



ENVIRONMENTAL ECONOMICS

R E S E A R C H S T R A T E G Y



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FOREWORD

The 2005 *Environmental Economics Research Strategy* (EERS) presents a conceptual framework for future economics and decision science research of the U.S. Environmental Protection Agency (EPA). This research strategy identifies the economics and decision science research areas important to EPA programs and EPA's planned research agenda in these areas. This program implements components of the Office of Research and Development's (ORD's) Strategic Plan and is consistent with priorities outlined in EPA's 2003 Strategic Plan.

This research strategy outlines EPA's research effort to provide the necessary behavioral science foundation for making decisions and designing environmental policies at the least cost to American businesses and consumers. To be effective, the Agency must understand how people and firms make decisions about and affect the environment and, in turn, how the environment affects Americans' quality of life. High-quality environmental economics research is the best way to improve this understanding.

EPA developed the EERS to guide future environmental economics research at the Agency. EPA program staff and managers identified desired research results, and external peer reviewers assisted EPA in developing a novel and feasible research agenda to meet these needs. Different program offices in EPA need different types of economics research to accomplish their individual missions. Regulatory offices need better tools to evaluate the costs and benefits of preventing or reducing pollution damage to health and ecosystems. Innovation and information offices need to understand how and when collaborative approaches can succeed and how and why information disclosure works to change firm or market behavior. Enforcement personnel need better tools to identify facilities for inspections and enforcement actions while identifying those who would benefit from technical assistance to improve environmental performance. All programs should understand how to design implementation strategies that will take advantage of market forces to reduce costs for businesses and the public and protect the environment.

The EERS' major strategic research directions include research in: (1) human health valuation; (2) ecological valuation; (3) environmental behavior and decision-making; (4) market mechanisms and incentives; and (5) benefits of environmental information disclosure. These strategic objectives frequently require an interdisciplinary approach to develop sound research. EPA will address the most important research gaps in these areas and will develop interdisciplinary teams and partnerships with other agencies when needed.

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EPA also wants to acknowledge the important contributions to the development of this document of external reviewers from the EPA Science Advisory Board's Environmental Economics Advisory Committee and selected reviewers. The Science Advisory Board members' diligence and insight have increased the value of this Strategy considerably by providing a critical review and suggesting important new avenues of research.

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PEER REVIEW HISTORY

Peer review is an important component of research strategy development. The peer review history for this Research Strategy follows:

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May 2003, Subhas Sikdar, Lee Mulkey, Lead Reviewers

EXTERNAL PEER REVIEW:

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GLOSSARY OF TERMS AND ACRONYMS

EPA **The United States Environmental Protection Agency (the Agency)**

EERS **Environmental Economics Research Strategy**

EPA Offices

Suboffices listed under Office

- Projects or Programs listed under suboffice with responsibility

OAR **Office of Air and Radiation**

OAP Office of Atmospheric Programs

OAQPS Office of Air Quality Planning and Standards

OIA Office of Indoor Air

OCFO **Office of the Chief Financial Officer**

OPAA Office of Planning, Analysis and Accountability

OCHP **Office of Children’s Health Protection**

OECA **Office of Enforcement and Compliance Assurance**

OEI **Office of Environmental Information**

OPEI **Office of Policy, Economics, and Innovation**

NCEE National Center for Environmental Economics

- **EBASP:** Ecological Benefits Assessment Strategic Plan

NCEI National Center for Environmental Innovation

ORP Office of Regulatory Programs

OPPTS Office of Pollution Prevention and Toxic Substances

- OPP** Office of Pesticide Programs
- OPPT** Office of Pollution Prevention and Toxics

ORD Office of Research and Development

- NCEA** National Center for Environmental Assessment
- NCER** National Center for Environmental Research
- **STAR:** Science To Achieve Results
- NERL** National Exposure Research Laboratory
- NHEERL** National Health and Environmental Effects Research Laboratory
- NRMRL** National Risk Management Research Laboratory
- OSP** Office of Science Policy

OSWER Office of Solid Waste and Emergency Response

- OERR** Office of Emergency Response and Remediation
- OSW** Office of Solid Waste

OW Office of Water

- OGWDW** Office of Ground Water and Drinking Water
- OST** Office of Science and Technology
- OWM** Office of Wastewater Management
- OWOW** Office of Wetlands, Oceans and Watersheds

SAB EPA's Science Advisory Board

- EEAC** Environmental Economics Advisory Committee (of the SAB)

