

RESOURCES

RESOURCES FOR THE FUTURE



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MARINE LIFE**

**TRANSGENIC TREES
AND TRADE**

**ENERGY
EFFICIENCY PROGRAMS**

**BUSH AND KERRY ON
ENERGY AND THE ENVIRONMENT**





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PAUL R. PORTNEY

Arizona Dreamin'

Readers, a confession is in order. Although I have been at Resources for the Future (RFF) for almost all of the past 32 years, and although RFF has always concerned itself in part with the conservation of natural resources, including wilderness areas, I'm not really much of an outdoorsman. To be sure, I make a beeline for the golf course every chance I get and enjoy walking along the Potomac River near my home as often as I can. But that really doesn't count. Rafting, camping, and hiking in this country's scenic wilderness have never been my cup of tea.

A month ago I made a first effort at remedying that and spent nine days rafting down the Colorado River as it meanders through the lower half of the Grand Canyon. It was an experience I won't ever forget, because I was reminded that it's one thing to study a problem from the confines of one's office in Washington, DC, and quite another to get out "into the field," as they say. Thus, it's not surprising that the late John Krutilla spent a good part of his professional lifetime at RFF writing about how one might ascribe value to the preservation of the wild, since he was an avid hiker and outdoorsman. Nor is it surprising that the late Marion Clawson was intensely interested during his professional career in the management of public lands, since he grew up the child of western homesteaders.

Growing up in Detroit as the son and grandson of men who made their living in the auto industry may be why my own research at RFF has centered on the costs and benefits

of air pollution control, especially that from cars. As researchers, our best work may be on those things that interest us personally before they hook us professionally. That said, even a "tenderfoot" like myself couldn't help but marvel at the sheer grandeur of the canyon, the complexity of the water resource issues surrounding the river that runs through it, the commitment to wilderness preservation of the men and women who guide rafters along the river, and the efforts of the National Park Service to safeguard this geological wonder.

As you read about RFF's work in the pages of *Resources*, you should know that in addition to their scholarly pursuits, our researchers are also tromping through forests, talking with fishermen, touring power plants and Superfund sites, visiting coffee farmers, and working with villagers in the developing world. In fact, these very outside interests may well have preceded their scholarly pursuits. Had I been lucky enough to float through the Grand Canyon in my 30th rather than my 60th year, I might be working on the economics of the national parks today!

Thanks for your interest in and support for Resources for the Future, and please enjoy this issue.

Paul R. Portney

Rep. Mark Udall Says “Hyperpartisanship” to Blame for Failure to Pass Energy Bill



Congress’s ongoing struggle to pass a comprehensive energy bill is caused, in no small part, by “hyperpartisanship,” said Rep. Mark Udall (D-CO), who spoke at an RFF Policy Leadership Forum in early September.

Both sides are deadlocked over the bill because of numerous amendments over controversial issues like opening up the Arctic National Wildlife Reserve for drilling. If this provision alone were taken off the table, Udall suggested, many more Democrats would work for the bill’s passage.

While critical of the Bush administration’s activism on the bill, Udall said, “We all share some of the blame.” The process of bringing the

bill to fruition, which has gone on for many years, has been encumbered by constant shifts in political priorities. “Not everyone has been at the table and fully involved,” he said, and that has prompted many legislators and special interest groups, Democrat and Republican, to introduce language to meet their needs.

Udall said he was deeply disappointed by the fact that the current version of the bill fails to address two key problems: the reliability of the nation’s power generation grid, despite last summer’s widespread blackout; and extension of the renewable energy production tax credit, which is now buried in the current tax reform proposal. Utilities need more time and predictability as they move

toward greater use of renewable sources, he said.

While the administration and Congress are at a standoff over energy policy, the states are forging ahead anyway, Udall said. Sixteen states have passed renewable energy portfolio standards, requiring utilities to generate some percentage of their power from renewable sources. And Colorado may become number 17, Udall said proudly. A state ballot initiative, which he helped drive with support from the Republican state treasurer, has a good chance of passage this fall, he said.

“We told the voters that it would bring economic development in rural communities, help diversify our energy sources, and bring new jobs to Colorado, ones that would be tough to send offshore,” he said. “We want to see if we can become the Saudi Arabia of wind and solar power generation,” he joked.

Udall’s commitment to making renewable energy a much greater priority extends back to Congress, where he serves as the co-chair of the Renewable Energy and Energy Efficiency Caucus, which has 224 members spread across the political and geographical landscape. He is also a member of the House Resources, Science, and Small Business Committees and the Science Subcommittee on Environment, Technology, and Standards as well as the Subcommittee on Space. ■

We told the voters that the state ballot initiative would bring economic development in rural communities, help diversify our energy sources, and bring new jobs to Colorado. We want to see if we can become the Saudi Arabia of wind and solar power generation.

Amory Lovins at RFF: “Our Energy Future Is Based on Choice, Not Fate”

Our dependence on oil can be eliminated by proven and attractive technologies that create wealth, enhance choice, and strengthen national security, according to Rocky Mountain Institute CEO Amory Lovins, who spoke at an RFF Policy Leadership Forum in September. The revolutionary thinking of the “consultant physicist” has earned him international recognition, including a MacArthur Fellowship, an award from the Heinz Family Foundation, and eight honorary doctorates.

America’s consumption of oil risks both the nation’s competitive strength and its security, Lovins noted, and he outlined strategies for dramatically reducing U.S. oil usage through better efficiency, competitive biofuels, and saved natural gas. His presentation focused on the automotive industry and drew from *Winning the Oil Endgame: Innovation for Profits, Jobs, and Security*, his new study that was supported in part by the Department of Defense.

Lovins believes that unless key changes are made in the U.S. auto industry soon, Japan and the EU will “eat Detroit’s jobs for lunch.” Foreign auto competitors are researching lighter, more fuel-efficient cars, and American manufacturers cannot afford to be left behind, he said. In addition, U.S. overdependence on oil contributes to energy insecurity, geopolitical rivalries, price volatility, and climate concerns.

Avoiding these consequences—and an energy future dictated by OPEC or marred by sizable cost-benefit trade-offs—is possible, Lovins asserted, declaring that “the United States has more market power than OPEC.” While OPEC may control the supply, the United States controls the demand. U.S. manufacturers and consumers proved this during the 1970s oil crisis by curbing demand enough to essentially break the OPEC cartel, he said.

A Superefficient Future?

By 2025, Lovins projected that cars and light trucks, such as SUVs, pickups, and vans, will account for half of U.S. oil use, a situation that is essentially untenable. The way out, he said, will come from ultralight materials like carbon-fiber composites that can halve vehicle weight, increase safety, and boost efficiency to about 85 miles per gallon for a midsize car or 66 m.p.g. for a midsize SUV. Much of these energy savings comes from the ultralight materials because, according to Lovins, currently three-quarters of fuel use is accounted for by the weight of the vehicle.

Lovins faulted consumers and automakers alike for limiting their views on what is possible. Basic auto industry and policy assumptions are that trade-offs are inevitable and that superefficient cars will only sell with government intervention. Lovins wondered, however, “what if superefficiency makes a *better* car?” A breakthrough in successfully manufacturing these improved vehicles, he noted, would create a car consumers would want to buy anyway.

Traditional objections that lightweight vehicles would be too expensive and unsafe are no longer valid, Lovins argued. Carbon-fiber vehicles are simpler and cheaper to manufacture, he said, citing an SUV prototype made up of 14 body parts that snap together.



Ease of manufacturing doesn’t mean unsafe, however. Though light, carbon fiber is strong, absorbing 6 to 12 times as much energy per pound as steel.

Rocky Mountain Institute’s new report identifies four integrated steps to this new future for energy and the automotive industry:

- double the efficiency of using oil,
- apply creative business models and public policies,
- provide one-fourth of U.S. oil needs by spurring the development of a major domestic biofuels industry, and
- save half the projected 2025 use of natural gas.

To achieve this, Lovins calls for investments of \$180 billion over 10 years, with \$90 billion earmarked for transportation equipment and the other \$90 billion allocated to build an advanced biofuel industry. Considering the United States currently spends \$120 billion per year on oil imports, these investments would generate \$150 billion per year in societal value by 2025—including one million new American jobs, the majority of them in rural areas.

The auto industry once switched, in six years, from open-wood bodied cars to 70 percent closed-steel ones, Lovins said. “With the right steps taken now, we can win the oil endgame within a decade.” ■

Who Has the Best Ways to Shape Environmental Policy, the United States or Europe?

Policymakers in the United States often assert that economic carrots on sticks can produce better—and voluntary—environmental improvements, while Europeans usually lean toward more punitive governmental regulation. Although they are contrasting strategies, they can both lead to similar outcomes and have a place in the regulatory arsenal.

That was the consensus of a panel of administrators and scholars who commented at a June seminar on a new RFF Press book, *Choosing Environmental Policy: Comparing Instruments and Outcomes in the United State and Europe*, edited by RFF Fellows Winston Harrington and Richard Morgenstern and Thomas Sterner of the University of Gothenburg.

In reviewing the impact of market-based economic incentives and direct regulation, the authors find that neither alternative is clearly superior in every circumstance. In fact, says, Josephine Cooper, vice president of government and industry affairs for Toyota, practice varies from one country to another because of different cultures.

“So much environmental regulation both here and abroad is based on hypothesis rather than real-world experience,” said Cooper. “This book looks at the actual success rates of policies implemented over several years under market conditions. It provides valuable



practical lessons to both the regulators and the regulated.”

The book focuses on genuine outcomes in an area of policy that has been left largely to theoretical modeling. In general, Morgenstern said, economic incentives have resulted in greater reductions of emissions than they were originally designed to produce, while what is commonly called command-and-control regulation has resulted in less. One reason, Harrington noted, is that under a system of tradable permits a violator’s competitors have a direct incentive to insist on compliance.

John Graham, administrator of OMB’s Office of Information and Regulatory Affairs, pointed out that actual practice reflects a lot of mixes between

the two alternatives. He warned against the assumption that economic incentives are widely accepted in American politics, citing Congress’s recent refusal even to give serious consideration to trading schemes for fuel economy standards on the automobile industry.

In discussing questions for future research, Albert McGartland, director of the National Center for Environmental Economics at EPA said that it would be worth knowing the relative effectiveness of the various methods of encouraging technological development to combat pollution. Cooper observed that command-and-control works better in implementing safety regulations in the auto industry, while it has a dampening effect on technological innovations to aid the environment.

