exempt bond financing, net of current portion		6,555,000	6,755,000
Liabilities under split-interest agreements		587,296	549,823
Funds held for others		80,068	86,482
Total liabilities		\$ 9,188,594	\$ 9,397,410
NET ASSETS			
Unrestricted		43,918,849	42,224,369
Temporarily restricted		2,991,156	1,934,132
Permanently restricted		5,811,948	5,804,901
Total net assets		\$ 52,721,953	\$ 49,963,402
TOTAL LIABILITIES AND NET ASSETS		\$ 61,910,547	\$ 59,360,812

CHANGES IN UNRESTRICTED NET ASSETS

REVENUE

Individual contributions	\$ 750,648	\$ 665,955
Foundation grants	2,832,347	879,323
Corporate contributions	1,151,500	1,883,520
Government grants and contracts	2,359,512	2,535,865
Other institution grants	873,177	896,605
Rental income	2,143,349	1,754,990
Investment income net of fees	1,685,782	1,507,315
Telephone revenue	109,311	106,620
Book sales	318,419	362,429
Total operating revenue	\$ 12,224,045	\$ 10,592,622

EXPENSES

Programs

Research	\$ 7,189,252	\$ 6,618,050
Academic Relations	396,162	254,667
RFF Press	564,501	600,041
Communications	1,003,731	962,121
Other direct	283,243	425,824
Total program expenses	\$ 9,436,889	\$ 8,860,703

Fundraising	727,413	595,826
Management and administration	1,659,049	1,637,197
Building operations and maintenance	1,271,206	1,096,541
Total functional expenses	\$ 13,094,557	\$ 12,190,267

Change in unrestricted net assets from operations	(870,512)	(1,597,645)
---	-----------	-------------

Non-operating revenues (expenses)

Realized gain on investment transactions	3,067,084	2,799,551
Unrealized gain (loss) on investment transactions	452,979	(363,741)
Other	109,000	76,514

INCREASE (DECREASE) IN UNRESTRICTED NET ASSETS	2,758,551	914,679
---	------------------	----------------

NET ASSETS AT BEGINNING OF YEAR	49,963,402	49,048,723
--	-------------------	-------------------

NET ASSETS AT END OF YEAR	\$ 52,721,953	\$ 49,963,402
----------------------------------	----------------------	----------------------

RFF research and educational programs continued to be vital in 2007, representing 72.1 percent of total expenses. Management and administration, and development expenses combined were only 18.3 percent of the total. The balance is related to facilities rented to other nonprofit organizations.



Individual Donors

Resources for the Future gratefully acknowledges gifts received from the following donors during the 2007 fiscal year (October 1, 2006 through September 30, 2007). Donors are listed according to the cumulative total given during this period. Donors who made gifts of at least \$5,000 are designated members of RFF's Council and receive special benefits, including complimentary copies of all RFF publications, special access to RFF researchers, and invitations to Council Meetings and other RFF by-invitation-only events.

\$25,000 AND MORE

Preston Chiaro
Lyle E. Gramley
Charles F. Kalmbach
Lawrence H. Linden

\$10,000 TO \$24,999
W. Bowman Cutter
Steven W. Percy
Peter J. Robertson
Matthew R. Simmons

\$5,000 TO \$9,999
Christopher C. Aitken
John M. Deutch
E. Linn Draper, Jr.
Mohamed T. El-Ashry
John Evangelakos
Linda J. Fisher
Dod A. Fraser
Bob and Jill Fri
Darius W. Gaskins
Kathleen and Edward F. Hand
R. Glenn Hubbard
Peter R. Kagan and
Susannah A. Smetana
Denis P. Kelleher
Raymond J. Kopp
Frank E. Loy
Michael A. Mantell
Ethan J. Podell

Helen Raffel
Roger W. Sant
The Schmitz-Fromherz Family
Fund
John M. Stephenson
Edward L. Strobehn Jr.
Stephen Thacker
M. Gordon Wolman and
Elaine Wolman

\$1,000 TO \$4,999

Catherine G. Abbott
Vicky A. Bailey
Harold Brown
John M. Campbell, Jr.
Emery N. Castle
Lesli and Dan Creedon
Maureen L. Cropper
George C. Eads
Christopher J. Elliman
Robert James
Howard and Julia E. Klee
Jim Maddy
Colin Moseley
Robert S. Pindyck
Paul R. Portney
William D. Ruckelshaus
Robert L. Sansom
Thomas C. Schelling
Phil Sharp
Pamela Spofford
John E. Tilton

\$1,000 AND UNDER

Richard Alper
Kenneth J. Arrow
Jesse H. Ausubel
H. Spencer Banzhaf
Michael J. Bean
C.F. Bentley
E. Peter Benzing
David Biltchik
Wallace D. Bowman
Barbara Bush
Richard V. Butler
William A. Butler
Shirley R. Caldwell
Frederick W. Camp
Melvyn L. Cantor and Kathryn
Gabler Philanthropy
Barbara U. Charlton

Norman L. Christensen
John C. Colman
Elinor Constable
Rebecca A. Craft
John H. Dalton
Rhonda Daniels
Joel Darmstadter
Robert T. Deacon
Joseph M. Dukert
Kelly Eakin
James R. Ellis
Lee H. Endress
Daniel C. Esty
Anthony C. Fisher
Margaret W. Fisher
Warren Fisher
Robert Frank, MD
Robert M. Frank, Jr.
Lee S. Friedman
William Fulkerson
Kathryn S. Fuller
The Funkhouser/Garlid/
McMahon/Moran Family
William D. George, Jr.
Shelby Gerking
Bob and Debbie Groberg
Jennifer Haddox-Schatz
Perry R. Hagenstein
Robert I. Hanfling
Russel H. Herman
William Hildreth
Fisher Howe
Holmes Hummel
Leonard S. Hyman
Richard W. Johnson
Yoshiaki Kaoru
Paul D. Kaplan
James M. Kiefer
Robert Kistler
Daniel E. Klein
Jeff Kolb
Jacques J. Kozub
Thomas J. Lareau
Lester B. Lave
Robert C. Lind
Thomas E. Lovejoy
Renee A. McRae
Mary E. McWilliams
E. Gerald Meyer
Dade W. Moeller

William
Ernest J.
George
M. Gram
Merton
Blas Pér
Andrew
Edward
Laurel M
William
Jo Ann K
Gayle B
Eirik Ro
Carol M
Milton F
John and
Gunter
Charles
Sally and
Christop
Robert M
Richard
Thomas
M. Toub
Victori
Betty Va
William
Thomas
David L
Shirley B
J. Fred W
Chris G
Nathan
Shue Tu
Edgar P
Anony

William Moffat
Ernest J. Moniz
George G. Montgomery
M. Granger Morgan
Merton J. Peck
Blas Pérez-Henríquez
Andrew M. Petsonk
Edward L. Phillips and
Laurel Murphy
William Pizer
Jo Ann K. Pizer-Fox
Gayle B. Price
Eirik Romstad
Carol M. Rose
Milton Russell
John and Jean Schanz
Gunter Schramm
Charles Sercu
Sally and Bob Skillings
Christopher N. Sonnesyn
Robert N. Stavins
Richard and Martha Strombotne
Thomas H. Tietenberg
M. Toutain
Victoria J. Tschinkel
Betty Van Der Smissen
William D. Watson
Thomas C. Wegge
David L. Weimer
Shirley F. Weiss
J. Fred Weston
Chris G. Whipple
Nathaniel Wollman
Shue Tuck Wong
Edgar P. Young
Anonymous [1]

Legacy Society

RFF is especially grateful to the following individuals who have let us know that RFF is included in their estate plans. Legacy Society members whose gifts meet or exceed \$100,000 receive full Council benefits for life.

