TOWARD A NEW ERA OF ENVIRONMENTAL POLICY

by

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DURING THE 20 years following Earth Day in 1970, a host of environmental laws and regulations were enacted in the industrialized nations, and as a result, substantial gains have been made in environmental protection. But the United States and the world at large continue to face major environmental threats—both ongoing problems, such as local smog, ground water pollution, and regional acid rain, and newly recognized problems, including the possibility of global climate change. Increasingly, attention is being given by political leaders on both sides of the Atlantic to a promising set of new policies which recognize market force, not only as part of the problem, but also as a potential part of the solution.

In the United States, the nature and tone of political debate has evolved rapidly, culminating with the enactment in 1990 of a major overhaul of the Clean Air Act including the Bush Administration's proposal of a market-oriented approach to controlling acid rain.[1] Numerous factors contributed to this rapid evolution of policy prescriptions, including: strong interest within the Executive Office of the President; aggressive participation by some segments of the environmental community—notably, the Environmental Defense Fund; and the release of a bipartisan study,[2] initiated and sponsored by U.S. Senators Timothy Wirth (D-Colorado) and John Heinz (R-Pennsylvania), intended to find solutions to major environmental and natural resource problems. Their study dovetailed with interest within the Administration, the environmental community, and private industry, by proposing a series of measures which would enlist market forces to deter pollution and reduce waste of natural resources.[3] Partly in response, the Administrator of the U.S. Environmental Protection Agency (EPA), William K. Reilly, established an Economic Incentives Task Force to investigate the potential application of market-oriented policies throughout EPA's jurisdiction.[4]

In the United Kingdom, the Thatcher government embraced[5] a study directed by David Pearce of University College, London, which recommended increased reliance on economic-incentive mechanisms for environmental and natural resource problems.[6] Finally, as massive political and economic changes gripped the Soviet Union and Eastern Europe, a number of East Bloc nations began to express interest in market-oriented environmental policies.[7]

By early 1990, discussions of potential incentive-based policies had moved beyond the writing of reports to serious consideration of actual policy mechanisms for specific problems. This was true both within the Administration and within Congress. In addition to the President's proposal of a tradeable-permit system for acid rain control, Congress has had before it bills to apply economic-incentive mechanisms to problems as diverse as water pollution and hazardous waste management.[8] Further, the Administration has been examining seriously a number of incentive-based policies to address the threat of global climate change.[9]

Within the United States, these changes in the politics of environmental policy represent a dramatic departure from long-term trends. Until recently, only economists at universities and research institutions gave serious consideration to market-oriented environmental-protection policies. Late in the 1980s, however, a new environmentalism emerged which embraced these innovative approaches.[10] Among the leading environmental advocacy groups, the Environmental Defense Fund, the Wilderness Society, the National Audubon Society, the Sierra Club, and the Natural Resources Defense Council[11] have all come to support at least *selective* use of economic-incentive mechanisms. Because of the important political role played by the major environmental advocacy groups in the United States, such support is of major consequence.[12]

THE CONTEXT OF CHANGE: ENVIRONMENTAL QUALITY, ECONOMIC CONDITIONS, AND PUBLIC OPINION

U.S. environmental and natural resource policies have evolved over two decades in response to an array of perceived risks. Now, as new threats have arisen[13] and the cost of enforcing existing policies has escalated, the issue of how to share that burden has become a brake on needed action. It is less and less likely that environmental protection can be increased simply by spending more money on programs and policies already in place.[14] Moreover, the costs of environmental

compliance to the economy as a whole continue to increase.[15] It is therefore becoming increasingly clear that investments in environmental protection need to be cost-effective if the country is to maintain international competitive strength along with a better environment. It is unlikely that either the federal government or the U.S. economy as a whole will be able to afford higher environmental standards unless means are found which achieve the most protection possible for every dollar spent.

One approach which seems particularly promising is harnessing market forces to spur both technological advance and sustainable management of natural resources. By incorporating the forces of the marketplace into environmental programs, economic-incentive mechanisms can make the everyday economic decisions of individuals, businesses, and government work effectively for the environment.

A key to reducing inefficient natural resource use and environmental degradation is ensuring that consumers and producers face the true costs of their decisions—not just their direct costs, but the full social costs and consequences of their actions. Economic-incentive systems provide various ways to do this. Developing such innovative proposals in detail and putting them into action will be a complicated and difficult enterprise, but this is a challenge that must be met.[16]

CONVENTIONAL AND ECONOMIC-INCENTIVE APPROACHES: WHAT THEY ARE AND HOW THEY WORK

The environmental policymaker's task consists of two parts: one part deals with selecting an overall goal; the other involves selecting a means or "instrument" for achieving the goal. In practice, of course, these two aspects of environmental policy-making tend to be linked within the political process, since both the goal and the mechanism for achieving that goal have significant political ramifications.[17]

Economic criteria could theoretically play an important role in both parts of the policy process: determining the overall level of environmental quality that is selected as a goal or standard and identifying mechanisms for achieving that goal. The argument to do so rests on the observation that private firms, if left unregulated, will not choose a "socially efficient" level of environmental quality. This is because they are rarely, if ever, required to pay the full social costs of their actions. The economic paradigm calls for measuring the benefits of increased pollution control against the costs of control and choosing that level of pollution abatement where the additional benefits are

just equal to the additional costs, because it is at that level that net social benefits of pollution-control investments will be maximized.[18]

In addition to deciding on goals and standards, decision-makers must select specific mechanisms for achieving those goals. This chapter focuses exclusively on this part of the policy problem—the task of identifying optimal policy mechanisms. This focus stems from recognition of political realities and from observation of the fact that the recent round of economic-incentive policy recommendations has accented cost-minimizing (cost-effective) achievement of environmental goals, in contrast with economists' long-standing prescriptions for "efficient" policies, incorporating means and goals which maximize net-benefits.

In this context, the merit claimed for market-based approaches is that they provide direct incentives to achieve environmental outcomes in the least expensive (cost-effective) manner, and in a way which encourages the introduction of new and improved technologies. Note that such cost-effective, incentive-based policy mechanisms do not involve the use of economic criteria, exclusively or otherwise, to set environmental goals. In particular, incentive-based policies do not require the use of benefit-cost analysis or setting dollar values on environmental amenities or human health.

To understand the nature of market-based approaches, it is instructive to begin with a brief review of the dominant approach to environmental regulation in most countries, including the United States—command-and-control regulation.

Conventional Command-and-Control Regulatory Mechanisms

Two policy mechanisms are commonly used in the United States for controlling environmental pollution: uniform technology-based standards and uniform performance standards. Technology-based standards identify a specific process or technology that must be used to comply with a regulation. For example, utilities may be required to install a scrubber to control sulfur dioxide emissions. Performance standards, on the other hand, focus on output instead of input, and hence are more flexible than technology-based standards. A performance standard typically defines a performance measure (for example, maximum allowable units of pollutant emitted per time period) and gives firms some latitude in meeting this measure.

Although uniform emission standards may be effective in achieving environmental goals and standards, they do so at relatively high costs to society at large. This is because they lead to outcomes where firms

use unduly expensive means of controlling pollution. The reason is simple: the costs of controlling emissions of pollutants vary greatly from one source to another among and within firms. Indeed, the cost of controlling a unit of a given pollutant may vary by a factor of 100 or more among sources, depending upon such factors as the age and location of plants and the technologies at their disposal. Any given aggregate pollution level can be met at minimum aggregate control cost if and only if firms control at the same marginal cost,[19] as opposed to at the same emission (or control) level.

One approach to achieving such a cost-effective allocation of the pollution-control burden would be for the government (or some other centralized authority) to force all sources to control at the same marginal control cost and thus to make sure that low-cost controllers control more and high-cost controllers control less. But in addition to the obvious political problems attendant on such an approach, it would require that government have detailed information about the cost functions of individual firms and sources, information which the government clearly lacks and which it could come by only at great cost, if at all.

Are there any ways, then, that the cost-minimizing allocation can be achieved without the government having to obtain such costly information? The answer, of course, is that policy mechanisms based upon economic-incentive systems ensure that firms will undertake pollution-control efforts in the manner and degree which will result in a cost-effective allocation of the overall control burden. Most such approaches can be viewed as falling within one (or more) of five major categories: pollution charges, marketable permits, deposit-refund systems, market barrier reductions, and government subsidy elimination.

Pollution Charges

Charge systems impose a fee or tax on specific quantities (rates) of pollution (*not* simply on pollution-generating activities).[20] With such a system in place, it pays firms to spend to reduce pollution up to the point where the marginal cost of control is equal to the pollution tax rate. Thus, firms control to different degrees (high-cost controllers control less; low-cost controllers control more), but all firms experience approximately the same marginal cost of pollution control. This contrasts with the conventional, uniform-standards approach, under which higher-cost firms end up spending more than lower-cost firms would have to, to achieve a uniform standard, thus leading to higher total costs for society as a whole.

With an effective charge system, the total costs of pollution control are minimized, and ongoing incentives are provided for firms to develop and adopt newer, better (cheaper) pollution-control technologies. Examples of water pollution charges are found in several European nations, including France, the Netherlands, and West Germany.[21] A frequently discussed potential new application is a carbon tax to help control global warming.[22]

Marketable Permit Systems

One problem with emission charge systems is that governments do not know in advance what level of clean-up will result from any given charge. Marketable or tradeable permit systems eliminate this particular problem. These permit systems can achieve the same cost-minimizing allocation of the pollution-control burden as charge schemes, but do so in ways that avoid the problem of uncertain firm responses.[23] Under a system of marketable or tradeable permits, an allowable overall level of pollution is established and then allotted in the form of permits among firms. Firms that keep emission levels down, below the allotted level, may sell or lease[24] their surplus permits to other firms or use them to offset excess emissions in other parts of their own facilities. Thus, low-cost controllers have an incentive to control more. High-cost controllers have the option of buying permits instead of undertaking expensive control measures and thus controlling less, but overall environmental objectives are still met.

As with a charge system, the marginal cost of control becomes identical across firms, and thus the total, societal cost of control is reduced to its minimum level for the amount of pollution control achieved. In the case of local air-pollution control, for example, this approach could be substantially more efficient than current regulatory methods, both because its inherent flexibility takes advantage of differences in control costs ranging from $500/ton of emissions (fuel-volatility sources) to $39,000/ton (methanol-conversion sources) and because it allows individual firms to decide where and how to make desired reductions.[25]

Both taxes and permit systems can be used to improve environmental quality. Permit systems, for example, can limit the overall amount of emissions, and thus encourage firms to clean up. Likewise, if overall emission targets are viewed as too strict, the government may choose to increase the supply of permits.