Joseph Goffman, former senior attorney with Environmental Defense, advocated a broader look at the shift in American policy to economic incentives. This shift was partly a reaction, he said, to a crisis of confidence in the late 1980s regarding air quality and the difficulties of achieving further progress. “EPA bureaucrats’ feet were stuck in cement, and we are seeing that cement begin to dissolve” because regulators are perceiving the value of using marketable permit-based approaches to emissions control.

Miranda Schreurs of the University of Maryland asked how the American and European experience might apply to developing countries. Does it matter, she asked, what kind of pollution is the target—air or water pollution, for example? Further research, she said, might also look at voluntary agreements between government and industry, an instrument that has sometimes proved useful. ■

What Goes Up Must Come Down— Controlling Mercury Emissions

The fierce debate between the Bush administration and the environmental community about mercury pollution and what to do about it shows no signs of letting up. To facilitate discussion on this important issue, RFF held a forum in June to bring all sides together. Participants included Michael Miller, vice president for environment, Electric Power Research Institute; Pauline Middleton, president of the consulting firm Panorama Pathways; and Michael Murray, staff scientist at the National Wildlife Federation.

Mercury is a heavy metal that gets into waterways after it is released in medical and municipal waste or, more commonly, emitted when coal is burned to produce electric power. If consumed, the chemical is an acute neurotoxin. Mercury emissions caused by humans have declined by 50 percent since 1990, but the chemical accumulates in soil and in bodies of water over time, so it is still a cause for concern.

Currently more than 40 states have issued advisories about mercury contamination in a wide variety of fish species. The FDA and EPA recently issued warnings that pregnant women and small children should limit their consumption of some fish and avoid others altogether that come from more than 800,000 miles of rivers and 14 million acres of

lakes, including Lake Champlain and Walden Pond.

Most of the mercury deposited in the United States blows in from sources overseas, mainly in Asia, according to Miller. Similarly, two-thirds of mercury emissions from American power plants are deposited outside this country. Miller was optimistic that a cap-and-trade system, along with maximum achievable control technology, more commonly known as MACT, would reduce emissions by 5 percent nationwide and even more in the eastern half of the country.

Middleton emphasized the global nature of the problem. “Whatever goes up, must come down, and in the case of mercury, it comes back up again,” she said. Closer to home, coal-fired electricity generating plants produce about 40 percent of the mercury emissions in the United States and, Middleton said, are the only source not currently in dramatic decline. But she was also hopeful because field studies in Florida show that reducing emissions from local sources can result in sharply reduced contamination nearby.

Humans are not the only life form affected by mercury, Murray reminded the audience. Loons, otters, and egrets are other animals potentially harmed by consuming fish containing mercury. The widely forecast rise in the use of coal to generate power, he noted, will mean more mercury in the water unless emissions are curbed.

Both the Bush administration and its critics agree that emissions must be reduced, but there is no consensus whatsoever over how far, how fast, and by what means. The administration favors a cap-and-trade program, under which it would establish a nationwide ceiling for emissions but would allow utilities to trade

emissions permits among themselves to ensure that they made the reductions at the lowest possible cost. Most environmental organizations believe, to the contrary, that the Clean Air Act requires the application of maximum achievable control technology to each source. One reason is the fear that trading would inadvertently result in hot spots, or areas with concentrations of very high emissions.



Here again the panelists differed.

Cap-and-trade does not create hot spots, Miller said. But Middleton responded that emissions can have effects locally as well as globally. “We have to pay attention to where those hot spots are,” she said. ■

RFF Senior Fellows Dallas Burtraw and Karen Palmer have examined the mercury debate in depth; to learn more, visit www.rff.org/mercury.

Cutting Hunger and Poverty in Africa



The human costs of hunger, poverty, and disease in Africa are staggering. It is estimated that fully a third of sub-Saharan Africans go to bed hungry, and 31 million children under five there are malnourished. Experts and political leaders worldwide agree that agriculture can lead to economic growth and help cut hunger and poverty in Africa. However, a dramatic improvement in the level and quality of public investment in African agriculture—through more bilateral and multilateral assistance as well as increased budgets of individual countries—is needed to achieve this goal.

At present, there is a void of information on current public investment

activity in African agriculture, including the levels and effectiveness of U.S. agricultural development assistance. RFF Senior Fellow Michael R. Taylor and Research Associate Jody S. Tick are collaborating with The Partnership to Cut Hunger and Poverty in Africa on an analysis of the U.S. assistance program. This marks a first step toward providing policymakers with the analytical tools and information they need to construct enhanced and more effective public investment strategies.

The Partnership to Cut Hunger and Poverty in Africa was formed in early 2000 out of concern that the U.S. response to rising hunger and poverty in Africa was increasingly inadequate.

The executive board includes current and former African presidents, former U.S. government officials, university presidents, and representatives from the NGO community and the private sector.

The Partnership-RFF report will describe current U.S. programs, with particular emphasis on four countries—Mali, Mozambique, Ghana, and Uganda. It will examine the governance of the U.S. programs and document aid flows from all sources and over time, comparing them to the agricultural development programs of other developing countries and international development institutions, such as the World Bank. The authors will make specific recommendations about how to improve the U.S. program. A March 2005 release date is expected.

Taylor's interest in food-related policy issues dates back nearly 30 years, and he has served in senior policy positions at both FDA and USDA. He is focusing his attention on African agriculture and food security because, according to Taylor, "Africa remains the one region in the world where, without significant change, poverty and hunger will worsen in coming years. African agriculture, with adequate public investment of the kind on which all successful agriculture systems are built, can lead the way toward a better future for Africa's people." In 2003, he and Jerry Cayford co-wrote an RFF report, *American Patent Policy, Biotechnology, and African Agriculture: The Case for Policy Change*, available at www.rff.org/Documents/RFF-RPT-Patent.pdf. In 2001, he and Tick co-authored the RFF report, *Fulfilling the Promise: A Governance Analysis of the U.S. Response to the World Food Summit Goal of Cutting Hunger in Half by 2015*, available at www.rff.org/Documents/RFF-RPT-foodsafety.pdf. ■

Improving Public Participation along the Danube River

Being aware of what environmental problems exist and what steps are being taken to ameliorate them is becoming a basic right in many countries. In parts of Central and Eastern Europe, ready access to this kind of information is still quite new as governments begin to institute programs similar to the U.S. Freedom of Information Act for environmental data and information. But making these commitments real can be hard in places where, for many years, even something as simple as a city map was not easy to find, much less information about factories and which pollutants they produced.

RFF Resident Scholar Ruth Greenspan Bell is working on these issues as they pertain to cleanup of the

Danube River in Europe. Her current work builds on a previous partnership with the Regional Environmental Center for Central and Eastern Europe (REC) and New York University School of Law. Together, the three institutions conducted a pilot program that helped two EU accession countries, Slovenia and Hungary, build policies, legislation, and institutions that would support their commitments to provide public access to environmental information. More details about that project and its results can be found on the RFF website, at www.rff.org/danubeenvironmentalparticipation.

Now Bell and her colleagues will expand the program to five other Danube-basin countries: Romania, Bulgaria, Croatia, Serbia and Montenegro, and Bosnia and Herzegovina, as part of the Danube Regional Project.

The research team will start by evaluating the state of information access in each country and their policy options. In the course of the project, country participants will have the opportunity to examine models for information access from Western Europe, other countries of Central and Eastern Europe, and the United

States, from which they can select specific elements and approaches that can be adapted to their particular circumstances. Special attention will be given to information access about reducing pollution “hot spots.” Ideas will be “road-tested” through demonstration projects in each of the countries.

The end products of this effort will include handbooks, manuals, and other aids for governments and stakeholders. These materials will show how to make, process, and respond to information requests; how actively to make information available even before it is requested; and other techniques of environmental public participation. As with the pilot project, these products will be widely disseminated to reach as broad an audience as possible.

The Danube Regional Project, which is funding this effort, works in close partnership with the International Commission for the Protection of the Danube River, and both are based in Vienna. The project receives its support from the UN Development Programme and the Global Environment Fund. ■



Could Prize Money Promote Innovations in Space Technology?



The Ascender by Bristol Spaceplanes

Spurred in part by the success of prizes offered in the early 1900s to reward entrepreneurs like Charles Lindbergh for developing the airline industry, the National Aeronautics and Space Administration (NASA) is considering adding “inducement prizes” to its portfolio of ways to fund innovation in space technology. RFF Senior Fellow Molly K. Macauley recently testified before the House Subcommittee on Space and Aeronautics on the potential benefits and drawbacks of prizes as an addition to the current system of peer-reviewed grants and procurement contracts.

“For years, we have searched for the ‘magic bullet’ that would propel our nation back into space by way of the shuttle and space station for the multiple pursuits of scientific exploration on the one hand and a vibrant

commercial space industry on the other,” Macauley said. There is no lack of ingenuity in ideas for both of these goals. But critics of NASA’s plans—regardless of the scientific details involved—assert that they take resources away from pressing societal needs, she said. And critics of commercial space activities assert that such projects carry unique risks, take too much time to develop, and take too much time before they earn any money.