ABSTRACT

Economics research is an essential component for developing environmental policy. EPA developed the Environmental Economics Research Strategy (EERS) to guide future environmental economics research directions at the Agency. EERS authors interviewed EPA staff and managers to identify research priorities. These priorities were compared with existing research to establish strategic objectives whereby allocation of EPA resources could help the Agency and its clients to achieve their missions. The strategy and research objectives were peer reviewed by the EPA Science Advisory Board. The strategic research objectives include: (1) human health valuation; (2) ecological valuation; (3) environmental behavior and decision-making; (4) market mechanisms and incentives; and (5) benefits of environmental information disclosure. These strategic objectives frequently require an interdisciplinary approach to develop sound research. EPA will devote internal and extramural resources to filling the most important research gaps in these areas and will develop interdisciplinary teams when needed.

EXECUTIVE SUMMARY

BACKGROUND

The Environmental Protection Agency (EPA) needs accurate environmental economics research on which to base and evaluate policies. This Environmental Economics Research Strategy (EERS) has been developed to guide future environmental economics research at EPA. The focus of the EERS is to develop a comprehensive list of research priorities that are of interest and importance to environmental management over the long term.

The EERS was developed by a team from the National Center for Environmental Economics (NCEE) and the National Center for Environmental Research (NCER), working with EPA program offices, the Office of Research and Development (ORD) laboratories and centers, and EPA regions. NCEE provides research support and economic guidance to EPA programs, and NCER manages an economics and decision sciences research grants program. The findings of the EERS will guide research activities in both of these organizations and in ORD laboratories and centers, which provide multidisciplinary research support to programs and regions.

The EERS identifies priorities and research gaps, evaluates research tools, sets strategic research objectives, and suggests responsibilities and sequences for conducting or sponsoring research. EPA programs, other federal agencies, academics, states, local governments, and others can consult the EERS to understand what EPA (in particular, NCEE and NCER) has planned and the results the Agency expects. These parties can use the EERS to plan their own research or analyses to make the best use of EPA's efforts. The EERS will guide research for several years or until circumstances change, at which time it will be revised.

The EERS is based on research priority needs identified through in-person interviews with program economists, managers, and other users of economic research results. The offices that were interviewed identified short- and long-term research needs and anticipated potential changes in program structure and emphasis.

The priority research areas then were compared with existing research to determine what remained to be done. This comparison generated a short list of strategic research objectives. The research objectives were matched to available tools and resources to identify comparative advantages throughout EPA and to develop timelines for achieving the objectives. Finally, a draft of the research strategy was peer-reviewed by external academic economists through the auspices of EPA's Science Advisory Board (SAB).

RESEARCH PRIORITIES

The research team interviewed 75 people from 21 separate offices. These groups each established a list of research priorities and gave strength-of-preference weights to each. The research team combined the results, giving equal weights to each major program office. Table ES1 shows the final results.

Table ES1 shows the top 10 short- and long-term priorities, listed in long-term priority order. As the table shows, the relative priority rankings change based on whether the research areas are ranked by short-term weights, long-term weights, or the number of offices requesting each research topic.

The priority research areas were identified based on both the breadth (number of offices requesting research in a topical area) and depth (strength of preference score) of expressed need, as well as the opportunity to develop a coherent long-term program of research. The highest priority research topics are morbidity valuation; environmental behavior and decision-making; ecological valuation; the benefits of environmental information disclosure; mortality valuation; market mechanisms and incentives, including both trading and methods other than trading; green accounting, finance, and international trade; discounting and intergenerational equity; and integrating risk and uncertainty with valuation. The first five topics were the highest ranked research needs in the short term and long term, and the two market mechanism topics were the most highly ranked priorities based on the number of offices requesting the research.