The primary application of such mechanisms has taken place in the United States, under the Environmental Protection Agency's

(EPA) Emissions Trading Program (described below), the nationwide automotive-fuel lead-phasedown (which allowed refiners to "bank" and "trade"),[26] and the 1990 Clean Air Act amendments establishing a marketable permit system for acid rain control. Other potential areas of application include: local, "criteria" air-pollution control,[27] point and non-point source water-pollution control, chlorofluorocarbon (CFC) reduction,[28] and control of global warming through international trading in greenhouse gas permits and offsets.[29]

Deposit-Refund Systems

Under this approach, surcharges are paid when potentially polluting products are purchased. When the product's consumers/users return the product to an approved center for recycling or proper disposal, the deposit is refunded. This approach has already been used successfully in a number of states in so-called "bottle bills," designed to reduce littering with beverage containers and to reduce the flow of solid waste to costly landfills.[30] An advantage of deposit-refund systems is that they eliminate the incentive for illegal "midnight dumping" which exists under a simple waste-end tax or fee.

Deposit-refund systems can be used for containerizable hazardous waste and for certain forms of solid waste.[31] Lead-acid batteries, motor vehicle oil, and vehicle tires are obvious candidates. Denmark has such a plan for mercury and cadmium batteries, and Norway and Sweden have successful deposit-refund systems for car bodies.[32] There are proposals in the U.S. Congress for applying the deposit-refund concept to new problem areas.[33]

Removing Market Barriers

In some cases, substantial gains can be made in environmental protection simply by removing existing government-mandated barriers to market activity. For example, measures which facilitate the voluntary exchange of water rights can promote more efficient allocation and use of scarce water supplies, while curbing the need for expensive and environmentally disruptive new water supply projects.[34] Negotiations are now underway for a major market-oriented water exchange in southern California. Other applications of the general concept include competitive bidding for solid waste management[35] and comprehensive least-cost bidding at electrical utilities,[36] a measure which would promote economically rational energy generation and consumption.

Eliminating Government Subsidies

In theory, subsidies can provide important economic incentives to address environmental problems. Indeed, subsidies are the mirror image of various kinds of taxes. In practice, however, many subsidies promote economically inefficient and environmentally unsound development. A major example is provided by "below-cost timber sales"—where the Forest Service does not recover the full cost of making timber available.[37] The result has been excessive timber cutting, which has led to substantial losses of habitat and damage to watersheds. Gradual removal of these subsidies would foster environmental protection and increase net federal revenues.[38]

Other examples of subsidies which are both economically inefficient and environmentally disruptive include those associated with U.S. Army Corps of Engineers flood-control projects, U.S. Bureau of Reclamation projects, and agricultural price supports.[39]

Comparing Market-Based Approaches with Conventional Policies

At a time of substantial concern in the United States regarding the country's international competitiveness, incentive-based approaches can provide huge savings and increases in productivity. It has been estimated, for example, that a market-based approach to acid rain reduction could save up to $3 billion per year, compared with the cost of a dictated technological solution.[40] And, incentive-based approaches need not be any more expensive for the government to administer than conventional, regulatory methods. In fact, funds from tradeable-permit auctions could be used to help finance an expanded EPA budget.[41] Also, such systems provide incentives for one firm to monitor the activities of other pollutant-emitting firms—another manifestation of the discipline of a competitive market. This is not to suggest, however, that environmental protection can be achieved without significant government expenditures, since no program of controls can be effective without a commitment by government to monitoring and enforcement.

Most importantly, economic-incentive approaches allow greater levels of protection for any given *aggregate* cost of control. Rather than dictating to enterprises how they should manufacture their products, incentive-based systems impose a cost on pollution-causing activities, leaving it to individual firms to decide among themselves how to

achieve the required level of environmental protection. Market forces will drive these decisions toward least-cost solutions.

Market forces also lead to powerful incentives for the development of new pollution-control technologies and expertise by the private sector. Because investments in pollution control lead to tangible, positive effects on profits under incentive-based systems, these policies provide significant inducements for firms to adopt pollution-control technologies. In turn, incentives are created for those same firms or others to carry out research and development of cheaper and better pollution-abatement techniques.[42]

A potential difficulty with incentive-based approaches is that such policies will require regulators to change the way they think about their jobs.[43] No longer will regulators be in the business of evaluating different pollution control technologies and strategies. Firms will do that for themselves, driven by the cost of continued pollution. Regulators may at first feel that they have less control over the system, because actual pollution-control decisions will be made by polluters, not by the government. But, this is the whole point of decentralized market approaches. These systems will be effective only if this decentralization of decision-making is allowed to work.

Incentive-based approaches have an added benefit; they can make the environmental debate more understandable to the general public. Because they do not dictate a particular technology, these approaches can focus attention directly on what our environmental goals should be, rather than on difficult technical questions concerning technological alternatives for reaching those goals.

Market-oriented policies, however, will not fit every problem. On the one hand, incentive-based approaches seem virtually tailor-made for problems such as acid rain, where concern focuses on aggregate pollution levels (within an airshed), since economic-incentive mechanisms allocate the pollution burden across firms to minimize total expenditures for any given level of aggregate control. On the other hand, with environmental problems which display local and threshold effects, concern focuses on the level of pollution emitted by individual sources. In this case, a conventional, command-and-control approach, such as a uniform emission standard, may represent the preferred policy.[44]

The best set of policies will probably involve a mix of market and more conventional regulatory processes. To design and implement improved policies, it will be necessary to adapt, not abandon, present programs and build step-by-step on U.S. and other industrialized nations' experience with market-based methods.

PREVIOUS U.S. EXPERIENCE WITH INCENTIVE-BASED ENVIRONMENTAL POLICIES

As noted above, market-based approaches for environmental protection have been implemented on a limited scale in the United States and several European nations. Three of the U.S. experiences are described here.

EPA's Emissions Trading Program

In 1974, EPA began to experiment with "emissions trading" as part of its program for the improvement of local air quality.[45] Firms that reduce emissions below the level required by law have been allowed to receive "credits" usable against higher emissions elsewhere. Under programs of "netting" and "bubbles," firms have been permitted to "trade" emissions reductions among sources within the firm, so long as total, combined emissions comply with an aggregate limit.

Emission credits have also been exchanged between firms. Under the "offset" program, begun in 1976, firms which wish to establish new sources in areas which are not in compliance with ambient air-quality standards have been required to offset their new emissions by reducing existing emissions by a greater amount. This can be done within the firm itself or through agreements with other firms. Finally, under the "banking" program, firms may store earned emission credits for future use, to allow either for internal expansion or for a sale of credits to other firms.

These programs were codified in EPA's Final Policy Statement on Emissions Trading in 1986, but their use to date has not been extensive.[46] States are not required to use them, and uncertainties about the future course of the programs have made firms reluctant to participate.[47] Nevertheless, companies such as Armco, Du Pont, USX, and 3M have traded emissions credits, and a market for transfers has arisen. Even this limited degree of participation in EPA's trading programs has resulted in more than $4 billion in savings in control costs, with no adverse effect on air quality.[48]

Tradeable Permits for Water Pollution Control

"Nonpoint" sources of water pollution, particularly agricultural and urban runoff, now constitute the major American water pollution problem, since municipal sewage-treatment programs have been

widely implemented. The experience of Dillon Reservoir, the major source of water for the city of Denver, Colorado, provides an example in which a trading approach has been successfully used to control nonpoint-source water pollution. By the late 1970s, nitrogen and phosphorus loading was turning the reservoir eutrophic, despite the fact that point sources in surrounding communities were controlled to best-available-technology standards. In order to preserve and protect water quality in the face of rapid population growth, a "point/nonpoint source control optimization" trading program was developed to cut phosphorus flows, mainly from nonpoint urban and agricultural sources.

The point/nonpoint source trading plan was developed with active participation of environmental groups, industry, and local and state governments, and was approved by the State of Colorado and EPA in 1984. The program allows for publicly-owned sewage treatment works (POTWs) to finance the control of pollution from nonpoint sources in lieu of upgrading their own treated effluent to drinking-water standards. The program is effective because the cost per pound of phosphorus removed via trading is $67, versus $824 per pound for the cheapest advanced treatment alternative developed for the POTWs. EPA has estimated that the plan has resulted in aggregate savings of over $1 million per year compared with the conventional approach of requiring tight controls solely on the discharges of four fairly small POTWs.

Voluntary Water Exchanges

In the Imperial Irrigation District (IID) of California, farmers are paying as little as $10 per acre-foot of water to irrigate cotton, while just a few hundred miles away in Los Angeles, local authorities of the Metropolitan Water District (MWD) are paying up to $200 for the same quantity of water. A free market in water rights, allowing voluntary exchanges, would make both parties better off: farmers would have financial incentives to conserve water, and if they did so successfully, urban needs could be met without shrinking agriculture and with less building of new dams and reservoirs. Environmental protection would gain, to the extent that these incentives were to result in more conservation of existing water supplies.

In March of 1983, the Environmental Defense Fund (EDF) published a proposal calling for MWD to finance the modernization of IID's water system in exchange for use of conserved water.[49] In November, 1988, after five years of negotiation, the two water giants

reached agreement on a historic $230 million water conservation and transfer arrangement,[50] which closely parallels EDF's original proposal of "Trading Conservation Investments for Water."