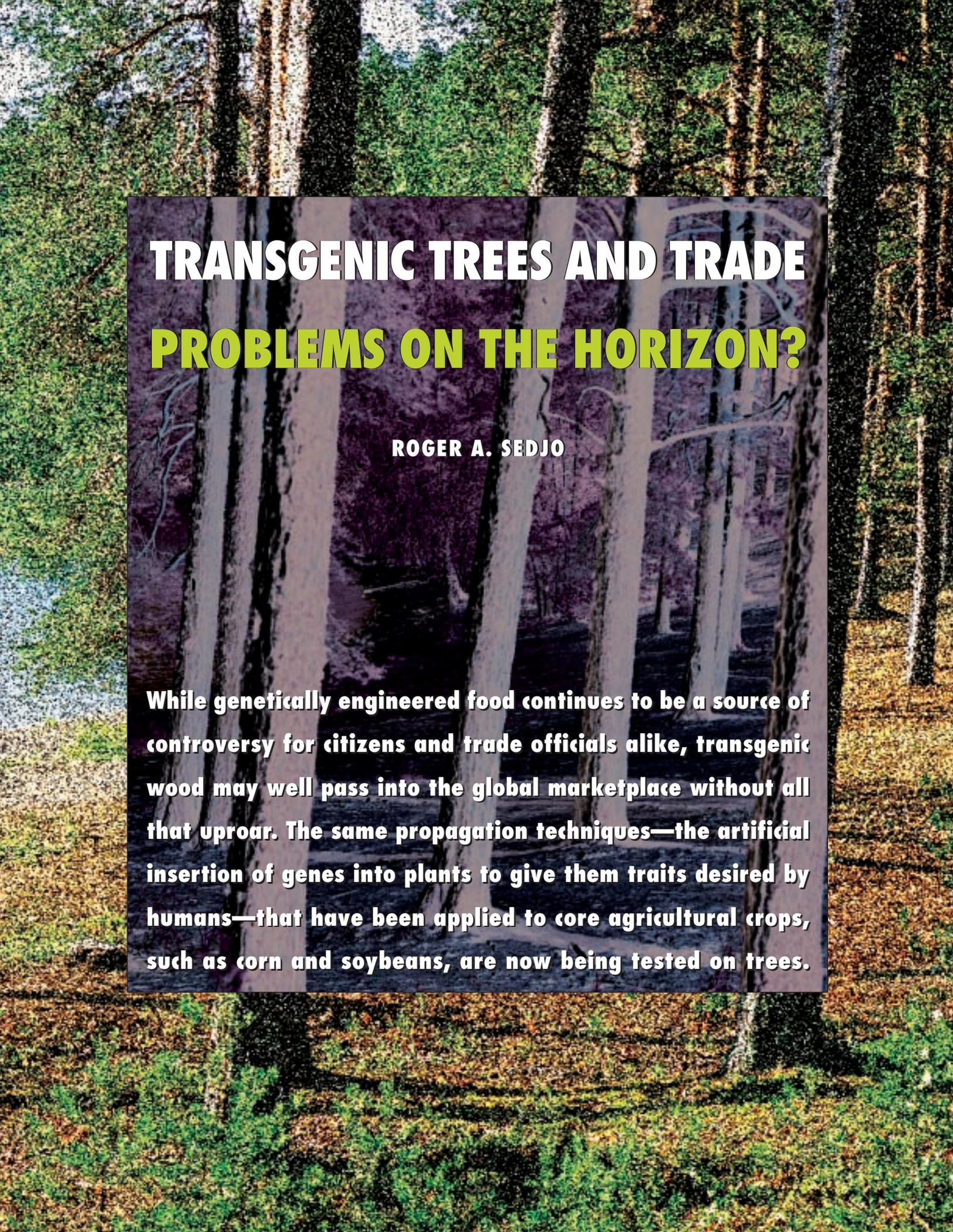
Obviously, priorities determine the allocation of budgets in both the private and government sectors of the economy, Macauley said. In other words, risk, long lead times, and long payback periods cannot themselves be blamed as a death knell for space efforts because significant investment takes place in other high-risk, highly uncertain industries, including

pharmaceutical development, information technology hardware and software, and hybrid autos.

Prizes are not the only solution for invigorating enthusiasm for space or elevating its priority in spending decisions, Macauley said. Nonetheless they could complement the federal government’s existing approaches to inducing innovation. Traditional R&D methods have their advantages and disadvantages, Macauley said. Research grants and many government contracts provide up-front money for researchers. But the current system does not necessarily encourage out-of-the-box thinking.

Another weakness from a broad, societal perspective is that taxpayers are, in effect, paying in advance for a project that may not even work. Under a system of prizes, awards are made only when the project succeeds. Macauley also noted that even if a prize goes unawarded because innovators fail, the lack of success generates important information for government. The failure to bestow a prize may mean that the specific technology has not yet passed the required threshold for advancement.

The history of the success of prizes—they were commonplace in the first decades of the 20th century—is attractive enough to warrant experimenting with their use in NASA activities, Macauley said. Further review of the structure of previous contests (their guidelines, funding, and results) and in particular, their assignment of intellectual property rights would provide helpful lessons learned as NASA continues its deliberations. But prizes cannot fully substitute for peer-reviewed grants and procurement contracts, she said. Taken together, all of these forms of financial support make up a portfolio of tools for encouraging innovation. ■



TRANSGENIC TREES AND TRADE PROBLEMS ON THE HORIZON?

ROGER A. SEDJO

While genetically engineered food continues to be a source of controversy for citizens and trade officials alike, transgenic wood may well pass into the global marketplace without all that uproar. The same propagation techniques—the artificial insertion of genes into plants to give them traits desired by humans—that have been applied to core agricultural crops, such as corn and soybeans, are now being tested on trees.



**Given the hurdles—
deregulation costs,
possible trade
restrictions, and small
markets—developers
are focusing their
efforts on modifying
wood fiber
characteristics of the
most widely planted
species.**



But unlike “Frankenfood,” the potential health and safety threats from the wood of modified trees are widely recognized to be essentially nonexistent and the possible regulatory and trade problems should be easier to surmount. As a result, the major concerns with transgenic trees have more to do with their possible effects on other plants and on the environment.

Although still at the experimental stage, high-yielding species of transgenic trees could have a significant effect on international trade in timber, a major traded commodity for the United States and a major export for much of South America. The reason why is that forest plantations now generate roughly one-third of today’s timber harvest, compared to an essentially negligible portion 50 years ago.

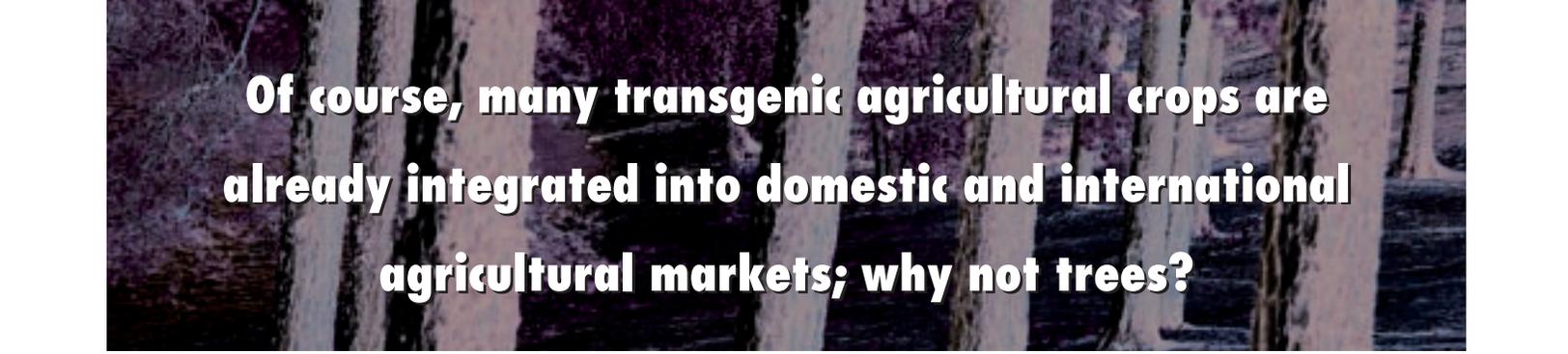
Industrial forestry is moving forward on two fronts with tree improvements from traditional breeding techniques and with major research efforts oriented to the production and commercialization of transgenic trees. While many of the productivity gains to date have come from traditional species selection and breeding, it appears only a matter of time before transgenic trees become commonplace.

Propagation innovations and the widespread introduction of fast-growing exotics have increased industrial wood production and even changed regional and international patterns of forest resource production and forest products trade. In the United States, plantations largely account for shifting the center of forestry from the West to the South. Abroad, South America is becoming a leading producer and exporter of plantation-grown wood and wood products, along with New Zealand, Australia, and South Africa.

Potential Barriers

International trade rules do not differentiate between indigenous and exotic wood or restrict trade in the wood or seed of genetically superior tree stock developed through traditional tree improvement programs. Although transgenic trees are, with very few exceptions, not yet commercialized, there are no international trade regulations for the wood of transgenic trees in world markets. However, the planting of living germplasm—the seed—is another story. Transgenic tree germplasm is generally regulated at the country level throughout the world, as it is for other transgenic crops. Of course, many transgenic agricultural crops are already integrated into domestic and international agricultural markets; why not trees?

Genetic engineering in forestry has tended to follow the pattern in agricultural crops. Early work focused on the transfer of an herbicide-resistant gene already implanted in



Of course, many transgenic agricultural crops are already integrated into domestic and international agricultural markets; why not trees?

“Roundup-ready” corn and soybeans. Other research has been undertaken to incorporate the Bt gene (*Bacillus thuringiensis*) that provides natural protection against certain pests. However, these activities seem to be attracting less research attention recently because of both regulatory and market forces.

Regulatory issues about transgenic plants center on health, safety, and environmental risks. Health and safety concerns arise when humans or animals consume a transgenic plant—generally not a problem for trees. The environmental effects of a transgenic include concerns that the transgenic itself might become a pest or, of greater concern, the possibility that a transferred gene might “escape” and alter the genetic makeup of a wild relative, perhaps increasing the fitness of the native plant and turning it into an invasive pest. In addition, an escaped gene might affect a pristine species and compromise its usefulness for developing improved hybrids the old-fashioned way.

Because of such fears, in most countries, a transgenic plant is automatically regulated. Before it can be commercialized in the United States, however, a transgenic plant is required to undergo a “deregulation” process that assesses the potential risks of adverse or damaging effects. Deregulation of trees with a Bt gene would involve two agencies—USDA’s Animal and Plant Health Inspection Service, under the Plant Protection Act, and EPA, under its regulatory responsibilities for toxics—making it costly for the plant developer. Moreover, deregulation of a transgenic in the United States does not necessarily mean that it can be marketed in other countries.

Market size is another consideration. In a tree plantation with a 20-year rotation, for example, only 5 percent of the land may be harvested and replanted each year. As a result, the market is small compared with that for annual crops like corn and soybeans. Furthermore, the market potential may not justify the costs of developing a plant and submitting it for deregulation in a particular country. Chile’s forest industry, for example, has an interest in the herbicide-resistant gene, but apparently the U.S. developer does not consider the market sufficiently attractive to justify adapting the gene to Chile’s planted Monterey pine (*Pinus radiata*) forests.