TABLE ES1. GENERAL RESEARCH PRIORITIES

Research Topics	Rank Based on Long Term	Rank Based on Short Term	Rank Based on Number of Offices Requesting	Number of Offices Requesting Research
Valuation of Reduced Morbidity Benefits	1	3	2	6
Environmental Behavior and Decision-Making	2	2	2	5
Valuation of Ecological Benefits	3	5	2	5
Benefits of Environmental Information Disclosure	4	4	10	2
Valuation of Mortality Benefits	5	1	7	3
Market Mechanisms and Incentives, Other Than Trading	5	7	1	7
Green Accounting/International Trade/Finance	7	9	6	4
Market Mechanisms and Incentives, Trading	8	6	2	6
Discounting/Intergenerational Equity	9	8	7	3
Risk and Uncertainty: Integration With Valuation	9	10	7	3

IDENTIFYING RESEARCH GAPS

After identifying priority research areas from EPA economists, the research strategy team focused on the highest priority research areas, reviewed existing literature in each area, and identified major gaps in which new high-quality research is both feasible and relevant to EPA's mission. The team evaluated research priorities based on five criteria. Research must:

- Be useful to EPA, states, or other clients;
- Fill a gap in the existing knowledge base;

- Be scientifically feasible and potentially of high quality;
- Be likely to provide useful answers within 5 to 10 years, and
- Be related to EPA's mission in a policy-relevant context.

A workshop held in late 2002 brought research clients together from many offices to further define research questions within the general areas in Table ES1. The workshop succeeded in further defining research questions in market mechanisms and incentives, ecological and human health valuation, and environmental decision-making.

STRATEGIC OBJECTIVES

Based on the above criteria and the results of the survey, workshop, and investigation of the existing research, implementation of the Research Strategy will focus on five strategic research objectives on which EPA has determined that concentrating research resources will make a difference:

1. Health Benefits Valuation
2. Ecological Benefits Valuation
3. Environmental Behavior and Decision-Making
4. Market Mechanisms and Incentives
5. Benefits of Environmental Information Disclosure.

EPA will focus research efforts toward these objectives after conducting comprehensive literature reviews in areas lacking them.

EXTERNAL PEER REVIEW

Acting through the auspices of EPA's SAB, an external panel of academic economists and decision scientists reviewed and commented on a draft of this Research Strategy. They concluded that the strategic objectives above were appropriate and that EPA had accurately characterized gaps in the literature. The review panel made several important suggestions for improving the strategy, including recommendations that EPA: increase its emphasis on morbidity valuation, develop interdisciplinary approaches for both health and ecological valuation, expand its research focus on compliance behavior to all environmental behavior, expand its research focus on market mechanisms and incentives to a broader range of financial incentives, evaluate the effects of regulations and other interventions on innovation, investigate risk-risk tradeoffs associated with interventions, and extend the outreach component of the strategy to more outlets and formats.

IMPLEMENTATION

To ensure that the return from research in these areas is maximized, resources will be dedicated to the further refinement of research questions as more information is developed. In addition, resources will be devoted to the development of the appropriate interdisciplinary research teams, provision of necessary infrastructure for information access and communication, periodic assessment of the state of existing research, and provision of analytic guidance as needed.

EPA uses a variety of vehicles for funding research outside the Agency. These funding vehicles include cooperative agreements, grants, and contracts. Each funding vehicle varies in its ability to generate research results in the short versus long run, in the degree of EPA's participation in and influence on research outcomes, in the expected quality and generalizability of research results, and in its ability to supply basic versus applied research. EPA will match these characteristics to the type and timing of needed research for each strategic research objective.

ORD's NCER plans and manages the Science To Achieve Results (STAR) grant program, EPA's primary research grant program. The Economics and Decision Sciences component of the STAR program will sponsor solicitations for each strategic research objective to obtain needed research results from academic economists and decision scientists.

EPA's in-house research centers, including ORD and NCEE of the Office of Policy, Economics, and Innovation, can be used as substitutes for, or complements to, externally funded research. NCEE has a number of environmental economists well suited to conduct research and analysis on crosscutting issues for program offices and regions. NCEE provides research-related guidance, workshops, and seminars.

Effective achievement of the strategic research objectives frequently requires interdisciplinary research approaches. ORD conducts research on integrated risk assessment research questions and regularly collaborates with NCEE. ORD and NCEE will strengthen this collaboration by searching for opportunities for interdisciplinary approaches to address the strategic objectives. A detailed discussion of projects conducted at NCEE and ORD is available in Chapter 4.

Finally, EPA will communicate and disseminate research results through existing venues, such as EPA workshops, seminars, and document databases, and will develop new venues where feasible and appropriate.

BACKGROUND

There is increasing awareness throughout the federal government of the value of economic analysis for public policy decisions. Both Congress and a series of presidents have enacted legislation and executive orders that require federal agencies to conduct economic analyses to support policy or regulatory decisions.¹ It is generally agreed that paying attention to economic principles and information can yield more efficient resource use.