This southern California water rights swap may be the harbinger of a more enlightened western water policy, since it demonstrates that such trades can be executed on a significant scale. Such optimism seems to be validated by reports of greatly increased interest in water marketing in Colorado, New Mexico, Arizona, Nevada, Utah, and California.[51]

Other Examples

Although it is only recently that increased attention has been given to incentive-based environmental protection strategies, additional examples exist of policies which are already operative. Among these are EPA's tradeable permit system for implementing the Montreal Protocol's stratospheric ozone-depletion restrictions; the nationwide automotive-fuel lead phasedown; and some "experimental" use of comprehensive least-cost bidding by electrical utilities.[52] Also, as noted above, several European nations have had significant experience with the use of economic incentive mechanisms.[53]

IDENTIFYING INNOVATIVE SOLUTIONS TO ENVIRONMENTAL PROBLEMS: CRITERIA AND RECOMMENDATIONS

In order to identify appropriate policies for specific environmental and natural resource problems, a variety of criteria need to be considered, including the following: Will the policy effectively achieve environmental goals? Will the policy approach be cost-effective? That is, will it achieve environmental goals at least cost to society at large? Will the strategy provide relevant government agencies with the information they need? How easy (or costly) will monitoring and enforcement be? Will the policy be flexible in the face of change; i.e., when changes occur in tastes, technology, or resource use, will the policy accommodate these changes and remain effective or will it become ineffective (or even counter-productive)? Will the policy give industry positive, dynamic incentives? For example, will it encourage firms to develop new, environment-saving technologies, or will it encourage firms to retain existing, inefficient plants? Will the economic effects of the policy be equitably distributed? Will the purpose

and nature of the policy be broadly understandable to the general public? Will the policy be truly feasible, in terms of both enactment and implementation? Based upon these criteria,[54] and building upon the experiences which the United States and other nations have already had with innovative, incentive-based policies, it is possible to suggest specific mechanisms for individual problem areas. In the following sections, recommendations are offered for several of the major environmental and natural resource problems faced by the United States.

The Greenhouse Effect and Global Climate Change

The possibility of global climate change due to the greenhouse effect may be the single most important environmental threat our planet has faced since the beginning of the industrial revolution. Gases such as carbon dioxide (CO_2), methane, nitrous oxide, and chloroflourocarbons transmit the sun's visible radiation, which warms the earth's surface, but these same gases absorb infrared radiation, thus preventing the escape of atmospheric heat into space. The process is similar to that which occurs in an ordinary greenhouse or in a closed automobile left in the sun.

Man's burning of fuels—particularly of fossil fuels—has doubled the concentration of CO_2 in the atmosphere since the beginning of the industrial revolution. A doubling of today's concentrations could occur in 30 to 50 years. The resulting global temperature increases may produce climate changes at unprecedented speed. It is expected that by the middle of the next century, average surface temperatures may rise in the range of 5–10 degrees Fahrenheit, an increase over 60 years equivalent to the warming since the last Ice Age, 18,000 years ago.[55] These temperature increases could cause massive changes in global precipitation patterns, storm intensities, and ocean levels.[56] Increased support is needed for basic research on atmospheric and global systems, and for research on alternative strategies to deal with this global problem. We need to compare the costs of specific means of prevention with the expected benefits of prevention (the avoided costs of adapting to climate change).

Research on prevention strategies will need to examine improved energy efficiency and demand management; renewable energy resources; more efficient generation technologies; safe nuclear power; and factors affecting forest depletion worldwide, including population growth. Adaptation strategies which should be assessed include: the development of drought-resistant strains of agricultural crops;

increased efficiency of irrigation methods; mapping sea-level rises; and methods of protecting major urban areas and other shorelines from heightened sea levels and increased storm intensities. Such research efforts can begin to identify the best strategies—whether based upon prevention or adaptation or, more likely, some combination of the two approaches.

Based upon a more complete understanding of the causes and consequences of global climate change, specific policies leading to mitigation and/or adaptation can then be considered. Several such policies are described here.

Policies to Encourage Energy Efficiency

Encouraging more efficient use of energy resources can reduce the burning of fossil fuels for electricity and increase energy efficiency in transportation and other sectors of the economy. One example of a policy change to consider would be to factor social—especially environmental—costs into the calculations used in the Public Utilities Regulatory Policy Act (PURPA) of 1978. This legislation was written to encourage the use of alternative sources of energy at a time when oil and gas prices were rising rapidly. It based the incentives offered on a calculation of market prices of fossil fuels and an administrative determination of the costs that could be avoided by shifting to alternative energy sources.

An important problem lies in the fact that the market sets coal, oil, and natural gas prices without reference to the environmental consequences (costs) associated with their extraction and use. PURPA, too, makes no calculation of these costs, and thus does not guide administrators to measure accurately the costs avoided by switching to alternative energy sources. Amending PURPA to fill this accounting gap would enable administrators to factor in more of the true costs of fossil-fuel energy usage when evaluating bids to meet energy demands. It would give utilities accurate signals of the social price of competing energy sources and would provide a consistent and comprehensive framework for weighing the costs and benefits of energy investments.

Offsetting New Sources of Greenhouse Gases

New sources of greenhouse gases, particularly stationary sources of carbon dioxide, could be required to compensate for proposed emissions. Compensation could be achieved by any available means that would create offsetting emission reductions. Offsets might be generated by investing in energy conservation, retiring older, more CO_2-

intensive facilities, investing in mass transit, or even carrying out collaborative investments in tree plantations with forest product firms. Since requiring offsets for new CO_2 sources would increase the cost of constructing power plants and industrial boilers, utilities and others would be spurred to make greater investments in energy efficiency. In general, the offset approach would stimulate the search for new and cheaper ways of eliminating or reducing CO_2 emissions.

Because the greenhouse problem is concerned with a set of gases, the offset concept could be expanded beyond one-to-one trading of emissions in a single gas. The domestic program to manage CFCs provides an immediate opportunity. EPA is implementing a program of marketable permits to control production and trade in the fully halogenated chlorofluorocarbons, notoriously strong greenhouse gases. Since transferable permits will exist, offsets could take the form of buying up and shelving appropriate CFC production entitlements.

Preventing Deforestation Through Debt-Forest Swaps

Because forests are important reservoirs of carbon (absorbers of CO_2), there is a close link between deforestation (particularly by burning) and CO_2 increases in the atmosphere. At the same time, many of the world's developed economies are both important greenhouse gas (GHG) emitters and major financiers of economic development in the less developed countries (LDCs), the main repositories of the world's tropical forest resources. Many LDCs have found that they can no longer meet their massive debt obligations and invest adequately in growth at home. Their dilemma has threatened the solvency of major banking institutions in the developed world, and this debt burden has created pressures for LDCs to accelerate exploitation of their natural resource endowments.

The developed and less developed nations thus share common interests in the tropical forests, a nexus between climate change and debt problems. These common interests could be furthered by extending the concept of "offsets" into the international arena through "debt-for-forest swaps," several of which have already been arranged by the World Wildlife Fund and other organizations.[57] Maintaining (rather than burning) tropical forests can constitute a significant source of greenhouse gas reductions; and voluntary debt-forest swaps will benefit debt-burdened LDCs.[58]

International Trading in Greenhouse Gases

The global nature of the greenhouse problem will require truly international efforts, and it is likely that negotiations to produce an

international agreement will be a necessary step. Possible forms for such an agreement range from a "Law of the Atmosphere" to a "Convention on Greenhouse Gases," modeled on the protocol for stratospheric ozone protection.[59] In the latter case, some elements of the Montreal ozone agreement offer particular promise: flexibility in national implementation, ease of verification, and separate "equity provisions" for less developed countries (LDCs).

The Montreal agreement sets an important precedent by providing that nations can trade emission entitlements. This market-oriented flexibility in meeting standards will mean achieving those standards at the least possible overall cost.[60] Given the intimate link between greenhouse gas emissions and energy use, an international system of transferable emission permits would be desirable because it would handle distributional problems (i.e. LDC participation) explicitly while allowing for efficient allocations to emerge; and, it would provide incentives for efficient greenhouse gas management, including the possible use of forests as "carbon reservoirs."

Stratospheric Ozone Depletion

Anthropogenic emissions of CFCs and other chemicals are causing the depletion of stratospheric ozone.[61] As a result, ultraviolet radiation will reach the earth's surface in increasing amounts, potentially elevating human skin-cancer incidence, promoting cataracts, suppressing immune responses, and causing other adverse effects to animals, plants, and valuable materials.

The most important potential ozone depletors (PODs) are CFC-11, 12, and 113, carbon tetrachloride, methyl chloroform, and Halon 1301 and 1211.[62] All are artificially synthesized compounds used in a wide variety of industrial processes and consumer products. The CFCs of concern are used to produce rigid insulating foams and flexible cushioning foams; as refrigerants in industrial, mobile, and home air-conditioning systems and refrigerators; as aerosol propellants except in the few countries (including the United States) which have prohibited all but "essential" aerosol applications;[63] in degreasing, metal cleaning, and other industrial applications; and in dry cleaning. Additionally, Halons are used as fire extinguishants.

Phasing Out Potential Ozone Depletors With Tradeable Permits

To implement the Montreal Protocol's restrictions, EPA has promulgated a system of nationwide tradeable permits to achieve specified control levels. This market-based approach will stimulate firms to

adopt measures tailored to specific circumstances, and will provide industry with incentives to develop substitute chemicals, industrial processes, and consumer products.[64] A complete phaseout of ozone-depleting substances could also be accomplished through a tradeable permit system in an effective and relatively inexpensive manner. The conventional command-and-control approach of developing specific requirements for the hundreds of POD applications and enforcing these requirements on the thousands of firms which use PODs would be an administrative nightmare. In contrast, a marketable permit system would provide economic incentives for firms to determine on their own how to reduce PODs, while reserving these chemicals for their most valued uses, thereby minimizing the costs of reducing POD use. Furthermore, this approach provides industry with incentives to develop substitute chemicals, industrial processes, and consumer products.

Labelling POD-Containing Products

Labelling requirements may be effective if consumers are willing to pay slightly higher prices or purchase slightly "inferior" products if they know that by doing so they are protecting the ozone layer. In this case, firms would have economic and public-relations incentives to market non-depleting products. Such an approach contributed to a 50 percent decline in CFC use in aerosol products during the 1970s, even before federal bans became effective. Some firms are likely to label their products voluntarily; the effectiveness of such efforts would be increased by a requirement that products containing PODs or that emitted PODs in their manufacture be so labelled.

Local Air Pollution

As a result of 20 years of federal attention to local air pollution problems, there have been substantial improvements in air quality in most parts of the United States. Nevertheless, more than 100 million Americans remain exposed to excessive smog (ambient ozone) levels and some 70 urban areas still lack adequate local plans to reduce them.

The Clean Air Act of 1970[65] established ambient air quality standards for several pollutants, including sulphur dioxide, particulates, carbon monoxide, and ozone. The general approach of the Act was to require EPA and the states to establish plans to achieve standards for the concentration of these pollutants in the air by specified deadlines. The deadlines have been extended repeatedly, however,

and today, 20 years after the passage of the Act, ambient air quality standards for ozone and carbon monoxide have not been met in many parts of the country.