Transgenic Possibilities

Given the hurdles—deregulation costs, possible trade restrictions, and small markets—developers are focusing their efforts on modifying wood fiber characteristics of the most widely planted species. It now appears that traditional breeding approaches will be used to achieve increased growth and biomass yields, while genetic engineering will focus on desired wood characteristics, such as increased useful fiber or fiber that is more cheaply processed into wood pulp.

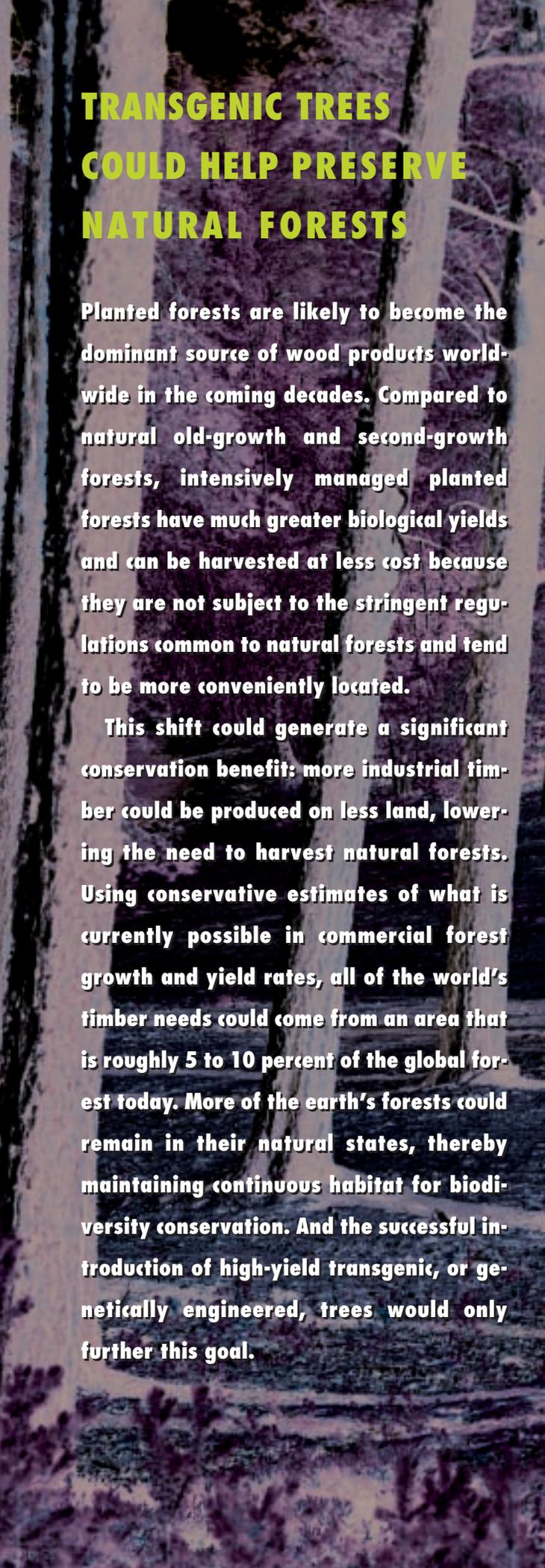
A U.S. tree biotech firm is working on innovations for loblolly pine, which is both the dominant plantation timber tree at home and a major species in several countries of South America. The innovations are largely fiber modifications to improve pulping characteristics, thereby lowering mill costs. The technical challenges involve transferring the genes for these particular fiber modifications and then developing a technique for low-cost, rapid transgenic seedling replication on the scale required for plantations.

Another attractive target is eucalyptus, and major innovations are now under way in Brazil, which currently prohibits some transgenics. However, transgenic food crops have recently been deregulated and are being grown, and the Brazilian forest product firms are betting that the transgenic tree ban will be removed. The payoff could be huge: eucalyptus grows very rapidly and is extensively planted worldwide, for both pulp and timber.

Other species of transgenic trees that are under development include a papaya that has been officially deregulated by the United States but is facing some resistance abroad, and a Monterey pine in New Zealand, where deregulation of new species has been put on hold. Finally, China is reported to have deregulated a hybrid poplar, which has been planted as a 700-acre commercial forest.

International Trade Issues

According to the basic rules of international trade, goods will flow from the country with a comparative advantage to countries with higher costs. In the case of international trade in wood, the basic product is raw wood, from which a great



TRANSGENIC TREES COULD HELP PRESERVE NATURAL FORESTS

Planted forests are likely to become the dominant source of wood products worldwide in the coming decades. Compared to natural old-growth and second-growth forests, intensively managed planted forests have much greater biological yields and can be harvested at less cost because they are not subject to the stringent regulations common to natural forests and tend to be more conveniently located.

This shift could generate a significant conservation benefit: more industrial timber could be produced on less land, lowering the need to harvest natural forests. Using conservative estimates of what is currently possible in commercial forest growth and yield rates, all of the world's timber needs could come from an area that is roughly 5 to 10 percent of the global forest today. More of the earth's forests could remain in their natural states, thereby maintaining continuous habitat for biodiversity conservation. And the successful introduction of high-yield transgenic, or genetically engineered, trees would only further this goal.

variety of products—building materials, pulp and paper, packaging materials—can be made. Consequently, the sheer number of products, as well as the benign nature of transgenic wood, makes prohibitions to international trade in transgenic wood unlikely.

However, trade in tree germplasm—seed or seedlings—may be viewed very differently. Concerns vary. Little gene escape is likely to occur in the natural environment if different plant families are involved. Since pines are not indigenous to South America, for example, gene transfer from a transgenic exotic pine to native tree species is unlikely. Similarly, eucalyptus is native to Australia, and the genes from bioengineered eucalyptus are unlikely to escape into native trees in other regions. Where native trees are modified, sterilization techniques would be used to control gene flow. But improved transgenic trees might well generate major shifts in the comparative advantages of timber-producing countries. The world has already seen a major restructuring attributable to traditional tree improvement: exotics have been widely planted in suitable regions, and intensive planted forest management is increasingly common. There is every reason to expect these trends to continue and even accelerate with transgenic forestry.

Transgenic forestry could also modify the geographic shifts in what can grow where. If bioengineering can improve tree performance in northern temperate and boreal sites, production could become more profitable there and improve the competitive position of areas with otherwise low productivity.

Some countries, for example Brazil and China, will undoubtedly deregulate transgenic trees and allow the production, sale, and export of transgenic wood. Other countries, and perhaps the European Union, may not allow production but will find it difficult to prohibit importation of harvested transgenic material, especially paper and wood products, due to the variety of forms and products that use wood and wood fiber, and also due to the rules of the World Trade Organization. As a result, we may see transgenic and nontransgenic wood trading and competing in the worldwide marketplace.

Enter Forest Certification

To promote sustainability and assure consumers that the wood products they purchase have come from well-managed forests, several organizations have created standards, sponsor forest audits, and represent themselves as certifiers of commercial forests. One of the major certifying groups, the Forest Stewardship Council (FSC), will not certify a forest that contains transgenic trees. Of course, at this point, such a standard is moot: there are essentially no deregulated transgenics to plant. However, FSC has withheld certification from

forest firms that conduct research related to the development of transgenic trees.

Whether such actions will halt the commercialization of transgenic trees and stall research and development remains to be seen. Although FSC certifies forests in most parts of the globe, there are other major forest certifiers, such as the Sustainable Forestry Initiative and the Pan European Forest Certification that are less skeptical of transgenics, requiring only that forest managers follow existing laws, practice sound science, and meet certification environmental standards. In theory, public demand for certified wood and a preference for FSC certification could inhibit the development of a transgenic wood market. However, there is little evidence that consumers today are willing to pay higher prices for certified wood. The lack of a price premium may reflect a relatively weak overall preference for certified wood, which may or may not transfer to transgenic wood.

And so we arrive at a curious situation: the goods (raw wood and products with wood from transgenic trees) will likely be widely traded but the important technology (transgenic seeds) may not. Firms in countries that already have a comparative advantage in wood production are more likely to import or develop the technology, undergo the deregulation process, and plant transgenic trees. Specialization in wood production might become even more intense in the few countries that employ the latest transgenic technology, further increasing their share of worldwide timber production, at the expense of those countries resisting the new technology. ■

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PRESIDENTIAL

CANDIDATES REPLY

ON ENERGY AND

THE ENVIRONMENT

Although environmental and energy issues have not been at the forefront in the presidential campaigns of 2004, it is clear that both leading candidates have markedly differing views regarding energy independence, regulatory policy, and resource management. RFF, which seeks to provide impartial and objective information on key energy and environmental options facing the United States, traditionally gives an opportunity for the two candidates to answer specific questions that we believe may not have received sufficient attention. The responses provided by President George W. Bush and Senator John F. Kerry follow.

However badly needed, new energy facilities—whether power plants, liquefied natural gas (LNG) terminals, electricity transmission lines, or petroleum refineries—are almost impossible to site because of intense local opposition. Is federal preemption necessary in cases like these and, if not, what can be done to break the NIMBY bottleneck?

BUSH One component of my comprehensive national energy plan is increasing domestic energy production, which in some cases requires building new infrastructure, including electricity transmission lines, pipelines, wind turbines, and refineries. Siting and constructing these facilities can run up against conflicting interests at the state and local levels, which is why this issue demands local, state, and national solutions. For electricity transmission lines, which involve the most difficult siting problems, I support federal preemption, but only as a last resort—that is, the federal government should collaborate with the relevant state and local agencies to try to meet their concerns but also should retain the right to construct energy projects that meet compelling national needs.

KERRY I believe that we need a balanced energy policy that recognizes the critical role energy plays in creating and preserving jobs and in ensuring our security. I also believe that we need an energy policy that lowers costs for the American consumer and that protects our environment. Under a Kerry–Edwards administration, there will be a new commitment to energy policy that will give all stakeholders—including consumers and communities—a seat at the policy-making table. With the federal government leading such an inclusive process, and by making clear the national priorities of a more secure and energy-independent America, I believe that we can overcome many obstacles to the siting of critical energy infrastructure. By reaching out to all stakeholders and undertaking an inclusive process and dialogue, I also believe that we can get new needed facilities sited without undue conflict and delay.

Would you favor an enhanced federal role in the creation of water markets, particularly in the western United States, in which water rights could be bought and sold?