Catherine G. Abbott
John F. Ahearne
Paul F. Balsler
Emery N. Castle
Thomas D. Crocker
J. Clarence Davies
Margaret W. Fisher
Maybelle Frashure
Kenneth D. Frederick
Robert W. Fri
Darius W. Gaskins
Lincoln Gordon
Robert E. Grady
Debbie Groberg
Winston Harrington
Donald M. Kerr
Thomas J. Klutznick
Allen V. Kneese*
John V. Krutilla*
Hans H. Landsberg*
Steven W. Percy
Paul R. Portney
William D. Ruckelshaus
Clifford S. Russell
Flora Stetson*
Helen Marie Streich
Edward L. Strohben Jr.
Victoria J. Tschinkel, founding member
Gilbert F. White*
Irving Zuckerman*

*Deceased

Corporate Contributors

RFF would like to thank all of the corporations and associations that supported our research and outreach efforts in 2007. These dedicated organizations share RFF's interest in improving the environmental and natural resource policy debate—and their contributions provide much of the general support required to run our day-to-day operations. RFF is proud to include for the first time a new donor level, the President's Circle, which recognizes those corporations and associations that donated \$50,000 or more annually. Since its founding in 1991, the RFF Council has recognized corporations and associations that contribute at least \$25,000 annually to RFF. The individuals listed in each of these two categories represent their respective organizations on the President's Circle and Council, and make up a valuable community of corporate stakeholders on which we rely for honest criticism and feedback of our work. This year we have six President's Circle members, eight new RFF Council members, and 11 new Corporate Associates.

RFF PRESIDENT'S CIRCLE \$50,000 AND ABOVE ANNUALLY

Meg McDonald
President
Alcoa Foundation

Thomas J. Gibson
Senior Vice President of
Advocacy
American Chemistry Council, Inc.

Bruce H. Braine
Vice President, Strategic Policy
Analysis
*American Electric Power
Company, Inc.*

Georgia A. Callahan
General Manager, Global Policy
& Strategy
Chevron Corporation

John W. Rowe
Chairman & Chief Executive
Officer
Exelon Corporation

Sherri K. Stuewer
Vice President, Safety, Health,
and Environment
ExxonMobil Corporation

Mark Tercek
Managing Director
Goldman, Sachs & Co.

Josephine S. Cooper
Group Vice President,
Government & Industry Affairs
Toyota Motor North America, Inc.

Cassie L. Phillips
Vice President, Sustainable
Forestry
Weyerhaeuser Company

RFF COUNCIL \$25,000 TO \$49,999 ANNUALLY

Robert L. Greco, III
Group Director, Downstream &
Industry Operations
American Petroleum Institute

James W. Ragland
Director, Economic Research
Group
Aramco Services Company

John J. Nepywoda
Director, Environmental Affairs
BP America, Inc.

Marty Muenzmaier
Director, Federal Government
Relations
Cargill, Inc.

Deborah L. Morrisett
Vice President, Regulatory
Affairs
Chrysler LLC

Mark A. Casper
Vice President, Environment,
Health & Safety
Cogentrix Energy, Inc.

R.A. Ridge
Vice President, Health, Safety &
Environment
ConocoPhillips

Peter A. Molinaro
Vice President of Federal & State
Government Affairs
The Dow Chemical Company

James E. Rogers
President & Chief Executive
Officer
Duke Energy

David K. Owens
Executive Vice President,
Business Operations
Edison Electric Institute

Polly L. Gault
Executive Vice President
Edison International

Steven R. Specker
President and Chief Executive
Officer
Electric Power Research Institute

Thomas M. Welsh
Assistant to the CEO
FirstEnergy Corporation

Admiral Frank L. "Skip"
Bowman
Chief Executive Officer
Nuclear Energy Institute

Steven L. Kline
Vice President, Federal
Governmental & Regulatory
Relations
PG&E Corporation

Jeffrey Sterba
Chairman, President & CEO
PNM Resources, Inc.

Paulette C. Pidcock
Vice President, Federal
Government Relations
PPL Corporation

Marcelle Shoop
Director, Environmental Policy
and Partnerships
Rio Tinto PLC

Richard M. Hayslip
Assistant General Manager
The Salt River Project

Curtis Frazier
Executive Vice President
Shell Gas and Power Americas

Chris M. Hobson
Senior Vice President,
Environmental Affairs
Southern Company

Ichiro Maeda
General Manager, General and
External Affairs
Tokyo Electric Power Company

Pierre S. DuPont
Two Sigma Investments LLC

David Geanacopoulos
Director of Industry-Government
Relations
Volkswagen of America, Inc.

RFF CORPORATE ASSOCIATES
UNDER \$25,000 ANNUALLY

Alliance of Automobile
Manufacturers

Association of International
Automobile Manufacturers

Allele

Alstom

Amtrak

ArborGen, LLC

Arete

The Babcock & Wilcox
Company

CF Industries

The Coca-Cola Company

Consolidated Edison of New
York

Constellation Energy

Cummins

Electricite de France

Elliot Company of Indianapolis

Energy

Ford Motor Company

General Electric Company

Georgia-Pacific LLC

Koch Industries

Mead Westvaco

Midwest Generation

Natsource

NJ Resource Company

Novartis

PacifiCorp

S.C. Johnson & Sons, Inc.

Stout & Teague Management
Corporation

Tucson Electric Power Company

Vinson & Elkins, LLP

Foundation and Government Support

FOUNDATIONS AND OTHER INSTITUTIONS

RFF would like to thank the many philanthropic foundations and other independent organizations that provided support in 2007. These gifts help diversify our funding base and extend our research on important policy issues.

The Abell Foundation, Inc.

Abelow Family Foundation

Alexander Foundation

The Andrew W. Mellon
Foundation

Doris Duke Charitable
Foundation

The Energy Foundation

Bill and Melinda Gates
Foundation

The Henry M. Jackson
Foundation

National Commission on Energy
Policy

The David and Lucille Packard
Foundation

The Robert Wood Johnson
Foundation

The Smith Richardson
Foundation

The G. Unger Vettleson
Foundation

The Simons Foundation
University of Virginia

GOVERNMENT AGENCIES

RFF receives approximately 20 percent of its total operating revenue in the form of project grants and contracts from government agencies. Government-sponsored research must be nonproprietary. That is, RFF insists on the right to share the results of its work with all participants in the policy process.

U.S. Department of Agriculture

U.S. Department of Energy

U.S. Environmental Protection
Agency

U.S. Geological Survey

National Aeronautics and Space
Administration

National Institutes of Health

National Science Foundation

The State of Maryland,
Department of Natural
Resources

The State of California,
Department of Natural
Resources

Board of Directors

Lawrence H. Linden*
Chair
Advisory Director, Goldman
Sachs

Frank E. Loy*
Vice Chair
Washington, DC

Philip R. Sharp*
President
Resources for the Future

Vicky A. Bailey
President, Anderson Stratton,
International LLC

Michael J. Bean
Chairman, Wildlife Program,
Environmental Defense

Preston Chiaro
Chief Executive Officer, Rio
Tinto Energy Group

Norman L. Christensen
Professor of Ecology, Duke
University

Maureen L. Cropper
Professor of Economics,
University of Maryland

W. Bowman Cutter
Managing Director,
Warburg Pincus

E. Linn Draper, Jr.*
Retired Chairman of the Board,
President, and CEO, American
Electric Power Company, Inc.

Mohamed T. El-Ashry*
Former CEO and Chairman,
Global Environment Facility

Daniel C. Esty
Hillhouse Professor of
Environmental Law and Policy,
Yale Law School

Linda J. Fisher
Vice President and Chief
Sustainability Officer, DuPont
Environment & Sustainability
Growth Center

Dod A. Fraser*
President, Sackett Partners
Incorporated

Kathryn S. Fuller
Chair, Ford Foundation Board
of Trustees

David G. Hawkins
Director of the Climate Center,
Natural Resources Defense
Council

R. Glenn Hubbard
Dean, Columbia University
School of Business

Charles F. Kalmbach*
Chief Executive Officer, DMB, Inc.