In many cases, additional emission reductions are going to have to be made by smaller, more dispersed sources, and by innovative emission control methods at large sources. Since it is very difficult to "command" innovation, it is unlikely that these reductions can be achieved exclusively by reliance on command-and-control approaches. To obtain further reductions, new strategies are needed to supplement conventional regulatory methods.

Tradeable Permits For Stationary Sources

A logical extension of EPA's initiatives with "emissions trading" is a comprehensive system of marketable emissions permits.[66] Under such a system, all major pollution sources would be required to have permits specifying their allowed amount of pollution discharge. Firms which can reduce discharges below their permit levels could sell their surplus to other firms; firms for whom compliance is relatively costly could choose instead to buy additional permits.

Systematic reduction of permit amounts would bring progress towards ambient goals. Permits could initially be distributed so that a plant which currently (and legally) emits ten tons of hydrocarbons would begin with ten permits. But the firm would know that those ten permits will become, for example, eight the next year, six two years later, and five after another year had passed. Each pollution source would then face a choice. It could either reduce its emissions in accord with the schedule, or it could seek to purchase additional permits from firms which manage to reduce their emissions faster than required.[67] This convertibility of cleanup into revenue would give firms an incentive to find cleaner (cheaper) ways of doing business and would put to work resources far greater than those currently commanded by regulators.

Incentive Approaches For Mobile-Source Air Pollution

Obviously, mobile sources play a major role in the air pollution problems of a number of cities. In areas such as Los Angeles and Houston, ozone standards would not be met even if industrial sources reduced emissions to zero. In such areas, air cleanup progress will probably require stricter emission standards for vehicles, but certain incentive-based systems also merit consideration. These include EPA's practice of allowing use of emission-reduction credits from mobile sources to meet stationary-source requirements, and fleetwide averaging and "bubbles" to comply with emission standards.

Acid Rain

Wet and dry atmospheric deposition of acidic substances—acid rain—has become one of the more well-known environmental threats in the United States, Canada, and Europe. Industrialized areas and their downwind neighbors commonly receive precipitation with elevated acid concentrations. Rainfall in eastern North America has increased in acidity, and specific localities have experienced acute problems, including the acidification of aquatic ecosystems. Other damage has been associated with degradation of natural and man-made materials, and with adverse impacts on visibility.

Though there are natural sources of acid deposition, human sources dominate production of the two primary pollutants, sulfates and nitrates. Man-made emissions of sulfur dioxide (SO_2), the primary target of most acid rain legislative proposals, totalled about 27 million tons nationwide in 1985, of which 15.8 million tons came from electric utilities. By 1995, over 90 percent of utility discharges of sulfur oxides will be accounted for by older utility plants. Control of emissions from these plants is thus the key issue in designing acid rain legislation, but several obstacles lie in the way of simply requiring stringent control devices to be installed on these older sources. In addition to political resistance from those who would bear the costs, it would be unnecessarily expensive and it would not target reductions in the most effective way. Since some electrical generating units will be retired as they outlive their useful economic lives, it would be wasteful in the extreme to force such plants to install expensive pollution-control equipment which would be used only a very short time.

While the environmental consequences of acid rain escalated throughout the 1980s, Congress was unable to agree on a policy response until 1990. Though many factors lay behind this, a major one was the high cost of control and social disruption that could be attendant on compliance, especially for high-sulfur coal mining and burning communities in Appalachia and the Midwest.

Acid Rain Reduction Credit Program

Patterned after EPA's emissions trading program,[68] this economic incentive approach to acid rain control offers the possibility of achieving emission reduction targets at lower cost, while dealing realistically and fairly with the problem of units that are about to be replaced. The Acid Rain Reduction Credit program would function like the "marketable emissions permits" system described above to deal with local air pollution problems, except that trading would occur on a national or regional basis.[69]

Any sources of emissions contributing to acid rain would be allowed to make "excess" reductions—below the target level—and these would be certified by EPA as acid rain reduction credits. These credits could then be used by the owners of the reducing source to meet the acid rain emission standards on some other source under their control; or they could be transferred (sold or leased) to another source. The advantage is that individual sources would decide what methods of control to utilize. With this approach, acid rain reduction goals could be met at much lower cost than would otherwise be possible. One study commissioned by EPA suggests that savings of up to 50 percent annually should be possible.[70]

A major political concern has been the impact of acid rain controls on communities economically dependent on high-sulfur coal mining. If initial permits were auctioned, revenues from the auction could be used to help finance the installation of retrofit and clean coal technology through federal cost-sharing arrangements. Facilities which currently utilize high-sulfur coal could qualify for these cost-sharing arrangements. Those sources which adopt scrubbers and similar technologies would then have marketable excess reductions, thus generating revenue in the process. The efficiency properties of the program can thus be combined with equitable protection for communities which are economically dependent upon the high-sulfur coal industry.

Late in 1990, new amendments to the Clean Air Act provided for the development of a marketable-permit approach to acid rain control very much along the lines of the program described above.

Indoor Radon Pollution

In 1984, an engineer at the Limerick Nuclear Power Plant in southeastern Pennsylvania set off radiation detectors as he arrived at work in the morning. The cause was found to be radioactive contamination from radon gas within his own home. EPA has since identified radon as one of the most serious environmental risks facing the nation, one that causes an estimated 5,000 to 20,000 lung-cancer deaths each year.[71] High human exposures occur when radon gas from soil with a high radium content enters a building through cracks or openings in the foundation. If the building has inadequate ventilation, radon concentrations can accumulate to unhealthy levels. Because radon exposure occurs largely in private homes, it has not been feasible to use the conventional regulatory approach of setting and enforcing health-based exposure standards.[72]

A Variety of Federal Actions

In applying market concepts to this problem, consideration could be given to a number of possible approaches, including tax incentives, subsidized loans, testing requirements for real estate transactions, and accelerated information dissemination, in combination with more conventional regulatory measures, such as construction codes and soil tests.[73]

Tax incentives and subsidized loans can be effective because radon mitigation imposes an economic burden. Radon mitigation could be encouraged by reducing its effective cost to homeowners. But, with such approaches, public understanding of the risks of radon would not be improved, and so cost-effective mitigation would not be induced. Alternatively, construction codes could be tightened to prevent leakage of soil gas into homes. EPA estimates that the cost of radon-proofing a house during construction ranges from $400 to $600, while retrofitting an existing house with the same equipment costs from $1,600 to $3,000. Relatively simple modifications of construction practices could therefore greatly reduce radon mitigation costs. But requiring all new construction to be radon-proof would be inefficient in the extreme, since only a small share of new homes are likely to have elevated radon levels. Soil testing could be used to target problem areas, but soil tests have not proven to be reliable in predicting actual indoor radon concentrations; exposures depend upon a large number of variables, in addition to radon content in soil gases.

There may be a need for improved government certification of testing and mitigation services. Although the private sector has responded quickly to the new demand for radon testing and mitigation services, some companies have exploited homeowners with deceptive and fraudulent practices. The government could stimulate more effective private market activity by improving certification of radon-service providers. But this type of regulation imposes barriers to entry and competition, and may thus raise costs to consumers.

Testing requirements for real estate transactions also merit consideration. The delayed effects of radon exposure make it easy for individuals to put off radon mitigation, and in many cases, concern for real estate values may provide a more immediate and tangible motive for homeowners to reduce radon levels. State or local requirements that homes be certified "radon free" might be highly effective. Some banks already have begun to require such certification before approving mortgage financing, just as they require termite inspections. But, unlike termite inspections, it is difficult to obtain an unbiased short-term test of indoor radon levels.

Finally, greater public resources could be used to disseminate

information to current and prospective homeowners. As unreliable as voluntary compliance often seems, most of the alternative approaches have serious deficiencies. Compared to conventional regulatory procedures, information programs are inexpensive and effective ways to let homeowners and buyers make informed decisions which reflect their own preferences and circumstances.

Threats to Energy Security and Environmental Quality

Crude petroleum accounts for over 40 percent of the nation's energy needs; and during the past 20 years, imports have been providing an increasing share of the crude oil used in the United States. Attempts to obtain domestic energy security through higher production of fossil fuels will run up against serious environmental problems. The United States could benefit by giving greater emphasis to strategies that increase energy efficiency.

Comprehensive Least-Cost Bidding at Electrical Utilities

Opening U.S. power markets up to allow methods of demand-management to compete with methods of power production is a market-oriented approach which some states have already taken. With conventional practices, an operating utility offers to purchase a given amount of capacity with specified characteristics of reliability and timing of generation. An auction takes place in which providers of electric energy services offer to meet the utility's needs. The utility then selects the least-cost option.

Under a simple extension of this process, potential contractors could offer bids based upon savings in power use. Since the utility's capacity problem is fundamentally one of demand exceeding supply, there is no reason to limit possible solutions to those which augment supply; means of curtailing demand can also be effective. The efficient approach is to utilize whatever solution is least expensive, be it on the supply side or the demand side. Thus, for example, the bidding process should allow conservation marketing and non-utility generation to compete with nuclear and conventional fossil-fuel generators on a least-cost basis. In this way, systems of comprehensive least-cost bidding will substantially increase the efficiency of energy production.[74]

Incentives For Greater Efficiency in the Motor Vehicle Sector

Since motor vehicles account for 63 percent of oil demand in the United States and 27 percent of total energy use, increasing the

efficiency of motor vehicles should be part of any portfolio of energy strategies. One cost-effective approach would be to increase the tax on "gas guzzlers" and use revenues from this tax (and perhaps from gasoline taxes) to provide rebates to purchasers of very efficient vehicles—"gas sippers."

Another incentive which merits consideration is an increase in current federal excise taxes on gasoline. The air quality costs of gasoline marketing and consumption, as well as energy security risks, may justify additional taxes on gasoline. Increased gasoline taxes can encourage people to cut down on driving and gasoline consumption.[75] Phased in by increments over a number of years, prospective gas tax increases would cause car purchasers to take future costs into account as they make investment decisions on new cars, while holding down the immediate impact on consumers.