BUSH Chronic water shortages in the West are among the greatest environmental challenges facing the nation in the coming decades. Some states are actively considering creating water markets within their borders to address these shortages, and I applaud those efforts. Establishing interstate water markets introduces very complex legal questions involving court decisions and preexisting interstate water compacts. These multi-state markets could help address water shortages in the West, but any attempt to create them must abide by outstanding legal arrangements and involve a collaborative process among states, tribes, farmers, and local communities that depends on water supplies.

Through my Water 2025 initiative, the Interior Department is working with states, water districts, tribes, and citizens to better meet the water needs of the West through conservation, water transfers, better collaboration among users, and new technologies. The entire approach builds upon a foundation of state water rights, existing contracts, and a competitive grant process.

KERRY The drought that has hit much of the West is the latest reminder that water is one of our most precious resources, and we must use every tool that we can to ensure that it is used wisely and is available to those most in need. Accordingly, I strongly support the increased flexibility that comes with the creation of water markets, so long as such markets are consistent with state law requirements and take into account potential environmental and third-party impacts (such as impacts on farmers whose water is being made available to urban areas).

As the manager of the largest water projects in the nation, the federal government can, and should, play a key role in working with the states to develop water markets and to introduce other modern tools that respond to our serious and growing needs for ample supplies of clean water for our farms and our cities. I will direct the Secretary of the Interior to push forward aggressively with states, tribes, and other interested parties to facilitate water marketing, conservation, and other modern water management approaches.

What do you regard as the greatest success of U.S. environmental policy? The greatest failure?

BUSH The Acid Rain program, which created an innovative market-based trading system to reduce harmful power plant emissions of sulfur dioxide and nitrogen oxides, has been an overwhelming success. My Clear Skies initiative, which will reduce power plant emissions of sulfur dioxide,

nitrogen oxides, and mercury by 70 percent, builds on this program, which has delivered cleaner air faster and cheaper than anticipated.

The Endangered Species Act (ESA) has served a noble purpose, which Americans overwhelmingly support. But over the last 30 years, successes under ESA have been fleeting, largely due to an ever-growing barrage of litigation preventing the Fish and Wildlife Service from protecting new species and recovering plants and animals already listed as threatened or endangered.

I remain committed to the goal of protecting species to enhance their chances for survival. I believe we can achieve greater progress in protecting species for future generations through results-based cooperative conservation programs and voluntary agreements that encourage private stewardship. The ESA must be updated to reflect new approaches that focus resources on species in need of recovery, not on lawsuits.

KERRY In the 1970s and 1980s, the United States moved aggressively, and in a bipartisan fashion, to respond to serious insults to our environment. By working together, significant progress was made to reduce pollution from industrial smokestacks, treat wastes that were discharged into our rivers and lakes, and clean up hazardous waste sites.

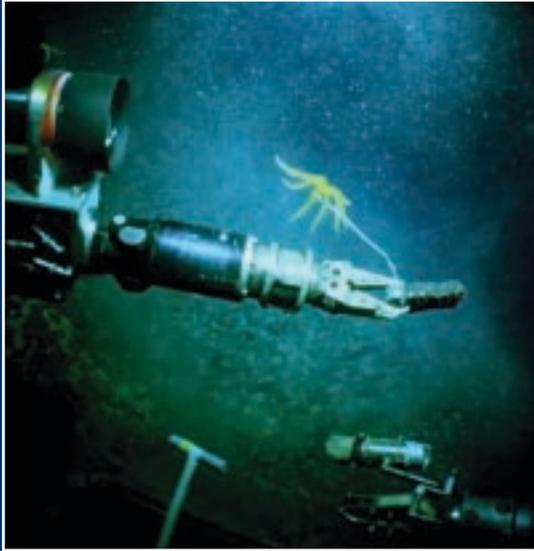
The greatest failure in environmental policy, in my view, has been the Bush administration's unwillingness to carry forward this successful formula and address the serious new threats that air and water emissions from industrial facilities now pose to the health of our citizens and to the long-term vitality of our economy. The current administration instead has favored special interests over *our* interests by shutting down enforcement actions against polluters and by supporting industry requests to roll back Clean Air Act requirements.

Should the United States adopt a single "recipe" for gasoline and abandon efforts to tailor separate blends for different metropolitan areas?

BUSH In 2001, following a recommendation in my National Energy Policy Report, the Environmental Protection Agency examined options to increase the flexibility of the nation's fuel system without affecting prices or fuel supplies. At this point, the agency continues to work with stakeholders to examine whether that is feasible.

KERRY The proliferation of "boutique" fuels has led to a segregated market that leads to higher prices and a lack of flexibility. I reject the idea that oil company profits should come first and that the answer to the boutique fuels issue is to waive all environmental requirements. I will work to develop a streamlined menu of fuels that can reduce supply bottlenecks, make markets more competitive, and lower prices without sacrificing clean air. ■

One fish



two fish



red fish



blue fish

What is the value of a census of marine life?

James N. Sanchirico and Michele T. Callaghan

Experts estimate that vast areas—approximately 95 percent—of the world’s oceans remain unexplored. Hundreds of scientists all over the world are attempting an equally vast undertaking to rectify this—a census of marine life (CoML). Unlike a typical census, this 10-year project, which was launched in 2000, has the ambitious goal of cataloguing what once lived in the oceans, what lives there now, and what is likely to live there in the future.

Advocates argue that the potential impact of the census for science and policy is almost as large as the undertaking itself. Ideally, it will lead to greater scientific returns than the status quo in ocean research (now an idiosyncratic set of research efforts); increase funding for ocean research; and inspire a new generation of marine scientists. Coordination in the development and purchasing of scientific instruments for the census might also spur technological advances and lower prices.

Census research and outreach could also be a vital force in fostering two dramatic shifts in what we know about ocean science and management. Marine populations were once thought to be open and distributed evenly across a homogenous ocean environment. An emerging perspective, however, is that marine populations reside in neighborhoods, possibly connected by dispersal of larvae and adults. Because oceans have historically been managed by relatively uniform systems of regulatory actions over space, this shift enables fine-tuning that will lead to more biologically and socioeconomically sustainable management. Second, countries appear to be moving away from managing the ocean solely for extractive uses, even as the number of economic activities is growing, toward a more holistic approach that includes conservation. One new trend that symbolizes both of these changes is the movement to establish networks of marine reserves, areas that are closed to all extractive uses.

Whether the full benefits of the CoML are realized will depend on the researchers involved, but the question goes beyond them. Rigorous science and outreach alone do not lead to sound policies. Management institutions need to have well-established means of turning science into policy, which requires adaptability. It will also be difficult to identify a causal relationship from CoML research because measuring the benefits of the research will be a difficult, if not impossible, task. And, even if the potential benefits could be quantified, there are socioeconomic and political potholes that must be navigated and filled along the way; otherwise, the magnitude and sustainability of the scientific returns are in jeopardy.

Some of these potholes can be avoided if CoML project leaders integrate stakeholders, social scientists, and regulators into the natural science work currently under way. Only a handful of such people are participating, out of the hundreds of natural scientists now involved.

Successfully navigating CoML research through the political economy of ocean management might not achieve the maximum returns possible, but it will ensure that the gains are greater than under the status quo.

From top left: A robotic arm and video camera record life at 3,000m deep in the Charlie Gibbs Fracture Zone (photo by Michael Vecchione, NOAA Fisheries Systematics Lab, National Museum of Natural History, Smithsonian Institution); A new species of grenadiers or rattails, *Caelorinchus mediterraneus*, found in the western Mediterranean (photo by Tomio Iwamoto); An undescribed and perhaps new species of Narco, a sub-group of jellyfish collected south of Banks Island, Canadian Arctic (photo by Kevin Raskoff). All photos courtesy Census of Marine Life.



Above right: The tube worm, *Lamelli-brachia luymesii*, lives symbiotically with bacteria on sulfide produced by anaerobic oxidation of oil and gas. Many oil and gas seeps in the Gulf of Mexico feature dozens of dense, bush-like aggregations. This tube worm “bush” shows the red gill-plumes of several worms (photo by Ian MacDonald, Texas A&M University, Corpus Christi).

Opposite: A new species of scorpionfish, *Scorpaenopsis vittapinna*, found in the Indo-Pacific area, one of a rapidly growing list of more than 15,300 marine fish species now logged in the CoML database (photo by Bill Eschmeyer and John E. Randall).

Along with improving the use of CoML science in ocean policy, such integration would help to address the concerns that governments will not be able to prevent a “gold rush” to exploit any new populations uncovered by the census.

How will the census work?

The census is jointly sponsored by governments and foundations across four continents and is coordinated by a secretariat at the Consortium of Oceanographic Research and Education in Washington, DC. It will entail developing baselines of what once lived in the oceans using archival information from monastic annals and ship logs, as well as sediment cores and other records. Scientists will also document present-day populations and where they are found. These baselines will be combined with oceanographic data in mathematical models to predict potential scenarios for the future state of the oceans. CoML researchers are working with the Ocean Biogeographical Information System to have all the data included in a central clearinghouse for marine biodiversity information.

A brief look at three pilot projects that comprise only a portion of the CoML will give a broad idea of how the census will affect important facets of ocean research and management in all oceanic zones. These projects are Tagging of Pacific Pelagics (TOPP), which includes animals that live in the open sea with broad public appeal such as sea lions and whales, as well as commercial fish stocks; Natural Geography of Inshore Areas (NaGISA), which offers local communities a chance to be involved in studying their shorelines; and exploration of ecosystems of the deep seas in the northern Mid-Atlantic.

In the TOPP program, researchers are developing and deploying state-of-the-art technologies to tag pelagics so that they can be tracked by satellite. In an example that predates the census, fisheries managers and scientists were surprised to learn that what they believed to be two populations of bluefin tuna might, in fact, be one group that moves between the eastern United States and the Mediterranean. CoML research will strengthen our knowledge of underwater “highways” and “watering holes” shared by turtles and swordfish, among others. In addition to learning about migration patterns, as these animals dive repeatedly, the tagged specimens will, in effect, provide a temperature profile of the ocean’s depths.

By its very definition, TOPP does not limit itself to one part of the ocean, but follows pelagic species wherever they go. In contrast, NaGISA researchers are measuring the abundance and diversity of marine life in the nearshore, a zone less than 20 meters deep. A unique

**Free-for-alls
will lead to a
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aspect of this project—named for the Japanese word *nagisa*, meaning where the ocean meets the shore—is that it is both worldwide and fine in scale. Sampling is being done in an equatorial study from the east coast of Africa to the Palmyra Atoll in the Pacific Ocean and in a longitudinal study from Alaska to Antarctica.