Environmental issues and policies are among the many that benefit from high-quality economic analysis. EPA simultaneously faces increased pressure to remove or avoid economically burdensome environmental regulations and to do a better job of protecting ecosystems and human health, particularly among sensitive populations. The Office of Management and Budget has increased the stakes for EPA and other federal agencies by requiring more and higher quality economic analyses and improved underlying data. Across EPA, practitioners need applied and theoretically sound economic information, especially to analyze new environmental problems and regulatory tools. EPA also must ensure that its economic estimates are based on the best possible and practical scientific methods. This document, EPA's *Environmental Economics Research Strategy* (EERS), describes how EPA will develop research that provides the information and tools needed to continue to conduct economic analyses at EPA.

The primary role of environmental economics research for EPA and others with environmental management responsibilities is to develop the data and analytical methods needed to analyze environmental issues. These data and methods are crucial to understanding regulated entities' behavior, predicting responses to government policy interventions, evaluating the efficiency and equity effects of environmental rules and policies, and predicting future environmental problems driven by economic forces. The environmental economics research described in this Strategy will become a cornerstone of the economic analyses that EPA needs to develop environmental policy.

REPORT ORGANIZATION

This report consists of four chapters. This chapter explains the background for developing the EERS, including how EPA uses economics research, how this Strategy might be used, and some related efforts and plans. Chapter 2 reports the main findings from the needs assessment survey and workshop. Chapter 3 describes how EPA evaluated the remaining gaps in the research literature in priority economic research areas and developed strategic research goals to implement. Chapter 4 describes the research tools or approaches available to implement the strategy and how EPA plans to use these tools to generate and communicate needed research results. Appendix 1 provides more detail on the survey process. Appendix 2 discusses requests for economic analysis and research that are not discussed in Chapter 2. Appendix 3 discusses the relationship of this document to other research strategies and plans and similar documents. Appendix 4 describes the suite

¹ Executive Orders and Guidance include: EO 12866; OMB Circular A-4; EO 12898 (Environmental Justice); EO 13045 (Children's Health); EO 13132 (Federalism); EO 13175 (Indian Tribal governments); EO 13211 (Energy).

Laws include: The Regulatory Flexibility Act of 1980 (as amended by the Small Business Regulatory Enforcement Fairness Act in 1996); the Unfunded Mandates Reform Act of 1995; and the Paperwork Reduction Act of 1995.

of research tools available to EPA. Appendix 5 shows detailed results of the interviews that form the needs assessment. Appendix 6 contains the results of the SAB's peer review of a draft of this Strategy, and Appendix 7 contains EPA's responses to the SAB's comments.

EPA'S USE OF ECONOMICS RESEARCH

EPA's most frequent use of economics research is as a basis for benefit-cost, cost-effectiveness, and economic impact analyses for environmental regulations and other policies. Economic principles also are playing an increasingly important role in the design of implementation strategies, such as marketable pollution permit trading as an alternative to traditional regulation. Analysts have begun to use economics research to explain and predict individual or corporate environmental behavior in response to voluntary programs, incentives, regulations, or sanctions. Finally, EPA is using economic information to predict future environmental conditions (i.e., investigating the extent to which environmental problems are caused by economic activities or variables).

Benefit-Cost Analysis

Developing environmental regulations is a significant part of EPA's mission and is required by a number of federal laws. Many rules at EPA are subject to some degree of benefit-cost analysis. Generally, more detailed and sophisticated analyses are performed for rules with larger economic impacts. Benefit-cost analysis also supports the evaluation of existing and ongoing Agency initiatives or goals, through retrospective or prospective analyses of aggregate benefits and costs.

Over the past 25 years, there has been a steady increase in EPA's use of benefit-cost analysis in rulemaking, and a commensurate improvement in the analytical techniques and data sources available to the Agency. EPA has developed guidance for practitioners of benefit-cost and related analysis in *Guidelines for Preparing Economic Analyses* (U.S. EPA, 2000a, or the *Guidelines*) and is in the process of updating this guidance. The *Guidelines* provide a thorough overview of the current standards, practices, and available data for conducting economic analyses of environmental policies. They also acknowledge the deficiencies in the tools and data available to analysts that are needed to accurately assess benefits and costs.