Michael A. Mantell
Attorney, Resources Law Group

Steven W. Percy*
Treasurer
Former CEO, BP America

Peter J. Robertson
Vice Chairman of the Board,
Chevron Corporation

Matthew R. Simmons
Chairman, Simmons & Company
International

Robert N. Stavins
Albert Pratt Professor of Business
and Government, Harvard
University

Joseph E. Stiglitz
Professor of Economics, Business
and International Affairs,
Columbia University School of
Business

* Member of the Executive
Committee

Top row, from left: Mohamed T. El-Ashry, Charles F. Kalmbach,
W. Bowman Cutter, Frank E. Loy, Peter J. Robertson, Kathryn S. Fuller,
Dod A. Fraser

Bottom row, from left: Michael J. Bean, Linda J. Fisher, Lawrence H.
Linden, Philip R. Sharp, Maureen L. Cropper, Michael A. Mantell,
Daniel C. Esty

Not pictured: Vicky A. Bailey, Preston Chiaro, Norman L. Christensen, Jr.,
E. Linn Draper, Jr., David G. Hawkins, R. Glenn Hubbard, Steven W.
Percy, Matthew R. Simmons, Robert N. Stavins, Joseph Stiglitz

Staff and Fellows

AS OF SEPTEMBER 30, 2007

OFFICERS

Philip R. Sharp
President

Edward F. Hand
Vice President, Finance and Administration

Barbara Bush
Acting Secretary

RESEARCHERS

Joseph E. Aldy
Fellow

Ruth Greenspan Bell
Resident Scholar

Allen Blackman
Senior Fellow

James W. Boyd
Senior Fellow

Maciej F. Boni
Resident Scholar

Timothy J. Brennan
Senior Fellow

Dallas Burtraw
Senior Fellow

Susie Chung
Research Assistant

Conrad Coleman
Research Assistant

Abigail Colson
Research Assistant

Roger M. Cooke
Chauncey Starr Senior Fellow

Sarah Darley
Research Assistant

Joel Darmstadter
Senior Fellow

J. Clarence (Terry) Davies
Senior Fellow

Mike Eber
Research Assistant

Harrison Fell
Fellow

Carolyn Fischer
Fellow

Daniel Hall
Research Assistant

Winston Harrington
Senior Fellow

Evan Hermstadt
Research Assistant

Sandra A. Hoffman
Fellow

Danny Kahn
Senior Research Assistant

Raymond J. Kopp
Senior Fellow

Alan J. Krupnick
Senior Fellow and Division Director

Ramanan Laxminarayan
Senior Fellow

Molly K. Macauley
Senior Fellow

Virginia McConnell
Senior Fellow

Eleanor B. McCormick
Research Assistant

Richard D. Morgenstern
Senior Fellow

Erica Myers
Research Assistant

Urvashi Narain
Fellow

Karen Palmer
Darius Gaskins Senior Fellow

Ian W.H. Parry
Senior Fellow

Anthony Paul
Program Fellow

William A. Pizer
Senior Fellow

Katherine N. Probst
Senior Fellow

Elena A. Safirova
Fellow

Roger A. Sedjo
Senior Fellow

Leonard A. Shabman
Resident Scholar

Jhieh-Shyang Shih
Senior Fellow

Juha Siikamäki
Fellow

Richard Sweeney
Research Assistant

Sarah Jo Szambelan
Research Assistant

Shalini Vajjhala
Fellow

Margaret Walls
Senior Fellow and Division Director

Susan You
Research Assistant

Yatziri Zepeda Medina
Research Assistant

**EXTERNAL AFFAIRS
COMMUNICATIONS**

Stanley N. Wellborn,
Director

John Anderson

Felicia Day

Adrienne Foerster

Scott D. Hase

Michael McGinnis
Scott Salyer
April Stanley

DEVELOPMENT

Angela Blake
Barbara Bush
Virginia N. Kromm
Michele Leahy
Lisa Mihalik

RFF PRESS

Don S. Reisman, Director
Tom Harnish
Grace E. Hill

FINANCE AND ADMINISTRATION

Marilyn S. Alano
Julie Alleyne
Aris M. Awang
Michael J. Brewer
Christopher B. Clotworthy
Mary Ann Daly
Amanda Gonzales
William Isaac
Griffin LeNoir
Maura McConville
David McLaughlin
Nauman Memon
Peter C. Nelson
Mara Parrish
Romulo Romero
Claudia Rios
Priscilla Ugoji
Marilyn M. Voigt

FELLOWSHIPS

Joseph L. Fisher Doctoral Dissertation Fellowship
Kwaw Andam
Etienne Benson
Junjie Zhang
Gilbert F. White
Postdoctoral Fellowship
Steve Gabriel
Fellowship in Environmental Regulatory Implementation
Kerry Rodgers
Cynthia Koehler
Steven Strauss
John V. Krutilla Research Stipend
Ahmed Mushfiq Mobarak
Walter O. Spofford, Memorial Internship
Xing Liang

UNIVERSITY FELLOWS

John F. Ahearne
Sigma Xi

John M. Antle
Montana State University

Jesse H. Ausubel
The Rockefeller University

Gardner M. Brown, Jr.
University of Washington

Maureen L. Cropper
University of Maryland

Partha Dasgupta
University of Cambridge

Robert T. Deacon
University of California, Santa Barbara

Hadi Dowlatabadi
The University of British Columbia

Lawrence H. Goulder
Stanford University

W. Michael Hanemann
University of California, Berkeley

Charles D. Kolstad
University of California, Santa Barbara

Jon A. Krosnick
Stanford University

John List
University of Chicago and NBER

Richard G. Newell
Nicholas School of the Environment and Earth Sciences, Duke University

Wallace Oates
University of Maryland

Stephen Polasky
University of Minnesota

Paul R. Portney
University of Arizona

James N. Sanchirico
University of California, Davis

V. Kerry Smith
Arizona State University

Thomas N.S. Sterner
University of Gothenburg

Robert N. Stavins
Harvard University

Michael Taylor
University of Maryland School of Medicine

John E. Tilton
Colorado School of Mines

Jonathan B. Wiener
Duke University



RESOURCES FOR THE FUTURE
1616 P Street, NW
Washington, DC 20036-1400

www.rff.org

The year 2008 marks the 35th anniversary of the Endangered Species Act, which won overwhelming support in Congress in 1973, and then rapidly became one of America's most controversial laws, generating hundreds of legal challenges by government authorities, conservationists, landowners, and industry.

Resources asked Michael Bean, one of the nation's foremost authorities on the act, to reflect on the policy questions around endangered species and discuss where the issue is heading. Bean is chair of the Wildlife Program at Environmental Defense and an RFF Board member. He was interviewed by RFF Fellow Carolyn Fischer. Their conversation follows.

Fischer: What circumstances surrounded the creation of the Endangered Species Act and what followed its enactment?

Bean: The act became law with virtually no controversy. Senate passage was unanimous, and there was only a smattering of opposition in the House. That unanimity reflected widespread sentiment that the nation needed to safeguard its natural biological heritage, just as it protects landmark buildings and historic sites. The act was quite comprehensive, encompassing not only vertebrates but also invertebrates and plants. Today there are approximately 1,300 listed species in this country, the majority of which are plants.