A third part of the census will cover the Mid-Atlantic Ridge, an underwater volcanic mountain range created by the spreading of the Eurasian and American continental plates that stretches from the polar regions in the north to Antarctica. Because its sampling will often occur along the seabed at depths greater than 3,500 meters, this facet of the census will likely be the most challenging. Scientists hope to determine if ridges and seamounts (mountains under the sea) have their own fauna or if coastal fauna are using them as stepping-stones. Documenting this region before economic forces drive people deeper into these areas in search of exploitable resources is vital for developing sustainable management.

Discovering patterns and potential oceanic biodiversity hot spots could be used in the design of marine reserves, which are typically thought of as being fixed in location and set aside for perpetuity. However, as we are already learning from CoML data, boundaries and locations of hot spots are dynamic, shifting with changes in the physical environment. This being the case, management agencies might need to use real-time oceanographic information to define the boundaries. These boundaries could be monitored and enforced with satellite tracking systems that either allow or lock out certain activities by various species at certain times and places.

What is the potential value of the census?

The services or outputs generated by the CoML, such as potential pharmaceutical discoveries, and the type of management institutions in place, along with other factors, all affect the economic value of scientific research. In many industries, rates of return from investments in R&D are measurable, because the outputs are typically traded in the marketplace—revealing both the customer’s willingness to pay for the product that embodies the information and the producer’s net returns, taking into account the R&D costs.

Most of the CoML outputs, however, will not be traded in a marketplace but rather are inputs into policy discussions regarding the conservation of natural resources, which are public goods. For example, information on the spatial and temporal distribution of endangered marine animals could be used to refine fishery management and maritime activities, reducing

the likelihood of fishing gear entanglement and animals being hit by vessels. In many cases, the information generated by the CoML will not even be the sole input but rather one component of a much larger analysis.

Given that the CoML is less than halfway complete, it is hard—and foolish—to predict what its value will be. This value may never be accurately accounted for, but it is clear that actions can be taken now to increase the census's worth to society. In particular, the benefits will depend in large part on the institutional structures using the research. This does not bode well for the CoML, since the marine regulatory environment is highly charged with many competing users, all of which are vying for limited resources where rights are not well defined. Pelagic species, deep-sea marine resources, and inhabitants of the coastal environs are all affected.

Institutional factors are more pronounced in CoML projects because many of the species spend time in the high seas, thereby requiring coordination among countries. For example, CoML research could be used to improve fishery management where increases in the returns to fishing will represent a portion of the value of the research. The sustainability of these increases, however, depends on the allocation of rights to the resource. Free-for-all will lead to a tragedy of the intellectual and ocean commons.

The lack of well-defined rights and established regulatory institutions contributes also to many of the distributional conflicts that affect how the research is used and valued. Distributional issues are often not acknowledged when advocates for more scientific research argue that the benefits of such efforts outweigh the costs. New information and the methods and effectiveness of dissemination strategies can, however, create winners and losers. Whether the net value is positive will, therefore, depend on the relative weights placed on the groups affected.

Distributional effects are not limited to current users of the information. Improved information on the life cycle of commercially harvested fish species resulting in reductions of total allowable catches will benefit future fishers, as the fish stock recovers and lowers the costs of fishing. The current set of fishers, however, face a cost in lost revenue from harvesting that might affect their ability to repay bank loans for fishing gear and equipment.

How to avoid potholes along the way

Driven by advances in scientific knowledge over the past 25 years and a growing marine conservation ethic, ocean management is moving away from the traditional production focus toward a multi-objective ecosystem approach. However, many basic questions remain to be explored, such as which areas are to be restricted and for what uses. Creating guidebooks on species' ranges will help in this endeavor, as will research on the causal factors that have an impact on oceanic systems, trophic interactions, and variations across space in population abundances.

While such a system is on the horizon, a more pressing issue for CoML researchers will be to avoid potential unintended consequences. For example, a biodiversity hot spot may be present in an area with insufficient marine management and enforcement to ensure protection. Individuals with economic interests could act on this information faster than governments. It is also easy to imagine that as scientists learn more about the diversity of species and local abundances that commercial fishers will also learn about them, especially if efforts are made to disseminate the research broadly. One study illustrated how improved El Niño forecasts resulted in a range of unintended consequences in Peruvian fisheries, including increased efficiency in exploitation by some groups that were given advance notice of likely shifts in population abundance.



Above: A MIR submersible being lowered into the depths of the Atlantic Ocean holds two researchers, the first people to visit the Charlie Gibbs Fracture Zone in the Mid-Atlantic Ridge (photo by Michael Vecchione, NOAA Fisheries Systematics Lab).



Above: These three sunflower sea stars, *Pycnopodia helianthoides*, were photographed during a NaGISA sampling dive in Prince William Sound. The Latin, which translates to dense-footed sunflower, refers to the thousands of tube-like feet on the underside of the arms that stretch out, making them resemble beautiful aquamarine sunflowers (photo by Casey Debenham).

The results from the CoML will stretch the limits of our current regulatory system and potentially make the regulated more disgruntled. This could occur, for example, if an endangered marine mammal or a deep-sea watering hole exists in an area, restricting commercial uses. Also, the prediction that new species inhabit heavily exploited areas could result in further restrictions, drawing the ire of current users, who might already feel overburdened with regulations.

Unintended negative consequences and ill-equipped institutional frameworks need not be a foregone conclusion. Under the current model, however, they are likely to come about unless efforts are made to ensure that rigorous policy analysis that incorporates CoML science is done along the way. Successfully navigating the research results through the political economy of ocean management might not achieve the maximum returns possible from the CoML, but it will ensure that the gains are greater than under the status quo.

To achieve this goal, a policy advisory committee should be created for each project. Such a committee could include anthropologists, economists, lawyers, political scientists, natural scientists, government representatives, industry (those using or affected by the information), and nongovernmental organizations.

The team of natural scientists behind the census is striving to create a flexible and adaptive research program on a scale not seen before in oceanic research. Such an undertaking will transform ocean science in the questions asked, methodologies employed, and the allocation of research funds. If the team does not reach out now to include other disciplines, however, they will not achieve the best transformation possible. ■

James N. Sanchirico is an RFF fellow. This article is a synopsis of his research project investigating the potential benefits of the Census of Marine Life. Funding was provided by Resources for the Future and the Alfred P. Sloan Foundation, which is a major supporter of the CoML. Sanchirico wishes to acknowledge the assistance that Assistant Editor Michele T. Callaghan gave in developing this article.

Further reading

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The Effectiveness and Cost of Energy Efficiency Programs

KENNETH GILLINGHAM, RICHARD NEWELL, AND KAREN PALMER

ENERGY EFFICIENCY PLAYS A CRITICAL ROLE in energy policy debates because meeting our future needs really boils down to only two options: increasing supply or decreasing demand.

However, in light of a range of energy issues—such as climate change, air pollution, and energy security—focusing exclusively on increasing supply is probably not the best way to go. Currently the United States emits approximately 1.58 billion metric tons of carbon equivalent (MMtCE) a year, and this number is rising steadily, presenting a daunting challenge to policymakers. Increasing energy efficiency holds the promise of providing a relatively inexpensive response to this challenge and other environmental effects of energy use, while continuing to meet demand.

The effectiveness and cost of government energy efficiency programs have, however, been the subject of a long-standing debate. To move beyond this point, two key questions need to be addressed. First, what types of energy efficiency programs have been implemented, and how much energy has been saved as a result? And, second, how much have these programs cost the public and private sectors, and how cost-effective have they been?

To look for answers, we evaluated the literature on a broad range of U.S. energy efficiency programs, with a focus on the adoption of energy efficient equipment and building practices (as opposed to transportation energy efficiency). Applicable programs and policies tended to fall into four general categories: appliance standards; utility-driven financial incentives — also referred to as energy demand-side management, or DSM; information and voluntary programs; and management of energy use by the federal government,

the nation's largest energy consumer.

Measuring the effectiveness or total energy savings from a conservation initiative or program can be difficult for a number of reasons and can lead to overly optimistic (or pessimistic) estimates. One problem is defining the baseline energy efficiency improvement that would occur in the absence of any program and avoiding double counting of the same energy savings attributed to multiple government programs. Another is accounting for “free riders,” people who receive rebates for energy efficient equipment that they would have purchased anyway. There is also the rebound effect, where people increase their utilization of equipment (for example, leaving their fluorescent lights on) because it costs less to operate. Another consideration is whether all of the salient costs (costs to the government, business, and consumers and losses due to quality changes) and the benefits of the programs (including otherwise unaccounted-for spillovers to energy savings in other areas) are being accounted for.

Our review reveals a lack of detailed independent *ex post* analyses of conservation programs, with almost all available quantitative estimates coming from institutions either administering or advocating the programs themselves. Independent analyses are key to understanding the robustness of the effectiveness and cost-effectiveness estimates reported here. Detailed analysis is particularly important for classes of programs, such as appliance standards or utility DSM, that policymakers may use more widely in the future.

Despite these caveats, the balance of evidence suggests that these programs are delivering positive net benefits and are likely to be a relatively inexpensive part of the overall solution to climate change mitigation.

Appliance Standards

MINIMUM ENERGY EFFICIENCY STANDARDS FOR appliances in the United States first appeared in response to the energy crises of the 1970s and early 1980s. Many states, particularly California and New York, implemented appliance standards to cut the growth in energy demand. Leading manufacturers responded by putting pressure on the federal government to develop national standards that would supersede those of the states. Since 1987, the federal government has enacted a series of laws and regulations mandating minimum appliance energy efficiencies.

National standards have been established for an array of household appliances, including refrigerators, kitchen ranges and ovens, dishwashers, washers, dryers, and air conditioners. Standards have also been established for lighting fixtures and residential and commercial heating and cooling equipment. Cumulative federal government expenditures for the appliance efficiency program totaled \$61 million in 2002 dollars in the period 1979 to 1993. The effectiveness and overall benefits and costs of standards are discussed below.

Demand-side Management

UTILITY-BASED PROGRAMS COVER A VARIETY OF ENERGY conservation and load management policies that allow utilities to better match demand with their generating capacity. Federal regulators and state public service commissions began implementing policies that led to the creation of utility DSM programs after the energy crises of the 1970s. Initially most were information-and-loan programs, designed to educate consumers and businesses about the cost-effectiveness of energy efficiency measures and to provide low-cost subsidized financing for investments in those measures.