With sufficient time and resources, economics research can provide the theoretical and technical basis for conducting the environmental economic analyses that EPA and others need. Although current economic analyses contribute valuable information to environmental policymakers, scientific limitations often prevent them from fully characterizing the benefits and costs of environmental quality changes. For example, it is common in benefit-cost and economic impact analyses to base social cost estimates on calculated engineering costs of pollution-control technologies. However, these costs exclude other costs faced by firms such as legal and reputation costs, costs to government such as monitoring and enforcement, and costs to consumers who might face higher prices or changes in the quality of the goods available on the market. Sound research will improve understanding of firm decision-making processes and help the government to design policies that achieve environmental quality goals as efficiently and effectively as possible. However, these costs are not the only environmentally related inputs, or factors of production, that might affect businesses. The actual decision processes of firms or individuals might include considerations of fines for noncompliance, legal costs, reputation, or relationships with the communities surrounding them. Sound research will improve understanding of these decision-making processes and help to achieve environmental quality goals in as cost-effective a manner as possible.

In most applied benefit-cost analyses, environmental benefits are even less well understood, or accepted, than costs, in large part because of the absence of markets for environmental goods and services. To the extent currently feasible, the *Guidelines* present an overview of the methods available and suggest best practices for estimating environmental benefits. However, EPA analysts recognize that additional environmental economics research is needed to develop techniques and data to fully evaluate the benefits of environmental improvement. These benefits include valuation of reductions in morbidity or mortality risk and improvements in ecological conditions. Primarily, we need to understand better how people understand and value changes in health risks and ecological services.

Efficient Environmental Policy

Economics research contributes to the development of economically efficient environmental policy.² An increasingly important economics research area is the development of market mechanisms or incentives (MM&Is) for environmental management. These complements or supplements to traditional regulations use competitive forces to attain environmental objectives. Federal agencies are required to identify and assess MM&Is as alternatives to direct regulation under Executive Order 12866. EPA's experience, particularly with the cap and trade program established under Title IV of the 1990 Clean Air Act (CAA) Amendments, is that sound theoretical, empirical, and experimental economics research can contribute to the design of more efficient and effective environmental policy. Research has shown that, compared with regulatory approaches, the Title IV cap and trade program has saved the electric utility industry billions of dollars while achieving a higher rate of SO₂ reductions (Ellerman and Montero, 2002). The use of MM&Is also is increasing at the state and federal levels (Hahn, 2000). More research on economic incentives will contribute to making emerging markets in pollution more feasible or more efficient as EPA and states apply these tools in new situations.

Understanding Environmental Behavior

Another area of economics research is identifying how firms react to a range of potential government interventions in different markets and under differing economic conditions. EPA, states, and others can use this research to tailor technical assistance, enforcement, and compliance activities to optimize the use of public resources (i.e., to achieve environmental quality most cost-effectively). Specific research can demonstrate the circumstances under which voluntary, incentive, technical assistance, and enforcement programs are effective at achieving society's environmental objectives.

A specific area of economics research under this topic is understanding how firms and industries initiate voluntary pollution prevention actions, either for financial reasons or in cooperation with the government. EPA, states, and others can use this research to identify situations and scenarios in which government policy would be most effective, namely those in which there is a possibility of financial as well as economic benefits. This research also could identify the types of incentives that could be used by the government to encourage such business behavior. It also could delineate performance measures to assess the financial, social, and environmental benefits of such business behavior. In addition, similar questions need to be addressed for consumers.

² Economically efficient environmental policy maximizes net benefits to society or achieves a given policy goal at the least cost.

PURPOSES OF THIS DOCUMENT

The principal purposes of this Research Strategy are to identify EPA's highest priority environmental economics research needs, set corresponding research objectives for the short and long terms, describe resources and tools available for achieving these research objectives, and suggest a timeframe and tools for meeting the objectives. Although prescriptive, the Research Strategy is intended to be flexible. The EERS provides an overall framework, so that, as circumstances and priorities change, EPA can respond without having to completely reconstruct this planning effort.

The audiences for this Strategy include EPA personnel, other federal agencies, state and local environmental agencies, nongovernmental organizations, academic researchers, elected officials, and anyone interested in environmental economics research. These audiences will use this Strategy according to their needs. At minimum, the EERS will make EPA's economics research intentions transparent. Other interested parties then can use this Strategy to complement or take advantage of EPA's research. The EERS is not intended to constrain independent research or analysis efforts by EPA program offices or regions. Rather, it will help guide (and outline) the activities of the two offices primarily responsible for crafting this Research Strategy, ORD and OPEI's NCEE.