However, the honeymoon was short-lived. Less than five years after enactment, conflict arose over the construction of the Tellico Dam on the Little Tennessee River, which put at risk a small fish, the snail darter. In 1978, the Supreme Court affirmed the authority of the Endangered Species Act, noting that Congress had spoken with absolute clarity—even to the extent of protecting a fish that had no obvious commercial or recreational value.

Then, about 10 years after that, another controversy arose involving the preservation of the northern spotted owl against logging activity in a large part of the West—Oregon, Washington, and northern California, involving large areas of public and private land. That dispute was a watershed because it showed that this law could affect more than isolated projects: it could disrupt whole economies in substantial and multiple ways.

Fischer: What is the status of the act today?

Bean: Currently, there is no serious effort to reauthorize the act, or even a high degree of consensus on how it might be modified. I think there is no prospect that this Congress is going to tackle this issue.

However, Congress is seriously considering measures to create stronger incentives for the private sector to cooperate with endangered species recovery work, including tax credits for conservation efforts by private landowners. That appears to have broad support from the White House and by both parties.

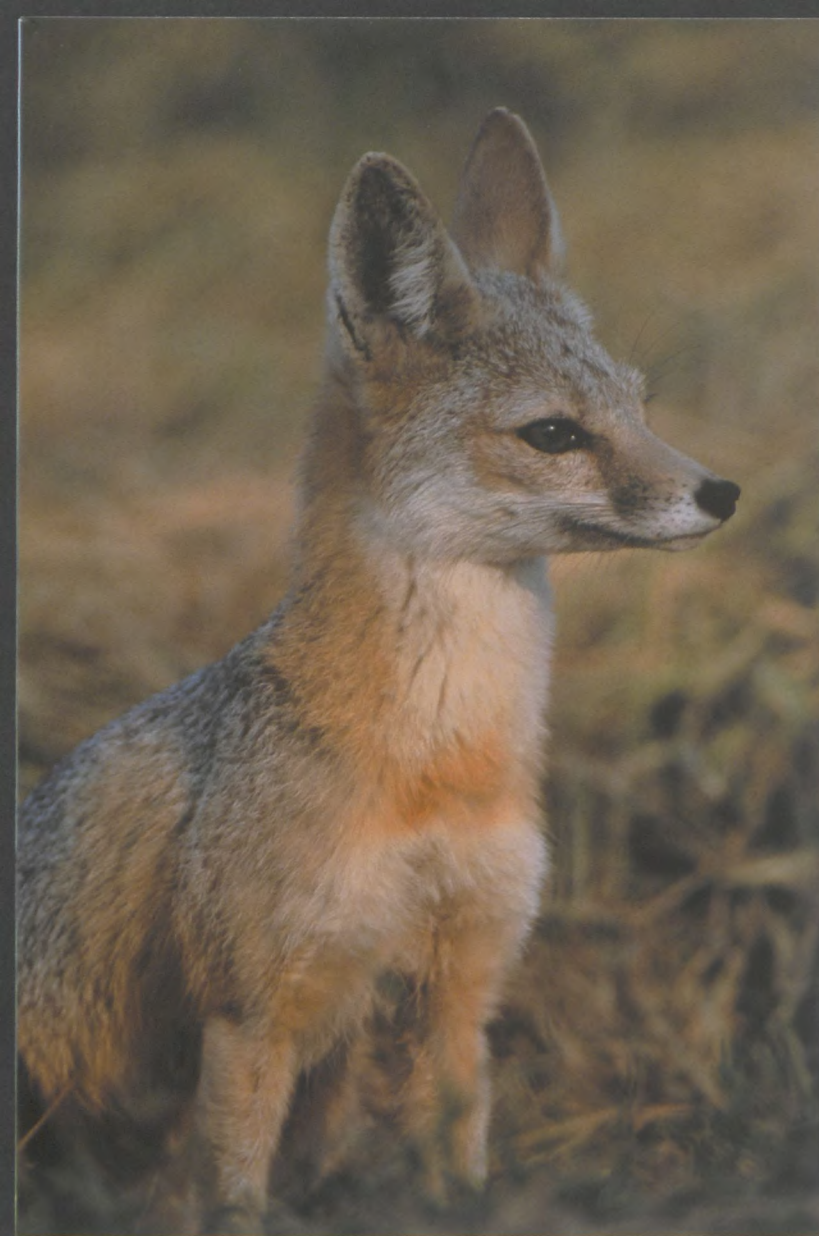
Of course, there are many administrative and regulatory measures—which don't require congressional action—that can strengthen

ENDANGERED SPECIES

Progress and Pitfalls During Three Decades of Controversy

A CONVERSATION WITH MICHAEL BEAN AND CAROLYN FISCHER





The San Joaquin kit fox is found in California's Central Valley.

or weaken the law. It has been reported that the Fish and Wildlife Service recently drafted proposed regulations that would limit the number of species that can be protected and curtail the acres of wildlife habitat to be preserved. They would shift enforcement of the act from the federal government to the states and dilute legal barriers that protect habitat from urban sprawl and logging or mining operations. Whether these proposals will actually be published is unclear.

Fischer: Are new species continually being added to the endangered list?

Bean: No. It has been more than a year since any species have been added, which is longer than at any time since the early 1980s. We know that some plants and animals are increasingly threatened because of commercial and industrial development, but the federal government has lagged in placing them on the list. One of the pos-

itive aspects of the Bush administration has been to encourage anticipatory approaches and take action to help species before they reach the point at which they need to be listed.

Another positive development is that three rather conspicuous and visible species were "de-listed" in early 2007, which is rather unusual. First was the Great Lakes grey wolf population, followed by the Yellowstone grizzly bear population, and shortly before the Fourth of July, the bald eagle was de-listed. These species had been on the first official list of endangered species since 1967. So it took four decades—getting from endangered to recovery is a long process.

Fischer: Was there something unusual about these three species?

Bean: Well, they are well-known, recognizable animals, associated with our national history, and they are somewhat charismatic in their allure. It is certainly true that the public recognizes a relatively few endangered species as iconic. The more prominent animal species tend to garner more public and financial support. They also are physically larger and occupy greater geographic regions—the bald eagle is present all across the country.

Whooping cranes are magnificent animals that had dropped in number to around 15 birds in the wild in the early 1940s. Six decades later, they are recovering but there still are only about 680 birds, and they will probably remain on the endangered list for many more years. By contrast, a small species like the Devil's Hole pupfish, which lives in a sinkhole in Nevada, doesn't attract much support—although its needs can probably be addressed reasonably well with a modest amount of intervention.

So it is indeed the case that there is a disparity as to where the money and attention go. Decisions are heavily influenced by public perception and by the history of wildlife management in this country. To be sure, birds and game animals have had a long history of attention from wildlife managers. In contrast, plants have received almost none, as have invertebrates and even some vertebrates like salamanders and small mammals. It's not just a matter of putting dollars on the most popular species as it is putting dollars into conservation efforts that American wildlife management understands and can influence.

Fischer: Does litigation help conservation efforts?

Bean: That is a complicated question to answer. On the one hand, legal challenges have been necessary to force agencies to do what the law requires, or to give some species a chance for survival. At the same time, so much litigation has been filed over the years that it has been difficult for responsible federal agencies to manage the program because they are constantly sidetracked by the need to respond.

Litigation can have profound impacts, however. This year, the Supreme Court made a ruling that limited the application of a key requirement of the act to discretionary federal activities only. This

was in a case involving the transfer of authority for some provisions of the Clean Water Act from EPA to the state of Arizona, and it will have broad policy implications.