Inefficient Use and Allocation of Water Supplies

If current practices continue, water shortages may become commonplace in the United States during the next two decades. Current policies do not give users appropriate incentives to take actions consistent with either the real economic costs or the environmental values of water resources. This lack of appropriate incentives results in grossly inefficient use of existing supplies, since decision-makers do not experience the true costs of their water-use decisions. Just as free markets in other goods and services in our society can result in efficient provision of those goods and services when and where they are needed, so, too, water markets can facilitate the provision of adequate supplies at the least overall cost.[76]

Water Markets

An effective approach to water supply problems would support development of federal and state policies which facilitate the voluntary buying and selling of water rights by individuals, firms, and other organizations, in order to increase the efficiency of the system—most notably by creating economic incentives for water conservation. Measures which facilitate voluntary water transfers will promote more efficient allocation and use of scarce water resources and curb the need for more (expensive and environmentally disruptive) water supply projects.[77]

The government should begin to remove barriers to voluntary water marketing by validating that voluntary transfers of water are permissible and by establishing rules to protect public and other

third-party[78] uses of water. One potential problem with applying this approach is that the economic values associated with water resources are well-defined for some uses but not for others, particularly those associated with environmental amenities. The difficulty of depending solely upon market-oriented approaches for all water quantity (and quality) problems suggests that the ultimate set of policies should involve a mix of market and more conventional regulatory processes.

Degradation of Surface and Ground Water Quality

Most water pollution control laws and regulations in the United States have been directed at point sources, such as factories and municipal waste-treatment facilities, which discharge pollutants into surface bodies of water.[79] Dispersed, non-point sources of discharge into surface waters—including farms and urban runoff—have not been adequately addressed, in part because such sources are much more difficult to control, particularly by conventional methods. A related and increasingly serious problem is the contamination of ground water supplies by seepage of hazardous chemicals stored in dump sites and municipal landfills, leaks from underground storage tanks, highway runoff, and infiltration of pesticides and fertilizer residues.

The Conservation Reserve Program and Water Quality Problems

Soil which erodes into waterways is a major non-point source of pollution. Sediment directly pollutes water by reducing light transmission, covering submerged plants and fish spawning beds, and impairing recreational uses. Eroded soils typically carry with them the residues of fertilizers and pesticides.

Soil conservation policy has traditionally focused on preserving soil productivity, although maintaining water quality is slowly becoming a goal as well. While the Conservation Reserve Program (CRP)[80] represents an improvement over past soil conservation efforts in that it focuses on highly erosive cropland, the program should be focused more directly on improving surface and ground water quality. This would be an important step toward control of non-point source water pollution from agricultural runoff. Eligibility criteria for the CRP should be broadened to include lands which are important in terms of water pollution.

Incentives and Federal Support for Environmentally Sound Farm Management Practices

Because the major pollutants which enter ground water and surface supplies from agricultural sources are pesticide and fertilizer resi-

dues, strong arguments exist to foster incentives for environmentally sound farm management practices, including ecologically benign pest management methods.

A tax on the use of certain pesticides could reduce use of environmentally damaging chemicals and encourage adoption of alternatives, such as integrated pest management, and sustainable agricultural practices such as crop rotation. A pesticide tax program would rely on farmers to make their own management decisions, balancing private benefits of using pesticides against social costs. Such a program would be flexible in the face of change, and would provide incentives for farmers to adopt more efficient technologies, such as disease- and insect-resistant crop strains, as they become available.

Tradeable Discharge Permit Systems For Point Sources

Federal laws for point-source water-pollution control have relied primarily on discharge permits issued by regulatory agencies, with pollution limits based on available control technologies. This system has had beneficial effects during the past decade in controlling conventional industrial and municipal sewage plant pollution. EPA's Construction Grants Program provided massive federal subsidies to achieve these results. But such approaches to point-source control, while holding each source to specified limits, do not restrain the *total* volume of discharges within a basin. In situations where this is a concern, the establishment of an overall watershed limit and the implementation of tradeable permits within it can be an effective and efficient way of achieving water quality goals.

Solid Waste Management

It is not an overstatement to say that a garbage crisis faces many municipalities. Los Angeles County landfills are expected to be full by 1994, New York City's landfill space will be totally exhausted by the year 2002, and Connecticut will run out of currently available landfill space within two or three years. At the same time, the environmental hazards of landfills are receiving increased recognition, and standards for new and existing landfills are being tightened. Thus, throughout the country, old landfills are filling up, and it is becoming more and more difficult to find sites for new landfills. Giant garbage incinerators are bringing with them equally-giant bond issues representing burdensome investments for many communities, and it also is becoming clear that incinerators produce their own set of significant environmental hazards.

Allowing Recycling to Compete

The vast majority of our garbage is recyclable. The critical question is whether recycling makes economic sense, and the answer is that recycling's most important economic benefits are typically gained from reducing the quantity of garbage which must otherwise be collected and disposed, not from revenue due to sales of recycled materials.[81]

A first step toward better solid waste management would be to stop financing garbage collection through property taxes and user fees which do not reflect quantities of trash picked up daily. While the administrative problems of developing and implementing alternative financing mechanisms will not be trivial, economically rational alternatives nonetheless merit consideration. Among these are "product-disposal charges" levied on bulk producers or importers of packaging materials, and "recycling-incentive taxes" to create price differentials which reflect differences among containers in the disposal problems they cause.[82] If communities are to adopt efficient solutions to their solid waste management problems, recycling must be considered on an equal basis with other alternatives. The bidding process for municipal waste management should be opened to all techniques, by specifying outputs and results rather than specific technologies.

Management of Toxic and Infectious Waste

As public concern regarding hazardous waste problems has increased and regulations have been tightened, the costs of managing existing stocks of hazardous wastes have increased dramatically. In this context, the notion of reducing the flow of toxic wastes from production processes is becoming more attractive. Policies which reduce toxic waste at the source will lessen the seemingly intractable problems of managing hazardous waste disposal and containment. Although federal legislation nominally encourages toxic waste source reduction, the actual focus of regulation has been on controlling pollution at the "end of the pipe."

Incentives For Source Reduction

To finance the cleanup of hazardous waste sites, the Superfund program imposes a "front-end" tax on the chemical and petroleum industries, unrelated to the toxicity of products or services.[83] This tax provides no incentive for firms to switch to less hazardous substances or to recycle wastes. A "waste-end" tax could induce industries to

reduce the toxicity of their products and processes and could also provide an incentive to consumers to substitute safer products. But waste-end taxes also provide incentives for illegal dumping. In some cases, the answer to this quandary will be a deposit-refund system, discussed below.

Another approach to source reduction is through labelling requirements which compel producers to inform consumers about the presence in products of known toxic substances which may present significant risks.[84] Appropriate labelling has the potential to reduce unknowing, involuntary exposures to hazardous substances; raise public awareness of the presence of toxics and thereby reduce consumer demand for particularly toxic products; and, encourage producers to substitute safer substances for more toxic ones in their products and services. This approach must be used only in limited cases, however, since excessive labelling may simply cause people to ignore signs or labels which warn of genuine risks.

A Deposit-Refund System For Containerized Wastes

One of the most difficult hazardous waste management problems is that posed by wastes generated in small enough quantities that they can be containerized, stored, shipped away from the place of generation, and dumped more or less anywhere in the environment.

When regulations make identifiable and measurable waste emissions more costly, illegal emissions become more attractive. To some degree, current policies raise the cost of approved disposal, relative to illegal disposal, and an effective mechanism does not exist to monitor actual disposal activities. Instead, federal policy approves methods and sites for waste disposal (narrowing the choices toward reliance on high-temperature incineration), and strives to enforce requirements via a manifest system designed to track hazardous wastes once they leave their place of generation.[85] But high-temperature incineration is more expensive than dumping waste in the woods, and the manifest system does not seem to perform as intended.[86] A waste-end tax would in certain instances only exacerbate the incentive problem which already exists.

One answer might come from a special front-end tax on waste precursors such as fresh solvent. Such a tax would work as a general incentive to reduce use and hence waste generation, and would give users an incentive to find safer substitute chemicals. This tax would have the further advantage of creating an incentive to recover and recycle taxed compounds rather than allow them to evaporate or otherwise be dissipated. Once waste is generated, however, incentives

that affect the choice of disposal methods would look much as they do now.

A resolution of this apparent policy dilemma may be a front-end tax which works as a deposit, with a refund payable when quantities of toxic substances are turned in to designated facilities, whether for recycling or disposal.[87] Such a deposit-refund system would provide important incentives for toxic management: first, there would be an incentive to follow rules for proper disposal and to recapture would-be losses from the production process; second, there would be an incentive for producers to look for non-hazardous substitutes; and third, agencies' monitoring problems would no longer include the nearly impossible task of preventing illegal dumping of small quantities at dispersed sites in the environment.

Public Lands Management

The public lands of the United States encompass more than 700 million acres, 25 percent of the nation's entire land base, and include mountains, plains, forests, grasslands, deserts, canyons, wetlands, lakes, rivers, seashores, and islands. The federal lands contain valuable natural resources, such as timber, minerals, oil and gas, and forage for livestock, all of which are highly valued (and priced) in the market place. Just as importantly, these lands also hold an immense treasure which is less readily measured in financial terms—wilderness, fish and wildlife and their habitats, watershed values, free-flowing rivers and streams, scenic beauty, outdoor recreational opportunities, and untapped scientific information.

Because a market economy makes it difficult for individual landowners to turn these general environmental values into profits, the burden of providing "environmental amenities" falls disproportionately on public lands. The federal lands—primarily national forests, national parks, national wildlife refuges, and the lands of the Bureau of Land Management—are thus logical units for the conservation of valuable ecosystems, scenic beauty, and outdoor recreational opportunities. Hence, the public lands logically provide benefits which private lands are unlikely to produce in our market economy. But sound management of public lands has been seriously impeded because of costly subsidies that exist for a few extractive industries, at the expense of the public's interests in environmental values and outdoor recreation.

Reducing Government Subsidies

The largest of these subsidies, and the one most in conflict with environmental values, is that given to timber sales in remote areas of

the national forests, particularly in the Rocky Mountains, Alaska, and the Northeast. Low-value timber is frequently sold from environmentally and recreationally valuable areas where roadbuilding to reach and harvest timber is expensive and damaging.[88] Below-cost timber sales—where the Forest Service does not recover the full cost of making timber available for sale—dominate in 73 of the agency's 123 administrative units. As a result, the Forest Service's national timber program has been costing the U.S. Treasury more than $400 million annually during recent years.[89] Gradual removal of these subsidies would foster protection of the environment and increase net revenues.