Utilities gradually learned that education alone produced limited energy savings. In addition, most consumers were not interested in subsidized loans. As a result, utilities moved toward programs with stronger financial incentives to convince consumers to make energy saving choices, typically rebates for purchasing designated energy efficient equipment, such as fluorescent light bulbs. Load management programs, another consistent element of utility DSM, aim to limit peak electricity loads, shift them to off-peak hours, or encourage consumers to change demand in response to changes in utilities' cost of providing power at different times of the day.

In the 1990s, utilities turned to market transformation strategies, whereby an attempt is made to change the market for particular types of equipment or energy services so that

more efficient practices become the norm. This process usually consists of a coordinated series of demonstrations, training, or other information and financial incentives, with the hope that once a market is completely transformed, there will be substantially greater energy savings as the participation or market penetration rate approaches 100 percent.

Utility DSM evolved into standard operating procedure for a large number of power companies. For example, in 1990 over 14 million residential, 125,000 commercial, and 37,500 industrial customers nationwide were involved in DSM programs run by over a thousand utilities, large and small. While DSM policies matured in the mid-1990s, many state governments began to deregulate utilities. Diminished funds resulted in energy companies' suspending or curtailing these programs, although in recent years spending on them has leveled off.

Voluntary and Information Programs

THE ENVIRONMENTAL PROTECTION AGENCY (EPA) and the Department of Energy (DOE) jointly run the voluntary labeling program, Energy Star, which provides information on the relative energy efficiency of products. It was designed to reward manufacturers of the most energy efficient products with positive publicity, thereby encouraging consumers to buy those products and other manufacturers to improve the energy efficiency of their own products. The program now covers a wide array of products, including major appliances, computers and monitors, office equipment, home electronics, and even new residential, commercial, and industrial buildings. In addition to the labeling program, Energy Star also encompasses a range of public-private partnerships (for example, Green Lights), many of which began as separate programs and were moved under the auspices of Energy Star in the late 1990s. EPA spends around \$50 million annually on administering all Energy Star programs.

DOE also runs two voluntary programs to report and reduce greenhouse gas emissions. The 1992 Energy Policy Act mandated the establishment of a national inventory of greenhouse gases and a national database of voluntary reductions in greenhouse gas emissions (commonly referred to as the Section 1605b program). Companies are required to report measures to reduce emissions on a yearly basis. Reductions could come from any of a variety of methods, including fuel switching, forest management practices, use of renewable energy, manufacture or use of low-emissions vehicles, greater appliance efficiency, and even nonvoluntary measures such as facility closings and governmental regulations.

In 2001 alone, 228 different companies or government agencies voluntarily reported reductions in greenhouse gas emissions for 1,705 projects. These reductions totaled 6.1 million metric tons of carbon equivalent from energy efficiency conservation projects not associated with other voluntary or DSM programs. The government administrative costs of the Section 1605b database and inventory system are currently less than \$500,000 annually.

One factor that needs to be accounted for is that most entities reporting tended to be affiliated with one or more of the other government programs, and some percentage of their registered emissions reductions would have occurred anyway, without the Section 1605b program.

DOE also runs a complementary, voluntary program for utilities. The Climate Challenge program is designed to facilitate voluntary emissions reductions that make sense on their own merits. To take part, a utility must report to DOE annually on its progress, be willing to confer with the agency on possible strategies, and agree to one or more of six specified reduction commitments.

What Is the Effectiveness and Cost of These Programs?

TAKEN TOGETHER, ESTIMATES INDICATE THAT THE conservation programs we reviewed save up to 4 quadrillion Btus (quads) of energy per year and reduce annual carbon emissions by as much as 63 million metric tons of carbon equivalent. This represents about a 3.5 percent reduction in annual carbon emissions relative to what they would have been in the absence of these programs. These estimates typically reflect the cumulative effect of programs (that is, all appliance efficiency standards currently in effect) on annual energy consumption. These total energy savings—4 quads—represent at most 6 percent of annual nontransportation energy consumption, which has hovered around 70 quads in recent years.

Most of these energy savings come from reduced energy use associated with residential and commercial buildings (as opposed to more efficient industrial processes), so another relevant basis of comparison is total energy use in buildings, which accounts for 54 percent of the 70 quads of nontransportation consumption. Consequently, the 4 quads of energy saved represent approximately 12 percent of all building-related energy use and about a 3.5 percent reduction in current annual carbon emissions.

The table opposite summarizes energy savings, costs, and carbon emissions savings for the largest-scale conservation programs. The programs are listed in an order roughly reflec-

ting our degree of confidence in the reliability of the estimates. Existing estimates suggest that minimum efficiency standards and DSM programs have provided some of the largest energy savings—about 1.2 and 0.6 quads, respectively, in 2000. Energy savings associated with the Energy Star and 1605b registry programs are also sizable (0.9 and 0.4 quads, respectively, in 2000), but it is less clear what portion of these savings would have occurred in the absence of these programs. Energy savings from other programs are relatively small or unavailable. We emphasize the use of quads for comparison among programs because many of the programs cover nonelectricity reductions, which have a different heat rate than electricity.

Bringing the energy savings and cost estimates together provides our measure of cost-effectiveness, defined as the annual cost of each conservation program divided by the physical energy savings it achieves. Estimates of overall cost-effectiveness are available only for efficiency standards for residential appliances (\$3.3 billion/quad saved in 2000) and DSM (\$2.9 billion/quad, including only utility costs for the energy efficiency portion of DSM). Note that higher dollars-per-quad cost-effectiveness estimates imply the program is *less* cost-effective (that is, it costs more per quad saved). If all energy savings were in the form of electricity, these estimates would translate to 3.8 cents/kilowatt-hour and 3.4 cents/kWh for appliance standards and utility DSM respectively.

The price of the energy that is saved by these programs can be used as a measure of benefits to which one can compare the cost-effectiveness estimates. While this price varies over time, as a benchmark the average price of electricity in 2000 was \$6.3 billion/quad of primary energy (or 7.4 cents/kWh of end-use consumption). As these energy savings are greater than the cost estimates cited above, this suggests that, as a group, efficiency standards are likely to have had positive net benefits (before environmental benefits are included). The cost-effectiveness of DSM is similar, but includes only utility costs. The average price we use for comparison is only a rough measure of benefits, however, and a more accurate measure would account for differences between this price and the *marginal* cost of the energy conserved.

The environmental benefits resulting from energy efficiency programs—from lower emissions of carbon dioxide (CO₂), nitrogen oxides (NO_x), sulfur dioxide (SO₂), and particulate matter (PM-10)—add value to these programs on top of the value of the energy they save. Based on national average emissions rates and available estimates of the dollar value of reducing air pollutants, we find that the environmental benefits of reduced energy consumption may add approximately 10 percent to the value of the energy savings rel-

ative to basing that value on the price of energy alone. That is, for every dollar energy efficiency programs save in reduced energy costs, they save about another 10 cents in reduced environmental harm. The majority (7 percent) of these benefits come from CO₂ reductions, with fewer benefits from NO_x (2 percent), and SO₂ and PM-10 (0.5 percent each). Including environmental benefits therefore strengthens the case for energy efficiency programs but does not dramatically change their value based simply on energy savings. Viewed as a means for addressing climate change, however, energy efficiency policies appear likely to be a relatively inexpensive option, as the energy savings alone can cover the cost.

The continued use of energy efficiency policies over more than two decades and the prospect of expanded and new policies on the horizon suggest that this approach to achieving energy and carbon reductions will have a lasting presence. This is particularly true if conservation programs have positive net benefits in their own right and therefore yield emissions reductions at zero or negative net cost. But even if these estimates are overly optimistic, energy efficiency programs can be an important part of a low-cost, moderate climate policy, given that the effect of existing efficiency programs is of similar magnitude to what rough estimates suggest might come from a moderate carbon tax. ■

Kenneth Gillingham is a former RFF research assistant, now a graduate student at Stanford University. Richard Newell is an RFF fellow; his research focuses on economic analysis of technological change and incentive-based policy, with applications primarily to climate change and energy technologies. Karen Palmer is an RFF senior fellow; her research interests include the environmental and economic consequences of electricity restructuring and of new environmental policy proposals targeted at the electricity sector.

Further Readings

This article is based on the authors' much longer, more comprehensive assessment of the literature on energy-efficiency programs, which was supported by the National Commission on Energy Policy. See *Retrospective Examination of Demand-Side Energy Efficiency Policies*, www.rff.org/Documents/RFF-DP-04-19rev.pdf.

Newell, Richard G. 2000. Balancing Policies for Energy Efficiency and Climate Change. *Resources*, Summer 2000 (140): 14–17. www.rff.org/Documents/RFF-Resources-140-balancpol.pdf.

Summary of Estimates of Energy Savings from Largest Conservation Programs in 2000

Program Name	Date	Energy Savings (quads)	Costs (billion \$2002)	Cost-Effectiveness (billion \$2002 per quad ^d)	Carbon Emissions Savings (MMtCE)
Appliance standards	2000	1.20	\$2.51 ^a	\$3.28 ^a	17.75
Utility DSM	2000	0.62	\$1.78 ^b	\$2.89 ^b (high \$19.64)	10.02
Energy Star	2001	less than 0.93	\$0.05 ^c	—	less than 13.80
1605b registry	2000	less than 0.41	\$0.0004 ^c	—	less than 6.08
DOE Climate Challenge	2000	less than 0.81	—	—	less than 12.04

^a Indicates that total costs and cost-effectiveness estimates are for residential appliance standards only while the energy savings and carbon emissions savings estimates are for commercial and residential standards combined. ^b Indicates only utility costs are included. ^c Indicates that only direct government administrative costs are included. ^d Billion dollars per quad of primary energy can be roughly converted to cents/kWh of end use consumption by multiplying by 1.166, which assumes all of the savings come from electricity using the average mix of generating facilities.

Advice and Insight from New RFF Board Member Michael Mantell



Resources recently talked to Michael Mantell, a new member of the RFF Board, about the evolving dynamics of environmental and natural resources policymaking and RFF's role in this process. Mantell is the founder of the Resources Law Group, a multidisciplinary practice that specializes in resources law and policy and in conservation philanthropy. Previously, he was Undersecretary for Resources for California.