Another case that the court may consider this term regards the listing of the Alabama Sturgeon, now found only in Alabama and thus not involved in interstate commerce. Barge interests using the Tennessee-Tombigbee Waterway have asked the Supreme Court to declare the listing of the sturgeon to be beyond the federal government's constitutional powers.

Fischer: Are private landowners becoming more active in preserving endangered species?

Bean: Absolutely. In my own work, I realized—probably later than I should have—that the stringent regulations imposed on private landowners caused some of them to do the opposite of what we wanted them to do. They refrained from the sort of management that would make their land better habitat. They reasoned that if they ended up with more endangered species on their land, they could have even more restrictions placed on the uses of their property.

A few years ago, we began working with landowners in North Carolina on behalf of an endangered bird known as the red-cockaded woodpecker. Landowners told us that if they could be freed from the worry that their good deeds would be punished, they would follow through. So, we worked with the Fish and Wildlife Service to

create so-called Safe Harbor Agreements that essentially froze their regulatory burdens if they embraced good wildlife management practices. Today there are between 50,000 and 60,000 acres owned by some 101 owners in North Carolina enrolled in these agreements, and the idea has been even more successful in South Carolina and Georgia. Woodpecker numbers are on the rise and other threatened species are benefiting as well.

In Texas, cooperative Safe Harbor Agreements have probably ensured the salvation of the Northern Aplomado falcon. That species has increased from zero nesting pairs in the mid-1990s to at least 40 known nesting pairs, about two-thirds of the way to the target set for reclassifying the species from endangered to threatened.

Fischer: Has the Bush administration encouraged such efforts?

Bean: Early on, the administration announced two new programs—one called the Landowner Incentive Program and the other, the Private Stewardship Grants Program. They originally were envisioned as \$50 million initiatives, but in the president's budget proposal for 2008, no funding was requested for these programs. So that has been a disappointing abandonment of approaches that have been shown to work.

When DDT was banned in 1972, bald eagle numbers began to rise.



Where ESA Has Succeeded and Where the Challenges Still Remain

FIVE SUCCESS STORIES

Gray Wolf. Extirpated from most of its historic range as a result of shooting and poisoning, the gray wolf has made a steady comeback. Establishment of experimental populations of wolves in the Yellowstone area and in central Idaho, though initially controversial (the American Farm Bureau Federation and even some environmental groups filed suit challenging this action), have been remarkably successful. In 2007, the U.S. Fish and Wildlife Service declared the Minnesota and western Great Lakes population of gray wolves to be recovered and proposed to remove the northern Rocky Mountain population from the endangered list as well.

Northern Aplomado Falcon. Eliminated from the United States by the middle of the 20th century, this rare falcon has made a comeback: over the past decade, a breeding population in Texas of approximately forty pairs has been established. Key to the success of that effort has been the use of "Safe Harbor Agreements" to secure the cooperation of the ranch owners on whose ranches captive-bred falcons have been released. Over two million acres of private rangeland is now encompassed in these agreements. Meanwhile, in 2006, falcon releases began in New Mexico as part of an experimental population authorized there.

American Bald Eagle. Symbol of the nation, the bald eagle was declared fully recovered and taken off the endangered list just in time for Fourth of July celebrations in 2007. The banning of most uses of the pesticide DDT in the United States in 1972 made the eagle's recovery possible. Its recovery was accelerated by the heightened protection it received under the Endangered Species Act, acquisition of key habitats, and an aggressive effort to reintroduce the eagle into areas it had formerly oc-

cupied. As a result of these actions, eagle numbers have increased from fewer than 500 known breeding pairs in the lower 48 states in the early 1960s to over 10,000 today.

Kemp's Ridley Sea Turtle. Tens of thousands of adult females once clambered ashore in a single day to lay their eggs on the beaches of Mexico that served as the only known nesting sites for this species. By the 1960s, however, these remarkable "arribadas" were gone and only a few hundred females nested each year. Protection of the Mexican nesting beaches, establishment of a new nesting site in Texas as a result of "head-starting" hatchlings there, and strongly resisted requirements for American shrimp boats to use specially designed excluder devices to reduce turtle drownings have contributed to a steady increase in the turtle's nesting numbers.

Whooping Crane. The whooping crane has benefited from one of the longest sustained conservation efforts for any species in the United States. By the early 1940s, fewer than 20 birds could be found along the Gulf coast, where the crane winters. When its breeding habitat was discovered in Canada some years later, an intensive rescue effort was made possible. Captive breeding, establishment of a new migratory population entirely in the United States, and vigilant law enforcement has slowly but steadily rebuilt crane numbers to over 500 today. While full recovery is still many years away, the crane is demonstrably more secure than ever before.

FIVE HIGHLY THREATENED SPECIES

Ocelot. Only a few dozen of these small spotted cats persist in two populations in extreme southern Texas, where little of its native thornscrub habitat remains. Efforts to construct a border fence along the Mexican border may prevent genetic interchange with more abundant ocelot populations south of the border. That development would seriously imperil the

future of this already beleaguered cat in the United States.

Ivory-billed Woodpecker. It is unclear whether this large woodpecker still survives. Presumed extinct for many decades, the woodpecker was reported sighted (and briefly filmed) in 2006 in the bottomland hardwood swamps of the Cache River National Wildlife Refuge in Arkansas. Despite intensive subsequent searches, however, there is no conclusive evidence that it survives today (and some controversy over the accuracy of the identifications made in 2006). The ivory-billed woodpecker's decline and possible extinction is due to the loss of its forested swamp habitat in the American South.

Schaus Swallowtail Butterfly. This extremely rare butterfly is restricted to a few small sites in the Florida Keys, where its remaining hardwood hammock sites could be destroyed by a hurricane. A successful captive breeding effort helped prevent the near extinction of this species following a previous hurricane.

Alabama Sturgeon. An ancient fish of the Mobile Basin, the Alabama sturgeon is one of the rarest fish in North America. In the past decade, only a handful of specimens have been found in the wild. Despite the sturgeon's extreme rarity, barge interests have asked the United States Supreme Court to rule that the listing of the fish as an endangered species is unconstitutional because it now occurs in only one state (formerly in two) and is no longer utilized in interstate commerce, though it once was.

San Joaquin Kit Fox. This small fox of California's Central Valley has lost most of its native habitat to intensive agriculture and urban development. Though protected as an endangered species since the first official federal list of endangered species was promulgated in 1967, the kit fox is likely rarer today than ever before.

Source: Environmental Defense



The whooping crane has come back from near extinction to more than 500 birds today.

Fischer: Can you give some examples of what owners are asked to do in various parts of the country?

Bean: Sure. It may involve some prescribed burning in longleaf pine forests in the southeastern United States, or restoration of riparian or wetland habitats in the West, which have suffered dramatically over the last 30 or 40 years. In Florida, owners are being encouraged to stem the spread of Kogon grass, an Asian invasive species that is very hard to eradicate once it is established, which is interfering with gopher tortoise populations.

In New England, the bog turtle is being helped by restoration of open, sunny, wetland meadows. This traditionally was accomplished by elk and buffalo grazing in pre-agricultural times, and then by farm animals. But with the decline of farming in the northeast, my organization has actually rented goats to beat back the undesirable woody vegetation and free up the areas that the bog turtle depends upon.

Fischer: When the act is eventually reauthorized, what changes would you recommend?

Bean: Three things. First, more attention needs to be given to incentives. The act now is largely prohibitory and doesn't have provisions that encourage landowners to do more than the minimum. This could change as the result of work by organizations like RFF to better measure the value of ecosystem services, and by establishing conservation banks and other market mechanisms to reward positive behavior toward endangered species.