ORD and OPEI have a unique and multifaceted cross-office working relationship. The two offices share responsibility for developing and implementing this EERS. OPEI/NCEE has the lead responsibility for developing guidance and providing advice and technical support to programs and regions on issues of economic analysis. Part of this responsibility is met through internally conducted research in support of programs, supplemented by contractual arrangements with vendors and cooperative research agreements with, and grants to, qualified external economic researchers.

ORD conducts internal research in support of program activities, principally in an integrated framework with engineers, economists, and health scientists. ORD scientists from several laboratories and centers also cooperate with NCEE researchers on a number of interdisciplinary projects that integrate economics with health and ecological research.

ORD's NCER administers the STAR grant program, of which economics and decision science research is a significant and crosscutting component. NCEE has participated extensively in the economics research elements of the STAR grant program since its inception in 1995. NCEE staff members assist with writing research solicitations, co-hosting conferences, reviewing proposals, and assisting NCER with annual and strategic planning. Staff economists from the programs and regions also contribute to these tasks.

NCEE and ORD will plan future activities to achieve the research objectives identified here. NCER will schedule grant solicitations, or Requests For Applications (RFAs), to support external research on priority topics for the next few years, to the extent funding and grant limitations allow. Each year, NCER plans three or four RFAs in areas related to benefit-cost analysis, MM&I program design and evaluation, regulated entities' environmental behavior and decision-making, and the use of economic information to predict future environmental problems. NCER will use the Research Strategy results to focus these RFAs on the research topics of interest in which the need for additional research is most critical.

OPEI's NCEE will use the EERS to help prioritize its internal and extramural research. NCEE also will produce new and or improved economic guidance on research areas identified in the EERS as Agency priorities change.

The Research Strategy's objectives include both problem-driven (applied) and core research. These research types are described in more detail in ORD's Strategic Plan (U.S. EPA, 2001a). Problem-driven environmental economics research addresses specific, identified problems such as valuation of water quality. Core environmental economics research provides theoretical bases and methodological improvements that can be used to improve the understanding of human behavior with respect to environmental issues and problems, as well as tools that can be applied generally to solve environmental problems. Core research also can be accompanied by environmental economics data that can be used by other researchers and analysts.

ORD will use the Strategy to plan specific internal economics research projects for the next few years and to target research areas for extramural funding. The strategic research objectives developed will be translated into long-term goals in ORD's multiyear plan for economics and decision sciences. This link demonstrates ORD's commitment to providing the economics research that EPA needs. The path for attaining the long-term goal will be mapped out using Annual Performance Goals (APGs), which are evaluated using Annual Performance Measures (APMs). The Government Performance and Results Act requires agencies to establish strategic goals, APGs, and APMs; these goals and measures also are routinely used in ORD's annual budget process.

The EERS will discuss briefly, but not plan for, economic analyses of EPA program-specific issues. Here, the EERS makes a distinction between economic analysis and economics research. *Economic analysis* applies the tools and data developed by economics research to evaluate a particular issue or environmental problem for a specific policy purpose.³ *Economics research*, whether applied or basic, creates generalizable theory, hypotheses, methods, and data that can be applied to other circumstances. For the EERS to consider a research topic, the requested research must pose some question of interest to one or more programs over the long term. The EERS will focus on research that can serve the needs of several programs or regions, rather than analyses tailored to a short-term program-specific need. These analytical efforts are handled best by the programs and regions directly involved in specific environmental issues, although assistance from ORD or NCEE sometimes may be appropriate.

RELATIONSHIP TO OTHER STRATEGIES, PLANS, AND DOCUMENTS

The EERS follows related efforts, particularly an economic research needs assessment survey conducted in 1997. It also is related to and will inform the efforts and strategies of a number of organizations within EPA, notably the EPA Strategic Plan, the work of NCEE and ORD's laboratories and centers, the ORD Strategic Plan, and a number of other research strategies and program efforts. The relationship of the EERS to other strategies, plans, and documents is detailed in Appendix 3.

ENVIRONMENTAL ECONOMICS STRATEGY DEVELOPMENT PROCESS

Internal EPA Review

The NCEE/ORD research strategy team jointly determined that a new and formal research strategy would be timely. The team assembled a workgroup from offices, research laboratories, and regions throughout EPA to draft this Strategy. Workgroup members are economists and users of economic information who represent

³ When program offices requested analytical assistance during the development of the EERS, specific requests were noted and are described in Appendix 2; they might provide direction for program assistance in the future.

the concerns and needs of their offices with respect to economic issues. Much of the writing in this report is based on contributions and suggestions of these workgroup members, especially the emphasis on emerging issues and evaluation of strategic and administrative initiatives. This group is responsible for reviewing the document, disseminating it for review to economists and managers within their offices, and conducting an internal peer review. ORD's Science Council and NCEE administrators also reviewed the EERS.