Investing Revenue From Nonrenewable Resources in Recreational and Environmental Assets

The national Land and Water Conservation Fund was established in 1964 to ensure that a portion of receipts from federal offshore oil and gas leasing would be invested in acquiring inholdings,[90] private parcels within the boundaries of federal lands, and in other additions to the national parks, national forests, national wildlife refuges, and other public holdings; and would be used to support similar investment by state and local governments through matching grants. Through the Fund, depletion of nonrenewable resources pays for renewable resource protection. Over the years, more than six million acres have been acquired by this means at local, state, and federal levels. But annual outlays from the Fund have dwindled to historic lows, despite increases in revenues from offshore leasing.

The use of the Fund should be expanded to leverage state, local, and private action and investment in protecting open space for public purposes. To meet the nation's growing demand for outdoor recreation,[91] this strategy of reinvesting revenues from nonrenewable resources would create a system that maintains the necessary level of investment, putting money to work at the local and state levels as well as at the federal level, and leveraging private and other non-federal contributions to such efforts.[92]

Depletion of Wetland Resources

Since the time of European settlement of the North American continent, wetlands have been drained, cleared, and filled for agricultural, municipal, and industrial uses. In their natural state, however, wetlands also produce significant benefits—regulation of water flows, filtration and purification of water, and provision of habitat for flora

and fauna. Yet wetland losses now average 450,000 acres annually, an area about half the size of Rhode Island.[93]

If wetlands are so valuable in their natural state, why are they nevertheless being eliminated at this rate? The answer is that the nature of wetland benefits are such that their owners usually cannot capture those benefits for their own use (or sale). Flood protection benefits accrue to others downstream; fish and wildlife that breed and inhabit the wetlands migrate; and benefits associated with improved water quality and sediment trapping cannot be commercially exploited. For the owner of a wetland to benefit from the resource, he often has to alter and develop it. Since the vast majority of wetlands are privately owned, the nation's system of wetlands is extremely vulnerable. By far the most important economic sector absorbing wetlands is agriculture, accounting for 87 percent of recent wetland conversions.

Improving the Use of Environmental Impact Statements

An important question, in the context of environmental impact statements (EISs), is whether the estimated areas of impact of federal flood-control and drainage projects on wetlands should be limited to (minimal) construction impacts, or whether they should include impacts which occur when such projects lead private landowners to clear their wetland holdings. During the past fifteen years, in preparing their EISs, federal agencies typically have not included as impact areas of projects wetland areas cleared and drained by private landowners.[94] It has now become clear, however, that federal flood-control and drainage projects directly induce private landowners to convert their wetland holdings to dry croplands.[95] These impacts should be candidly assessed through the EIS process. Impact areas must be correctly defined to include areas where drainage and clearing are (economically) induced.

Market Incentives to Reflect Wetland Values

Government subsidies which promote economically inefficient and environmentally unsound development in wetland areas should be removed. Among the policy initiatives to consider are: ending totally subsidized construction of federal flood-control and drainage projects;[96] eliminating favorable tax treatment of wetland conversion;[97] and implementing cross-compliance legislation linked to receipt of federal commodity program payments.[98]

Restructuring of the Federal-Aid in Fish Restoration Fund

Since lack of funding is the primary limit on current wetland acquisition programs, it would be valuable to modify the Federal-Aid in Fish

Restoration Fund (Dingell-Johnson Act) program, which currently authorizes matching grants to the states for up to 75 percent of the cost of projects undertaken to enhance sport fish resources, so that matching grants would include wetland acquisition and restoration projects. This proposed change would place part of the responsibility for protection on the beneficiaries of these resources, as most species of sport fish depend upon wetland habitats for some portion of their life cycle.[99]

A Sport Fishing Conservation Stamp

For the long run, consideration should be given to a Sport Fishing Conservation Stamp, modelled after the highly successful "Duck Stamp" program, in which the U.S. Fish and Wildlife Service (under authority of the Migratory Bird Conservation Act of 1934) acquires wetland habitats with revenues from the sale of mandatory federal Duck Stamps to holders of state hunting licenses. The proposed fishing stamp would be required of all state-licensed fishermen, with the revenues used exclusively for wetland acquisition. The logic behind this proposal is analogous to the reasoning behind the Duck Stamp program (and the recommendation above for restructuring the Federal-Aid in Fish Restoration Fund). The proposed stamp would essentially be a user fee, in which beneficiaries are paying for their wetlands' provision and protection. How much wetland protection would this proposal provide? A $1 stamp would raise up to $20 million annually.[100]

MARKET-BASED ENVIRONMENTALISM: A NEW ERA FROM AN OLD IDEA?

Across the United States and throughout the industrialized world, there exists a strong consensus in favor of effective environmental protection. In many cases, our environmental goals are clear—the question is how to achieve those goals. The policy tools chosen *do* make a difference.

Although conventional regulatory policies have sometimes worked well, they have tended to pit economic and environmental goals against each other, frequently producing paralysis rather than progress. In the long run, economic and environmental goals must complement one another, because both must be served if either is to be achieved. Fortunately, innovative approaches to environmental protection policy can address this dual-goal reality. This can be done by applying economic incentive mechanisms to the work of environmental protection.

While the policy prescriptions described in this chapter represent a substantial departure from the mainstream of U.S. policies developed and implemented over the past twenty years, it is also true that incentive-based approaches to environmental and natural resource problems have been suggested countless times before. For at least three decades, economists and others have been recommending these ideas. But likewise, for that same period of time, policymakers have consistently ignored such suggestions.

Is there any reason to believe that these new policy proposals will fare better among today's policymakers than previous ones? Is this just another wave of interest, or is it the beginning of a new era of policy? Unfortunately, it is much too soon to provide a definitive answer to this question. But it should be noted that incentive-based policies for environmental protection and natural resource management are now receiving attention from policymakers which is unprecedented, both in its intensity and its diversity.

In fairness to future generations, it is essential to begin now to deal with long-term economic and environmental problems. Sustainable solutions to today's problems are required, because the debts we incur today—whether economic or environmental—will some day have to be paid. If Theodore Roosevelt's conservation ethic at the beginning of the twentieth century represented the first important era of environmental concern in this country, then the decade of important new laws and regulations following Earth Day in 1970 was the second era. The United States now faces a new challenge—to move aggressively into a third era, a period when practical and economically sensible policies will provide more effective and efficient management of natural resources and protection of the environment.

NOTES

1. On June 12, 1989, President Bush proposed a "tradeable permit system" for acid rain control as part of the Administration's Clean Air Act amendments. This proposal was sent to Congress on July 21, 1989, as Title V of the Administration's bill. A House-Senate compromise bill was approved by the House of Representatives on October 26, 1990 and by the Senate the following day. The President signed the bill into law on November 15, 1990.

2. Robert N. Stavins, ed., *"Project 88: Harnessing Market Forces to Protect Our Environment—Initiatives for the New President,"* A Public Policy Study sponsored by Senator Timothy E. Wirth, Colorado, and Senator John Heinz, Pennsylvania. Washington, D.C.: December 1988. This chapter draws, in part, upon that study, and upon Robert W. Hahn and Robert N. Stavins, "Incentive-Based Environmental Regulation: A New Era From an Old Idea?" *Ecology Law Quarterly*, vol. 18, 1991.

3. Several other studies followed the Project 88 report. See: John L. Moore, et al., *Using Incentives for Environmental Protection: An Overview*, Congressional Research Service Report to the Congress, # 89–360 ENR, Washington, D.C.: June 1989; and Robert C. Anderson, et al., "*The Use of Economic Incentive Mechanisms in Environmental Management*," Draft report, Washington, D.C.: American Petroleum Institute, September 1989.

4. The final report of the Economic Incentives Task Force was nearing completion in the spring of 1990.

5. Nicholas Schoon, "Markets in 'Permits to Pollute' Proposed," *The Independent*, London, August 16, 1989; and Marion Shoard, "Clearing the Air With a Tax," *The Times*, London, September 15, 1989.

6. David Pearce, Anil Markandya, and Edward B. Barbier, *Blueprint for a Green Economy*. London: Earthscan Publications, 1989.

7. Within the Soviet Union, the Central Institute of Mathematics and Economics (Tsemi) of the Academy of Sciences has advocated the use of pollution taxes for a variety of environmental problems, while in Poland, government officials have endorsed marketable permit programs to help address air and water pollution problems (John Palmisano, personal communication, December 8, 1989).

8. For example, the Battery Recycling and Research Act of 1989, introduced by George Hochbrueckner (D-New York) in the House of Representatives and Albert Gore (D-Tennessee) in the Senate, would allow for the adoption of motor-vehicle battery deposit-refund systems at the state or local level. A more comprehensive bill, the Consumer Products Recovery Act of 1989, was introduced in the Senate by John Heinz (R-Pennsylvania) and Timothy Wirth (D-Colorado), and in the House by Esteban Torres (D-California) and Claudine Schneider (R-Rhode Island).

9. The Administration has suggested that consideration be given to the use of international tradeable permit mechanisms for the management of global climate change. See: George Bush, "Remarks at the Intergovernmental Panel on Climate Change," Washington, D.C.: Office of the Press Secretary, February 5, 1990. For further details, see: "Materials for the Informal Seminar on U.S. Experience with 'Comprehensive' and 'Emissions Trading' Approaches to Environmental Policy," prepared for presentation at U.S. Department of State, February 3, 1990.

10. Frederic D. Krupp, "New Environmentalism Factors in Economic Needs," *Wall Street Journal*, November 20, 1986, p. 34.

11. The endorsement of the Natural Resources Defense Council—a leader on clean air issues—for a tradeable permit system for acid rain control was particularly important. See: Matthew L. Wald, "Searching for Incentives to Entice Polluters," *New York Times*, October 8, 1989.

12. For an analysis of causes of recent changes in the reception given to incentive-based environmental-protection strategies by the various members of the policy community—including environmental organizations, private industry, the Administration, and the Congress—see: Robert W. Hahn and Robert N. Stavins, "Incentive-Based Environmental Regulation: A New Era from an Old Idea?", *Ecology Law Quarterly*, vol. 18, 1991.

13. A discussion of future environmental challenges is provided by Milton Russell, "Environmental Protection for the 1990s and Beyond," *Environment*, 29 (1987): 12–38.