Second, we clearly need to figure out a way to forge a more effective working partnership with the states so that better federal-state coordination can take place. And third, if we are really serious about preventing extinctions of any plant or animal in the United States—as the act now mandates—it is going to take resources that far exceed what Congress has provided up to now. Given ongoing climate changes, commercial development and residential expansion, and globalization trends, we need to invest much more in conservation and wildlife recovery efforts at every level of society. ■



A Recipe to Fight Vitamin A Deficiency in India: Add Mustard and Stir?

**Ramanan Laxminarayan, Jeffrey Chow,
Eili Klein, and Paula Tarnapol Whitacre**

Have you had your vitamin A today? You need it for such essential processes as growth, vision, and resistance to infectious disease. Chances are, you don't have much to worry about. Most adults who consume dairy products, meat, and vegetables on a regular basis are okay, as these products either contain or are fortified with vitamin A or beta-carotene, a precursor to vitamin A.

But worldwide, the situation is quite different. Vitamin A deficiency (VAD) is a significant cause of blindness and death, especially for children and pregnant and lactating women. According to the World Health Organization, an estimated 250 million preschool-age children in more than 100 countries are vitamin A deficient. Of these, between 250,000 to 500,000 lose their sight each year as a result, and more than half die within 12 months. VAD also increases the risk of dying from diseases such as malaria and measles: estimates suggest that it contributes to the deaths of 1.2 to 3 million children annually. Approximately 7.2 million pregnant women in developing countries also suffer from VAD, which means their infants are likely born in an already compromised state.

Beyond the immediate impact on families, VAD also has a financial impact on a country. Poor nutritional status can reduce a country's gross domestic product by 2 to 3 percent annually, according to the World Bank. In addition, VAD and other nutritional deficiencies can result in significant outlays when treatment of otherwise preventable illnesses strains overburdened health systems. Conversely, improving a person's nutritional status can increase his or her lifetime earnings by at least 10 percent, which can make a considerable difference to a country's economy as a whole.

India has some of the highest rates of VAD in the world. Each year, it is associated with the deaths of 330,000 children in India alone. Although vitamin A status has improved in the past few decades, a survey by the National Nutrition Monitoring Bureau indicates that 57 percent of Indian children—35.4 million children—were vitamin A deficient in the late 1990s. Data also suggest that while VAD affects both rural and urban households, it generally results from malnutrition.

Getting Public Health Programs Working

Over the past few decades, as the link between VAD and mortality and morbidity have become better understood, countries and international organizations have developed three main approaches to boost vitamin A levels: periodic supplementation of young children with high dosages of vitamin A; fortification of commonly eaten foods with vitamin A, often with other micronutrients; and other food-based approaches such as nutrition education and promotion of home vegetable gardens.

These approaches have had results, but, as the numbers show, they have not solved the problem. Moreover, supplementation, the most commonly used intervention, is on the decline, because it has often been implemented alongside polio immunization campaigns that are winding down in many countries.

Experiences in India with these three interventions illustrate how difficult it is to get public health programs working on the ground. Although the country launched one of the world's first supplementation programs to fight blindness in 1970, only a small percentage of children now receive the recommended twice-yearly dosages of vitamin A, and coverage varies greatly by state and by income level.

Supplementation programs in India also suffer from a lack of support from India's medical establishment—which, despite widespread evidence—has not uniformly endorsed vitamin A's link to mortality, and has displayed a preference for fortification and food-based approaches over supplementation. Unfortunately, India's highly decentralized food-processing systems and varied diets hamper these other approaches, as well. Despite many innovative attempts and pilot projects with foods that range from rice, to tea, to fortified candies, less than one percent of food in India is fortified with vitamin A or any other micronutrient. India's low meat and dairy consumption increases the likelihood that people, especially the poor, will get enough vitamin A from their diet alone.

New advances in biotechnology have generated the possibility that foods genetically modified to express excess amounts of vitamin A may be an alternative. To assess the potential of this approach, the U.S. Agency for International Development and the International Center for Tropical Agriculture asked RFF to look at one potential option: biofortification of mustard seed with vitamin A. (This article is based on a new RFF report, *Closing India's Nutrition Gap: The Role of Golden Mustard in Fighting Vitamin A Deficiency*, by the authors. See ▶ www.rff.org/rff/goldenmustard.)

Why mustard? Cooking oil from pressed mustard seed is commonly used in northern India where VAD is most widely prevalent, especially among poor rural families that are often underserved by supplementation programs. Another advantage is that vitamin A is more easily digested when consumed with a moderate amount of fat, such as edible oil. In recent years, the Monsanto Company and The Energy and Resource Institute (TERI) in India—building on Monsanto's experience biofortifying canola oil, a close genetic relative to mustard, with vitamin A—succeeded in expressing high levels of beta-carotene in mustard seeds. The technology involved is similar to that used to develop the better-known "golden rice." Once pressed, the biofortified mustard oil retains high levels of beta-carotene, which is what gives the oil, like rice, its dark golden color. The fortified oil can provide far more vitamin A per serving than through traditional means.

However, after several years of laboratory work and very limited field trials, efforts to commercialize the technology have stalled,

despite a pledge from Monsanto to license the technology without cost. RFF was asked to help determine whether further investment in the technology should continue. Two main questions were addressed: first, whether mustard production and consumption indicate its appropriateness as a vehicle to increase vitamin A intake; and second, whether biofortification costs, particularly compared with existing interventions, justify further investigation. If VAD-affected individuals do not consume mustard in sufficient quantities, especially children and women, or if the costs are unreasonably high, it is not worth exploring further.

The study did not take into account the political, social, and environmental questions that have been central in the debate about genetically modified foods worldwide, issues that policymakers cannot ignore. But it provides a piece to the puzzle as new ways are sought to improve nutrition worldwide.

Mustard from Mela to Mouth

As with many crops in India, mustard is grown primarily on a small scale, with most of the country's 40 to 50 million mustard farmers planting about five acres annually. Production, like consumption, is concentrated in the north. Farmers generally purchase new seed each year, typically at melas (farm fairs), which also serve as a source of agricultural information. A number of public and private institutions also support producers and processors and are potential avenues to introduce information about "golden" mustard or even distribute seed.

About 90 percent of the mustard seed grown in India goes to make oil. Large manufacturers process the highest volume of oil (about 75 percent of the total annual production of about 2 million metric tons); small-scale facilities are more inefficient, although far more numerous. Although no reliable data exist about the extent of home production, anecdotally it is believed to be high.

Studies on similar types of oil show it must be stored in dark containers, as vitamin A breaks down in light, and for a limited amount of time (nine months in lab conditions, probably less in situations of extreme heat or cold). Therefore, the feasibility of biofortified mustard as a reliable vehicle to increase vitamin A intake depends in large part on proper packaging and storage. In India, mustard oil is purchased in small quantities from bulk suppliers or in bottles or cans as branded oil—in either case, opaque packaging would be needed. While it has a shelf life of up to a year, it is typically distributed far more quickly from processor to consumer.

Mustard oil is prized for its pungency and is a staple in many households, regardless of income, in both urban and rural areas. Although not all states with VAD problems are mustard consumers (again, keeping in mind regional preferences), it is consumed in a significant number of states where VAD is also prevalent. Assuming that all mustard oil was biofortified and none of the vitamin A was

lost during storage or cooking—admittedly very optimistic assumptions—a child would need less than one teaspoon a day to get their recommended daily allowance, assuming no other source of the vitamin was available.

Consumption among the poor is closely tied to household production of mustard oil, especially in rural areas. Households with no cash income still consume small amounts, which suggests the need to get biofortified seed to home-based producers. On the other hand, some states with a high prevalence of VAD consume mustard oil shipped in from other states, most likely from one of the few large processors. In other words, both large commercial producers and small producers would need to buy or grow biofortified seed in order to reach all the people suffering from VAD.