Can you recall how you first became aware of RFF? Why did it appeal to you?

My relationship with RFF goes back some 25 years, to when I served on the law review at Lewis and Clark Law School. I was inspired by Marion Clawson's seminal work on land economics, which greatly influenced the future of public land management in this country, leading to the establishment of the Land and Water Conservation Fund, the National Wilderness Preservation Act, and the updated statutory frameworks governing the U.S. Forest Service and the Bureau of Land Management.

During my time at the Conservation Foundation, I worked with several RFF staff members and was always impressed with the objectivity and quality of their research and RFF's ability to reframe the national policy agenda.

What do you see as the next big challenges facing RFF?

The problems we face in our environment globally, nationally, and locally are only becoming more complex—it's no longer simply a matter of controlling what comes out of a pipe. In many ways, RFF performs an essential R&D

function, both in helping us to better understand emerging problems and in proposing practicable solutions. Forecasting has always been among RFF's strengths, with researchers looking ahead 20 to 30 years and laying the groundwork for new approaches to problems still on the horizon and encouraging worthy experiments in policy to address them.

Unfortunately, we also find ourselves in increasingly polarized times, when ideologies seem to carry more weight than reasonable, achievable solutions. And we all face an information overload. Consequently, RFF must speak ever more clearly and in every forum possible. In the academic world, RFF is well regarded, and it must increasingly find effective ways to engage and inform the policymaking world.

How is the conservation movement evolving at the state and national levels?

Given the constraints on the federal budget and polarization in Congress, states are coming to play much more of a leadership role, often working in partnership with philanthropists and other key groups. Activist state attorneys general are also banding together to

address larger issues, such as whether the Clean Air Act gives the EPA the authority to regulate greenhouse gas emissions from motor vehicles.

But what is new and heartwarming to me is the growth of interest in environmental issues among the African-American, Asian, and Latino communities. In California, there has been a sharp rise in the number of these voters who support conservation measures, and in higher proportion than the white population.

California is always in the vanguard of social and environmental change, and your work with the Resources Law Group puts you in the forefront. Can you tell us about an important recent victory?

California's coastal waters contain world-class resources but also face enormous threats. As a result, California passed a landmark law in 1999, the Marine Life Protection Act, which requires the creation of a master plan for a network of protected marine areas that would allow diminished fish stocks to rebuild and biodiversity to improve. However, the program had become moribund and politically charged. And the state government announced earlier this year that the program would be halted due to a lack of funds.

Working in collaboration, three foundations have developed a partnership with the Schwarzenegger administration to revitalize the program. They have agreed to fund scientific studies, public meetings, and other administrative costs needed to get the program implemented. A memorandum of understanding has been drawn up, outlining project objectives, process, and time frames. Together, the foundations will contribute about \$2.5 million per year for three years, and the state will increase its budget by \$500,000 in the first year, with the prospect of more in the future to ensure the success of this pathbreaking effort. ■

New RFF Fellow Siikamäki Develops Methods for Valuing Nature

The surroundings of his family's farm in Finland's Lake District sparked a lifelong fascination with the environment that shapes the research of RFF's new fellow, Juha Siikamäki. While he was fascinated by people living off the land, declining old-growth forests and lakes stifled with algal blooms concerned him as a youth. He saw the source of ecological problems in the competing interests of landowners, industries, and the gen-

eral public. He believes that economics—in particular studying how people value benefits of the environment—can provide a solution to these conflicts.

His professional career began in Helsinki as an economist for the Agricultural Economics Research Institute. Siikamäki later moved to the United States, receiving a master's degree and a doctorate from the University of California, Davis. Most recently Siikamäki was an economist at Triangle Economic Research, a research firm specializing in assessing damages to natural resources in the event of hazardous spills.

Siikamäki's research focuses on developing methods for valuing benefits and costs from environmental policy programs. Issues regarding the conservation of endangered species and



JUHA SIIKAMÄKI

their habitats and the design of large-scale conservation programs on private land provide a central theme for his research. The two elements of such programs, in his view, are landowners' willingness to enroll their land and the public's willingness to pay for it. At RFF he hopes to continue this work and

examine how to better incorporate ecological information into conservation policy analysis.

Beyond the environment, Siikamäki has studied food safety, consumer purchasing decisions, and survey design. He is a referee for the *Journal of Forest Economics and Agriculture* and *Ecosystems Journal*.

Siikamäki lives in Washington, DC, with his wife Sonia. ■

Book Notes

Northern Landscapes: The Struggle for Wilderness Alaska. Daniel Nelson, RFF Press

Heather L. Ross

If those who cannot remember the past are doomed to repeat it, are those who do remember favored to reach historic success? People looking to remember and learn from past accomplishment will find much of interest in Daniel Nelson's extensively researched and documented story of the struggle for wild Alaska, set against the backdrop of the campaign for statehood.

Congress awarded vast acreages of federal land to the state in 1958 and to native groups in 1971. During this same period, an effort to place wild lands in

permanent federal protection as parks, refuges, and wilderness areas also took root and grew. Nelson, a labor historian, intertwines the stories of these historic land allocations that culminated in the 1980 passage of the Alaska National Interest Lands Conservation Act (ANILCA), which set aside under federal stewardship more than 107 million acres, over a quarter of the state.

The story of how ANILCA came to pass is largely one of grassroots organizing, starting with an intellectual base of politically active Alaskans, reaching out to an array of other like-minded citizens, pushing forward against the "booster" mentality of the state's economic interests, grouping and regrouping through failure and success, and building a winning national coalition for the final legislative battle in Congress.

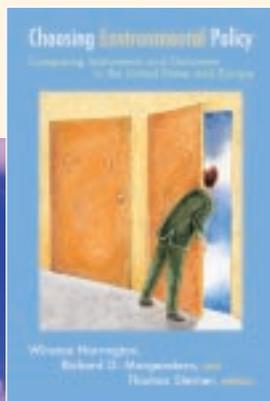
Nelson closely follows the extended

legislative battle and the corresponding public opinion and lobbying campaigns that Rep. Morris Udall called "head and shoulders above anything put together in the public interest field since the civil rights movement."

Nelson chronicles some memorable features of the 1970s environmental movement, including the rise to prominence of women and the support of eastern and mid-western Republicans. He also records the turning point signaled by the 1980 election of a Republican administration and Senate. Within two weeks of that election, the long struggle for Alaska lands came to an abrupt close, with a bill full of compromises sent to a lame-duck president, a bittersweet victory for some at the time but a lasting monument nonetheless to nature and to civic enterprise. ■

Heather L. Ross is a visiting scholar at RFF.

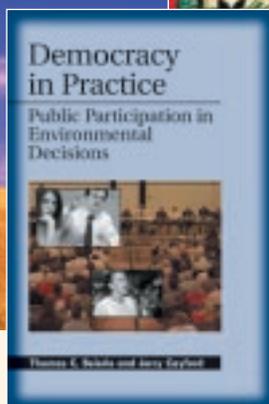
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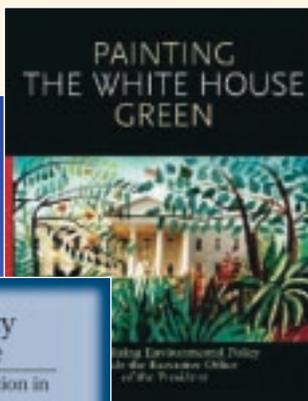
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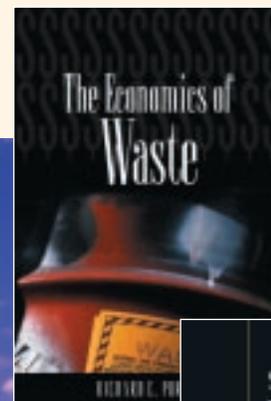
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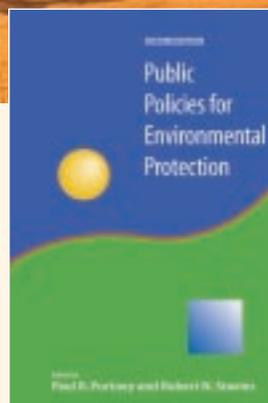
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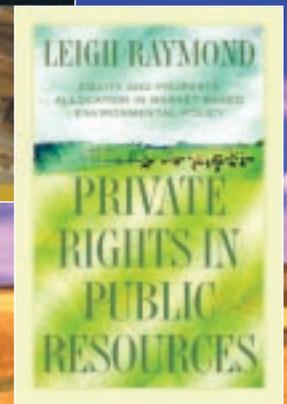
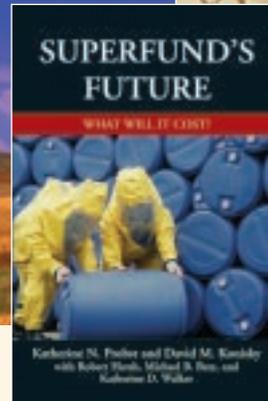
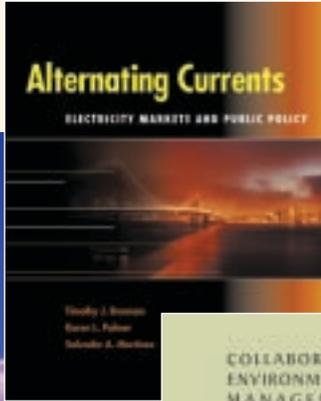
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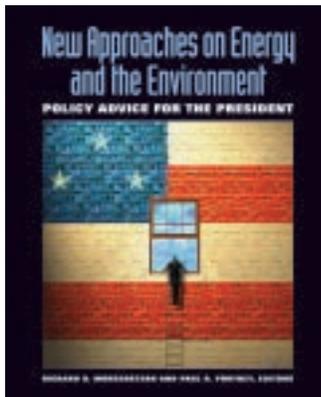


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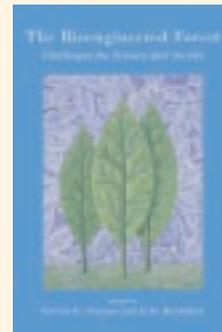
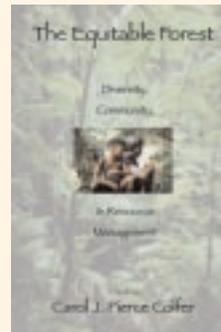
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