14. Federal expenditures for all environmental and natural resource programs in 1985 were about $13.4 billion (1.4 percent of all Federal outlays). See: U.S. Office of Management and Budget, *Budget of the U.S. Government, Historical Tables, Fiscal Year 1987*, Washington, D.C.: U.S. Government Printing Office, 1986; and U.S. Council of Economic Advisors, *Economic Report of the President*, Washington, D.C.: U.S. Government Printing Office, 1986. EPA recently estimated that this will rise to about $61 billion (in 1987 dollars) by the year 2000. See U.S. Environmental Protection Agency, *The Public Costs of Environmental Protection: 1981–2000*. Washington, D.C., May 1990.

15. In 1984, total U.S. expenditures on pollution control amounted to about $65 billion—63 percent by businesses, 21 percent by all levels of government, and 16 percent by consumers. Total pollution control expenditures were about 1.8 percent of GNP. See: Kit D. Farber and Gary L. Rutledge, "Pollution Abatement and Control Expenditures," *Survey of Current Business* 66 (1986): 100–103.

16. Public opinion polls consistently show that public concern over environmental quality has remained firm during energy crises, economic downturns, and tax revolts. See: Riley E. Dunlap, "Polls, Pollution, and Politics Revisited: Public Opinion on the Environment in the Reagan Era," *Environment* 29 (1987): 7–37; E. C. Ladd, "Clearing the Air: Public Opinion and Public Policy on the Environment," *Public Opinion*, February/March 1982, pp. 16–20; and Richard D. Lamm and Thomas A. Barron, "The Environmental Agenda for the Next Administration," *Environment* 30 (1988): 17–29.

17. There are exceptions to this linkage. A current example is provided by the consideration given in late 1989 and 1990 by the Bush administration to prospective policies for addressing global climate change due to the greenhouse effect. At the same time as the Administration has maintained that it is essentially too soon to establish goals and standards regarding greenhouse-gas sources and sinks, the President has recommended to the Intergovernmental Panel on Climate Change that cost-effective methods be used to achieve whatever standards may be set in the future through international negotiations. In particular, the Administration has suggested that consideration be given to the use of international tradeable permit mechanisms, an approach which is described below. See footnote, above, regarding the President's recommendations.

18. In order to maximize the net-benefits (the difference between total benefits and total costs) of pollution control, the pollutant is controlled to the level where marginal benefits of control are equal to marginal costs.

19. If firms are not controlling at the same marginal-cost of control, then the same aggregate level of pollution abatement can be achieved increasing the level of control at low-cost controllers and decreasing proportionately the level of control at high-cost controllers.

20. Pigou is generally credited with developing the idea of a corrective tax to discourage activities which generate externalities such as environmental

pollution. See: A. C. Pigou, *The Economics of Welfare*, 4th edition. London: Macmillan, 1932. Much of the contemporary literature may be traced to Coase's treatment. See: Ronald H. Coase, "The Problem of Social Cost," *Journal of Law and Economics* 3 (1960): 1–44.

21. J. B. Opschoor and Hans B. Vos, *Economic Instruments for Environmental Protection*, Paris: Organization for Economic Cooperation and Development, 1989.

22. This idea, which has come to be considered by policymakers only recently, dates back at least to: William D. Nordhaus, "How Fast Should We Graze the Global Commons?" *American Economic Review* 72 (1982): 242–246.

23. Robert Hahn and Roger Noll, "Designing a Market for Tradeable Permits," *Reform of Environmental Regulation*, Wesley Magat, ed. Cambridge: Ballinger, 1982, pp. 119–146.

24. The capability to lease credits is an important advantage of marketable permit systems. See: Roger K. Raufer and Stephen L. Feldman, *Acid Rain and Emissions Trading: Implementing a Market Approach to Pollution Control.* Totowa, New Jersey: Rowman & Littlefield, 1987.

25. Differences in source location and seasonal factors mean that not all emissions reductions are of equal value in terms of improving air quality, a problem which also applies to command-and-control approaches. While it is, of course, theoretically desirable to take account of such differences, it must be recognized that in some cases it may not be practical to do so. See: Tom H. Tietenberg, "Transferable Discharge Permits and the Control of Stationary Source Air Pollution: A Survey and Synthesis," *Land Economics* 56 (1980): 391–416.

26. Robert W. Hahn and Gordon L. Hester, "Where Did All the Markets Go? An Analysis of EPA's Emissions Trading Program," *Yale Journal on Regulation* 6 (1989): 109–153; and Robert W. Hahn and Gordon L. Hester, "Marketable Permits: Lessons for Theory and Practice," *Ecology Law Quarterly* 16 (1989): 361–406.

27. Robert W. Hahn, "Innovative Approaches for Revising the Clean Air Act," *Natural Resources Journal* 28 (1988): 171–188.

28. Although the term CFC is often used to indicate the class of potential ozone depleting (POD) substances, it is misleading. Only three of the seven most important PODs are CFCs, and several of the proposed POD substitutes are themselves CFCs.

29. Supra note 9.

30. Peter Bohm, *Deposit-Refund Systems: Theory and Applications to Environmental, Conservation, and Consumer Policy.* Washington, D.C.: Resources for the Future, 1981.

31. Robert W. Hahn, "An Evaluation of Options for Reducing Hazardous Waste." *Harvard Environmental Law Review* 12 (1986): 201–230. Also, see footnote, below.

32. Supra note 21.

33. Supra note 8.

34. Richard W. Wahl, *Markets for Federal Water: Subsidies, Property Rights, and the Bureau of Reclamation.* Washington, D.C.: Resources for the Future, 1989.

35. If communities are to adopt efficient solutions to their solid waste management problems, all methods, including surface disposal, incineration, and recycling, must be considered on an equal basis. The bidding process should be opened to all techniques, by specifying outputs and results rather than specific techniques.

36. Since an electrical utility's capacity problem is fundamentally one of expected demand exceeding expected supply, there is no reason to limit possible solutions to those which augment supply; means of curtailing demand can also be effective. The more cost-effective approach is to utilize whatever solution is least expensive, be it on the supply side or the demand side. See footnote 74, below.

37. Michael D. Bowes and John V. Krutilla, *Multiple-Use Management: The Economics of Public Forestlands*. Washington, D.C.: Resources for the Future, 1989.

38. Robert N. Stavins, "Alternative Renewable Resource Strategies: A Simulation of Optimal Use," *Journal of Environmental Economics and Management* 19 (1990): 143–159.

39. Tim Phipps, "The Farm Bill, Resources, and Environmental Quality," *Resources*, Winter 1986.

40. ICF Resources, Inc. *Analysis of Six and Eight Million Ton 30-Year/NSPS and 30-Year/1.2 Pound Sulfur Dioxide Emission Reduction Cases*. Washington, D.C., February 1986. More recent estimates indicate that the Bush Administration's proposed marketable permit program for acid rain control would save between $13 and $16 billion by the year 2010, compared with a conventional approach. See: Robert W. Hahn, "Designing Markets in Tradable Allowances for Reducing Acid Deposition." Draft manuscript. Washington, D.C., December 1989.

41. For further discussion of such possibilities, see: Bruce A. Ackerman and Richard B. Stewart, "Reforming Environmental Law: The Democratic Case for Market Incentives," *Columbia Journal of Environmental Law* 13 (1988): 171–199.

42. In general, the relative superiority (in terms of inducing technological innovation and diffusion) of incentive-based approaches, compared with conventional command-and-control approaches, is clear. See: Scott R. Milliman and Raymond Prince, "Firm Incentives to Promote Technological Change in Pollution Control," *Journal of Environmental Economics and Management* 17 (1989): 247–265. Under certain circumstances, however, emission credit trading may reduce firms' incentives to adopt new technology. On this, see: David A. Malueg, "Emission Credit Trading and the Incentive to Adopt New Pollution Abatement Technology," *Journal of Environmental Economics and Management* 16 (1989): 52–57.

43. Richard B. Stewart, "Controlling Environmental Risks Through Economic Incentives," *Columbia Journal of Environmental Law* 13 (1988): 153–169.

44. Even in the former case, where concern focuses on aggregate pollution levels, there are situations in which command-and-control approaches may turn out to be more efficient than incentive-based approaches (if the two approaches accomplish different levels of pollution control). See: Wallace E.

Oates, Paul A. Portney, and Albert M. McGartland, "The Net Benefits of Incentive Based Regulation: A Case Study of Environmental Standard Setting," *American Economic Review* 79 (1989): 1233–1242.

45. For a recent description of EPA's (and some European) experiences with incentive-based policies, see: Robert W. Hahn, "Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor's Orders," *Journal of Economic Perspectives* 3 (1989): 95–114. A quite different perspective is provided by: Michael H. Levin, "New Directions in Environmental Policy: The Case for Environmental Incentives." Proceedings of Annual Midwinter Meeting, American Bar Association, Section of Natural Resource Law. Keystone, Colorado, March 18–20, 1988.

46. Daniel J. Dudek, and John Palmisano, "Emissions Trading: Why is This Thoroughbred Hobbled?", *Columbia Journal of Environmental Law* 13 (1988): 217–256.

47. Richard A. Liroff, *Reforming Air Pollution Regulations: The Toil and Trouble of EPA's Bubble*. Washington, D.C.: The Conservation Foundation, 1986.

48. Jeremy Main, "Here Comes the Big New Cleanup," *Fortune*, November 21, 1988, pp. 102–118; and Carolyn Lochhead. "Credit Bartering in the Market for Air Pollution," *Insight*, July 3, 1989, pp. 15–17.

49. Robert N. Stavins, *Trading Conservation Investments for Water*. Berkeley, California: Environmental Defense Fund, 1983.

50. Willy Morris. "IID Approves State's First Water Swap with MWD," *Imperial Valley Press*, November 9, 1988.

51. Sandra D. Atchison, "Where Water is Money in the Bank," *Business Week*, August 15, 1988, p. 50.

52. Maine held one such auction in 1989; Massachusetts and New York have announced their intentions to hold similar auctions. These are discussed later in the chapter.

53. J. B. Opschoor and Hans B. Vos, *Economic Instruments for Environmental Protection*, Paris: Organization for Economic Cooperation and Development, 1989; and OECD Environment Committee on Natural Resource Management, *Renewable Natural Resources: Economic Incentives for Improved Management*, Paris: Organization for Economic Cooperation and Development, 1989. A brief overview was provided by: James David Spellman, "Environmental Needs Challenge the Global Marketplace," *Europe Magazine*, September 1989, pp. 18–20.