Is It Worth It?

An economic-based analysis of biofortified mustard to fight VAD does not provide the whole answer. However, the RFF analysis creates a framework against which to explore other issues. If biofortified

VITAMIN A

The ancient Egyptians and Greeks were on to something when they treated ocular problems with a piece of liver consumed or placed on top of the eyes. Centuries later, doctors recognized that meat and milk could cure night blindness, a symptom of vitamin A deficiency (VAD). By the early part of 20th century, the role that vitamins and other nutrients play in human health was firmly established, and VAD was generally eliminated from developed nations.

Vitamin A is consumed as retinol in animal foods, such as meat, dairy products, and eggs, or as carotenoids (principally beta-carotene) in many fruits and vegetables, such as dark green leafy vegetables, mangoes, and squash. Because the body absorbs retinol far more efficiently than carotenoids, adequate vitamin A intake requires more "retinol activity equivalents" from vegetable sources than from animal products—in other words, far larger amounts of fruits and vegetables must be consumed to reach the recommended daily allowance for vitamin A. Absorption of vitamin A also depends on a person's fat intake (because it is a fat-soluble vitamin, more fat is better in this instance), how the food is prepared and stored, and the presence or absence of parasites in the body.

The bottom line is that a person, especially a child, cannot realistically get sufficient vitamin A from diet alone if he or she consumes little or no animal products, even with lots of beta-carotene rich foods.

mustard can't meet the vitamin A needs of vulnerable populations—or would do so at a cost that makes it unfeasible on a wide enough basis to solve anything—then these other questions become moot.

The cost-effectiveness analysis compared supplementation, traditional fortification of processed mustard oil, and biofortification of mustard seed. The economic burden of avoiding diseases was calculated using disability-adjusted life years (DALYS), which is an adjusted measure of years lost due to premature death or disability, where different forms of disability are given different weights. The comparison is based on the cost per DALY averted (cost-effectiveness ratio) for each of the three interventions over a 20-year time frame.

Costs for supplementation include those associated with dosing children twice annually through existing health centers; training, promotion, and monitoring; and an additional amount to reach areas without functioning health centers. Costs of traditional fortification include processes to ensure product quality and to promote consumption, as well as to fortify the oil with beta-carotene. Biofortification costs include the same quality-related costs, as well as a one-time cost to account for research and development and licensing of the seed (estimated at \$5.6 million). Additional seed costs for farmers were not factored in, nor were potential costs related to uncertain environmental impacts of genetically modified crops.

The RFF analysis shows that the most cost-effective intervention remains supplementation, followed by biofortification and traditional fortification. Despite less favorable economic numbers, biofortified mustard has the potential to avert a greater burden of childhood and maternal death than both traditional fortification and supplementation, particularly in areas with weak coverage by the health care system.

No matter the analysis, mustard farmers must be willing to plant the biofortified varieties, and consumers must be willing to consume sufficient quantities of it. As traditional fortification efforts show, both a “push” strategy to increase the attractiveness to growers and oil producers and a “pull” strategy to increase consumer demand for fortified oil would be needed. These challenges are not novel to biofortification, but their successful resolution remains unknown.

Experience shows that Indian farmers are willing to adopt new technologies when they recognize tangible benefits, such as improved yield, higher revenues, lower price of inputs, or some combination. The RFF study looked at several strategies to provide incentives, from a full-scale plan to subsidize costs at all levels of production to a market-based approach that would target seed production alone. The latter is less resource-intensive and would probably yield comparable results. A program could offer free seeds or targeted seed subsidies, especially in areas where production and consumption are high so that demand could also be stimulated. While all seed would not have to be biofortified to accrue nutritional benefits, a significantly high amount would.

The challenge for biofortified mustard oil, as for other health



© DAVID ZIMMERLY

practices that do not result in immediate, visible benefits, is to educate consumers to want to use the enhanced product. Given some well-publicized cases with food adulteration in India, a campaign to reliably identify the enhanced product would be needed, reinforced by public health messages from credible sources such as the medical establishment and nonprofit organizations.

In short, a wide-scale attempt to introduce biofortified mustard would have to overcome hurdles to technology adoption by growers and gain acceptance by consumers to ensure that the projected benefits are achieved. The challenge is no less daunting than other health campaigns, including other methods of increasing vitamin A intake, but would have to be considered and planned for.

Wider Implications

A biofortification strategy can play an important role as part of a broader approach to reducing the prevalence of VAD in India. Such strategies can be cost-effective, feasible, and implemented under conditions where supplementation and fortification are currently disadvantaged. However, there are significant barriers. Perhaps foremost of these is that recognition of the importance of VAD as a public health problem in India is low. Without this recognition, all strategies to address VAD are doomed. Even with it, supporters would have to overcome many operational challenges. Additional concerns specific to biotechnology also cannot be ignored, as they remain a continuing barrier to adoption of mustard or any other genetically modified foods.

So, to biofortify or not to biofortify? Golden mustard is not the proverbial silver bullet to solve vitamin A or other micronutrient deficiencies. Yet, with evidence that millions of children and women in India and worldwide can benefit from even modest increases in consumption of the vitamin, it deserves a closer look. ■

RFF Establishes Major Research Initiative on Adaptation to Climate Change

The development of public policy to respond to climate change by mitigation—largely by reducing emissions of greenhouse gases—has been underway since the 1980s. The building blocks of mitigation policy are drawn from a 40-year legacy of research in environmental and resource economics that has led to the establishment of tried-and-true regulatory concepts, including emissions and performance standards, cap-and-trade permit systems, and emissions taxes.

However, even if the global community is successful in mitigating emissions to such an extent that catastrophic climate change can be avoided, the thermal inertia in the climate system itself will lead to inevitable change over the coming decades.

The recently released Fourth Assessment Report from Working Group II of the Intergovernmental Panel on Climate Change (IPCC 2007) describes the mix of impacts the United States would likely face, including a rising sea level, more moderate temperatures in the northern parts of the nation (possibly leading to longer growing seasons but also decreases in snow pack and increases in winter flooding), greater risk of drought, and more frequent wildfires and heat waves.

RFF has responded by establishing a major new research initiative on adaptation. The goal will be to supply the building blocks from which government adaptation policies can be constructed. This effort, the first in a long series of projects at RFF, will focus on the United States. The project will be led by RFF Senior Fellows Raymond Kopp, Molly Macauley, and Richard Morgenstern.

"Clearly, adaptation will be as crucial to managing climate change as mitigation," said Kopp, director of the RFF's Climate and Technology Policy Program. "To date, however, research on adaptation policy is both limited and scattershot. This work will bring a deeper and more coherent approach to the subject."

Crafting adaptation policy is complicated by both the intricacies of climate change and uncertainty about the vulnerability of natural and human-made assets to climate change and variability. In the first phase of the project, researchers will draw on available climate science as well as other natural sciences and engineering to analyze strategies and options that might enhance the ability of society to adapt. The environmental and other effects that will be studied follow the framework set forth in the IPCC report: freshwater resources; coastal and marine ecosystems; public health; agriculture; and industry, settlement, and society. Some of the questions that will be addressed include:

- How can we rank impacts and prioritize options?
- Which activities are best undertaken by the private sector and which by the government?
- Do we have all the institutions, public and private, needed to carry out these options?
- How will these options be financed?
- And for those impacts where there are no viable options, what should be done to address the distributional consequences?

In the second phase, pre-eminent social scientists will seek to answer these questions, building on the natural science assessments developed during the first phase. Findings will be discussed at a series of workshops, and col-

lected in a book to be published by RFF Press. A major dissemination conference and congressional briefings are planned.

Mapping Global Adaptation "Hotspots"

There's more adaptation work going on at RFF. In a new project funded by the MISTRA Foundation's Climate Policy Research Program, RFF Fellow Shalini Vajjhala and Research Assistant Yatziri Zepeda Medina are looking at how to set geographic priorities for building resilience to climate change. While mitigation efforts provide benefits everywhere, adaptation is an inherently local problem, where impacts and responses are likely to be highly site-specific. As a result, adaptation policy design is a spatial problem, where the locations of key populations and resources matter.

By overlaying maps of projected climate risks, including sea level rise, changes in disease vectors, and agriculture impacts, Vajjhala and Zepeda are working to create an analytic framework for evaluating multiple stressors associated with climate change and allocating international adaptation funding at the country level.

At the Bali meetings in December, the UN Framework Convention on Climate Change established an adaptation fund to be administered by the Global Environmental Facility and the World Bank, which will set global priorities for adaptation funding. However, there is still a long way to go before we have accurate forecasts of the local impacts of climate change. Vajjhala and Zepeda's study is intended to help bridge the divide between science and policy and lay the groundwork for identifying early investments that could help anticipate and avoid the worst potential outcomes even as climate forecasts improve. "In the absence of perfect foresight on where specific adaptations are likely to be most necessary and most effective," said Vajjhala, "our goal is to map out where we need to invest the greatest effort." ■

RFF Scholar Ian Parry First to Fill Kneese Chair

Senior Fellow Ian W.H. Parry is the first appointment to the Allen V. Kneese Chair in Environmental Economics at RFF, which was recently established to commemorate a long-time RFF scholar and visionary thinker. Parry, who has been at RFF since 1995, focuses on environmental regulation, transportation, tax policy, and public health issues.

The academic chair honors Allen Kneese's 40 years of pathbreaking research at the institution. Kneese, who died in 2001 at the age of 70, played a central role in developing the economic principles that have become crucial to environmental policy worldwide.

"By creating an appropriate tribute to extend the work of Allen Kneese—and pay homage to one of RFF's pioneering scholars—we will secure senior academic talent within our research staff and will recall the legacy of Allen's work for generations to come," said RFF President Phil Sharp. "Much of Parry's work over the last decade has focused on refining, broadening, and more generally applying the economic analysis of environmental policy design and instrument choice, which was pioneered by Allen Kneese and others at RFF. In particular, Parry has studied how environmental policies interact with the broader tax system, their incentives for induced technological change, and their distributional incidence across different income groups. He has applied this type of analysis to global warming and other air pollution problems as well as to policies to improve automobile fuel economy and reduce highway traffic congestion and accidents."

The Allen V. Kneese Chair in Environmental Economics will be a permanent senior research position. Contributions from Kneese's friends and colleagues, plus support from Kneese himself, provided endowment funding for the chair.

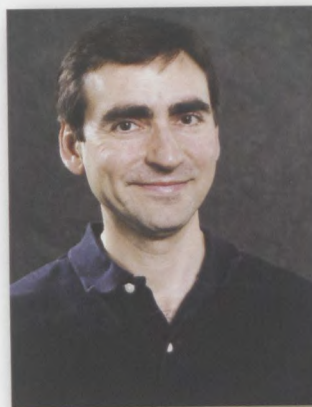
When Kneese joined RFF in 1961, economists were beginning to conclude that shortages of natural resources would not stop economic growth—and that the greater threat was the rising pollution that growth was creating. People had started "to raise the idea that you have all these waste materials coming 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.

Kneese was the first to recognize and model

the relations of air, water, and other forms of pollution. Many economic historians believe he single-handedly kept alive the idea of using economic incentives to encourage environmental improvements. In 1990, he and John V. Krutilla 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."

The Kneese Chair is the most recent chair to be endowed at RFF since the institution's 50th anniversary in 2002. Others include the Darius Gaskins Chair and the Chauncey Starr Chair in Risk Analysis. A fourth chair, established by Thomas Klutznick to focus on urban issues, will be filled at a future date. ■



IAN W.H. PARRY

INDE
ON T
Want
Consi
objecti
to dec
202.
FOR THE FUTURE

Resources
AUTHOR
N 167
TITLE

INGS
TIME
olved?
ature.
ations
ergy,
ion.



New from RFF Press

Wildfire Risk Human Perceptions and Management Implications

Wade E. Martin, Carol Raish,
and Brian Kent, editors

Cloth, ISBN 978-1-933115-51-1 \$85.00

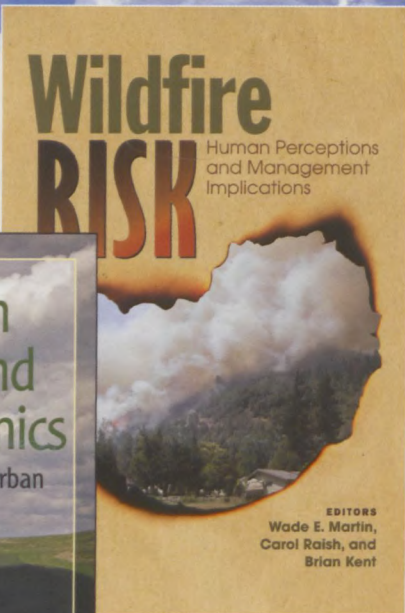
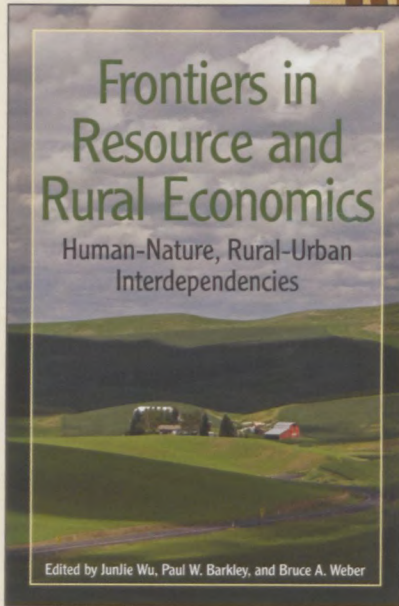
Paper, ISBN 978-1-933115-52-8 \$43.95

From the Corn Belt to the Gulf Societal and Environmental Implications of Alternative Agricultural Futures

Joan Iverson Nassauer,
Mary V. Santelmann, and
Donald Scavia, editors

Cloth, ISBN 978-1-933115-47-4 \$85.00

Paper, ISBN 978-1-933115-48-1 \$41.95



Frontiers in Resource and Rural Economics Human-Nature, Rural-Urban Interdependencies

Junjie Wu, Paul W. Barkley, and
Bruce A. Weber, editors

Cloth, ISBN 978-1-933115-64-1 \$85.00

Paper, ISBN 978-1-933115-65-8 \$41.95

Perspectives on Sustainable Resources in America

Roger A. Sedjo, editor

Cloth, ISBN 978-1-933115-62-7 \$80.00

Paper, ISBN 978-1-933115-63-4 \$38.95

PDF QUICK LINK ► Selecting a book title, or a cover, will take you to the RFF PRESS website with further information on the publication and its author.

TO ORDER, VISIT WWW.RFFPRESS.ORG OR CALL 800.537.5487 (U.S.) OR 410.516.6965



**RESOURCES
FOR THE FUTURE**

1616 P Street, NW
Washington, DC 20036-1400

RETURN SERVICE REQUESTED

NON-PROFIT
US POSTAGE PAID
PERMIT NO. 3361
BALTIMORE, MD



* 9 3 N 1 6 7 *