54. This set of criteria is based partly upon a similar set of criteria described by: Peter Bohm and Clifford S. Russell, "Comparative Analysis of Alternative Policy Instruments," *Handbook of Natural Resource and Energy Economics*, Volume I, eds. Allen V. Kneese and James L. Sweeney. Amsterdam: North-Holland, 1985 pp. 395–460.

55. For an examination of "scientific issues" surrounding the greenhouse effect and global warming, see: Stephen H. Schneider, "The Greenhouse Effect: What We Can or Should Do About It," *Preparing for Climate Change*, pp. 18–34, Proceedings of the First North American Conference on Preparing for Climate Change: A Cooperative Approach, Washington, D.C., October 27–29, 1987. Rockville, Maryland: Government Institutes, Inc., 1987.

56. Daniel J. Dudek, "Assessing the Implications of Changes in Carbon Dioxide Concentrations and Climate for Agriculture in the United States," *Preparing for Climate Change*, pp. 428–450.

57. Developing and developed nations have cooperated, to a limited degree, on international approaches to deforestation issues. An action plan has been co-sponsored by the World Bank, the United National Development Program, the Food and Agricultural Organization, and other agencies. See: World Resources Institute, *Tropical Forests: A Call for Action*. Washington, D.C., 1985.

58. Debt-forest swaps carried out between the U.S. government (directly or through commercial banks) and LDCs can produce intended, beneficial environmental effects only if LDCs are able to monitor and enforce the local execution of forest-saving plans. Related local administrative costs should therefore be included in designs of debt-forest swaps.

59. See the discussion later in this chapter of the Montreal Protocol for international reductions in the emissions of CFCs.

60. As an alternative to an emissions permit system, an emission fee (a carbon tax) has also been suggested. Supra note 22.

61. National Aeronautics and Space Administration, *Executive Summary, Ozone Trends Panel*. Washington, D.C., March 15, 1988.

62. Although the term CFC is often used to indicate the class of potential ozone depleting substances, it is misleading. Only three of the seven most important PODs are CFCs, and several of the proposed POD substitutes are CFCs, e.g. CFCs 134a, 141b, 142b, 143a, and 152a.

63. In 1978, the U.S. government banned all "non-essential" aerosol uses of CFC-11 and CFC-12, at that time the major application of these compounds. Canada, Sweden, and Norway enacted similar controls; and in the early 1980s, the European Economic Community capped CFC production at current capacity, a level well in excess of current production.

64. J. K. Hammit, *Timing Regulations to Prevent Stratospheric-Ozone Depletion*, R-3495-JMO/RC. Santa Monica: The RAND Corporation, April 1987; and A. S. Miller, and I. M. Mintzer, *The Sky is the Limit: Strategies for Protecting the Ozone Layer*, Research Report #3. Washington, D.C.: World Resources Institute, November 1986.

65. The Clean Air Act of 1963 was amended in 1967, 1970, and 1977.

66. Supra note 27.

67. It is possible that firms would choose to retain their own credits unless and until a secure, long-term and liquid secondary market is established. A government regulated brokerage exchange might provide needed security and liquidity.

68. This EPA program is described above in the context of local air quality protection policy. A detailed evaluation of the program can be found in: Tom H. Tietenberg, *Emissions Trading: An Exercise in Reforming Pollution Policy*. Washington: Resources for the Future, 1985.

69. The source-receptor relationship must be considered, since reducing acid rain precursors in California, for example, will not reduce acid rain on the East Coast.

70. ICF Resources, Inc., *Economic Analysis of Title V (Acid Rain Provisions) of the Administration's Proposed Clean Air Act Amendments (H.R. 3030/S. 1490).* Prepared for the U.S. Environmental Protection Agency. Washington, D.C., September 1989.

71. U.S. Environmental Protection Agency, Office of Air and Radiation, U.S. Department of Health and Human Services, and Centers for Disease Control, *A Citizen's Guide to Radon: What It Is and What to Do About It*, OPA-86–004, Washington, 1986.

72. U.S. General Accounting Office, "Indoor Radon: Limited Federal Response to Reduce Contamination in Housing," GAO/RCED-88–103, Washington, 1988.

73. F. Reed Johnson and Ralph A. Luken, "Radon Risk Information and Voluntary Protection: Evidence from a Natural Experiment," *Risk Analysis* 7 (1987): 97–107.

74. Charles Cicchetti and William Hogan, *Including Unbundled Demand Side Options in Electric Utility Bidding Programs.* Energy and Environmental Policy Center Discussion Paper E-88–07. Cambridge: Harvard University, August 1988.

75. A problem which needs to be addressed is that environmental damages, and hence the social costs of gasoline use, vary widely by geographic area.

76. For further discussion of some of these ideas, see: Zach Willey and Tom Graff, "Federal Water Policy in the United States—An Agenda for Economic and Environmental Reform," *Columbia Journal of Environmental Law* 13 (1988): 325–356.

77. Robert N. Stavins and Zach Willey, "Trading Conservation Investments for Water," *Regional and State Water Resources Planning and Management*, ed. R. J. Charbeneau, pp. 223–230. Bethesda, Maryland: American Water Resources Association, 1983.

78. A "third party" is a user of the water in question who is not associated either with the buyer or the seller of water rights.

79. Major U.S. laws affecting water quality include: the Water Pollution Control Act of 1948, amended in 1956, 1972, 1977, and 1987; the Water Quality Act of 1965; the Clean Water Restoration Act of 1966; the Water Quality Improvement Act of 1970; the Safe Drinking Water Act of 1974, amended in 1986; and the Clean Water Act of 1977.

80. Supra note 39.

81. Environmental Defense Fund, *Coming Full Circle: Successful Recycling Today.* New York, New York, 1988.

82. Frederick P. Anderson, et al., *Environmental Improvement Through Economic Incentives.* Washington, D.C.: Resources for the Future, 1977.

83. The Superfund program is carried out under authority of the Comprehensive, Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, and the Superfund Amendments and Reauthorization Act (SARA) of 1986.

84. For alternative perspectives on the use of labelling, see: David Roe, "Barking Up the Right Tree: Recent Progress in Focusing the Toxics Issue,"

Columbia Journal of Environmental Law 13 (1988): 275–283; and Melinda Haag, "Proposition 65's Right-To-Know Provision: Can It Keep Its Promise to California Voters?", *Ecology Law Quarterly* 14 (1987): 685–712.

85. This is carried out under authority of the Resource Conservation and Recovery Act (RCRA) of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984.

86. U.S. General Accounting Office, *Illegal Disposal of Hazardous Waste: Difficult to Detect or Deter*, RCED-85–2. Washington, D.C.: U.S. Government Printing Office, 1985.

87. Clifford S. Russell, "Economic Incentives in the Management of Hazardous Wastes," *Columbia Journal of Environmental Law* 13 (1988): 257–274.

88. H. Michael Anderson and Craig Gehrke, *National Forests, Policies for the Future, Volume I, Water Quality and Timber Management*, Washington, D.C.: The Wilderness Society, 1988; and David S. Wilcove, *National Forests, Policies for the Future, Volume 2, Protecting Biological Diversity*, Washington, D.C.: The Wilderness Society, 1988.

89. Barry R. Flamm, "Testimony on the Fiscal Year 1989 Budget Request for the Forest Service, U.S. Department of Agriculture," before the Interior Subcommittee of the Appropriations Committee, U.S. House of Representatives, Washington, D.C., 1988.

90. These are areas within national forests, national parks, and wildlife refuges for which funds have been authorized by Congress but for which appropriations have never been made. It is estimated that there are over $3 billion worth of inholdings in the Federal lands.

91. *Americans Outdoors: The Legacy, The Challenge*, Report of the President's Commission, Washington, D.C.: Island Press, 1987.

92. In terms of private land acquisition (for the public) the work of the Nature Conservancy has been a major force protecting threatened dryland and wetland habitats of ecological value through purchases and other arrangements. To date, the Conservancy has been involved in the preservation of nearly three million acres in North and South America.

93. Losses in specific regions have been even more dramatic. Originally, there were 26 million acres of wetlands in the Mississippi Delta; only 5 million remain. The prairie potholes in the Upper Midwest have shrunk from 20 million to 7 million acres. Florida's Everglades covered 2.3 million acres at the turn of the century; less than half survives. And the wetlands of California's Central Valley have been reduced from 4 million to 300,000 acres. See: Ralph W. Tiner, Jr., *Wetlands of the United States: Current Status and Recent Trends*. Newton Corner, Massachusetts: U.S. Department of the Interior, Fish and Wildlife Service, 1984.

94. This is despite the fact that inclusion of such "secondary impacts" in environmental impact statements is mandated by the National Environmental Policy Act of 1969.

95. Robert N. Stavins and Adam B. Jaffe, "Unintended Impacts of Public Investments on Private Decisions: The Depletion of Forested Wetlands," *American Economic Review* 80 (1990): 337–352.

96. Some progress has been made in this area with passage of the Water Resources Development Act of 1986 (PL 99–662). The Act provides for increased local cost-sharing (25%) of project costs and emphasizes proper identification and compensation for all project environmental costs. It is too early to say, however, whether full benefit financing and the laudable efficiency and environmental goals of the Act will be implemented through subsequent legislation and regulation.

97. Note that the Tax Reform Act of 1986 eliminated several tax code provisions which provided incentives for wetland conversion.

98. In this regard, the so-called "swampbusting provisions" of the 1985 "farm bill" constitute a move in the right direction. Title XII-C of Public Law 99–198, the Food Security Act of 1985, provides that a farm operator is ineligible for price-support payments, farm storage facility loans, crop insurance, disaster payments, and insured or guaranteed loans for any year in which annual crops were produced on converted wetlands. Unfortunately, it is not clear how successful USDA's interpretation and execution of the law will be.

99. The North American Wetlands Conservation Act of 1989 establishes a Wetland Trust Fund, to be financed by interest on the Pittman-Robertson account, fines and penalties, and direction appropriations. Appropriations of $15 million annually are authorized for the period 1991–1994, and a North American Wetlands Conservation Council is established to approve wetland restoration projects.

100. Scott A. Wolf, "The Sport Fishing Conservation Stamp: A Proposal for Wetland Protection." Unpublished B.A. thesis, Harvard College, 1988.