Peer Review

In 2004, a draft of the EERS was peer-reviewed by the EEAC, a subcommittee of EPA's SAB, in conformance with the guidance in EPA's *Peer Review Handbook* (U.S. EPA, 2000c). The SAB is a federally chartered advisory committee comprised of experts in various environmental science topics. The EEAC comprises esteemed environmental economists with a wide variety of interests and experience with issues affecting EPA economic analysis. The EEAC also was the SAB's formal peer-review panel for the *Guidelines for Preparing Economic Analyses*.

METHODS

The first section of this chapter presents a brief overview of the process used to identify research needs and to prioritize those needs. The following two sections describe the overall results in some detail. Detail on the survey process itself is presented in Appendix 1.

The development of this research plan follows ORD's general approach to setting research priorities, described in the ORD Strategic Plan (U.S. EPA 2001a). To select research topics, the team took the following steps:

1. Sought input from its customers as to the type of research that is of greatest importance to their programs;
2. Sought input from NCEE and ORD staff regarding the state of the science and the best opportunities for reducing uncertainty in EPA's understanding of important environmental economic issues (i.e., focus on the gaps in the existing research base);
3. Examined research activities in terms of scientific feasibility, resource constraints, tools and capabilities, compatibility with existing expertise, and EPA's ability to make a significant contribution relative to other research institutions doing work in the area; and
4. Consulted with external experts (peer review) to ensure that the research will be of high quality and will address important and novel issues.

The initial steps in the development of this strategy focused on soliciting client input from economists and users of economic information. The next two steps were used to further refine the research needs and plan implementation (see Chapters 3 and 4). The final step, peer review, will be conducted after internal EPA review is complete.

RESULTS

Clients were asked for their research needs in both the short (results in 3-5 years) and long term (results in more than 5 years). The remainder of this chapter presents overall results using short- and long-term preferences. The next section provides additional detail on priority areas. If more than one interview took place in a given office, the team aggregated results to the level of Assistant or Associate Administrator. Rankings were normalized within each of these organizations so that they add up to one for each office. Results are weighted equally across offices.

The following tables present the preferences for results of the research strategy interviews by general categories. Because interview subjects provided priority rankings for both short- and long-term needs, results are presented for each time period in Tables 2.1 and 2.2. Table 2.3 presents the number of offices that requested a research need in each category. In certain cases, expressed needs were determined to be for economic analysis and not research. An example is cost estimates for specific rules, which neither NCEE nor NCER could provide. These categories are discussed in Appendix 2 rather than this chapter for ease of presentation.

TABLE 2.1 GENERAL RESEARCH PRIORITIES - SHORT TERM

Research Category	Rank¹
Valuation of Mortality Benefits	1
Environmental Behavior and Decision-Making	2
Valuation of Reduced Morbidity Benefits	3
Benefits of Environmental Information Disclosure	4
Valuation of Ecological Benefits	5
MM&Is, Trading	6
MM&Is, Other Than Trading	7
Discounting/Intergenerational Equity	8
Green Accounting/International Trade/Finance	9
Risk and Uncertainty: Techniques, Integration With Valuation	10
Environmental Justice (EJ)	11
Cross-Regulation Interaction	12

TABLE 2.2 GENERAL RESEARCH PRIORITIES - LONG TERM

Research Category	Rank
Valuation of Reduced Morbidity Benefits	1
Environmental Behavior and Decision-Making	2
Valuation of Ecological Benefits	3
Benefits of Environmental Information Disclosure	4
Valuation of Mortality Benefits	5
MM&Is, Other Than Trading	6
Green Accounting/International Trade/Finance	7
MM&Is, Trading	8
Discounting/Intergenerational Equity	9
Risk and Uncertainty: Techniques, Integration With Valuation	10
Cross-Regulation Interaction	11
EJ	12

¹ Based on averaging across EPA offices.

TABLE 2.3 NUMBER OF OFFICES REQUESTING RESEARCH PRIORITIES TOPICS

Research Category	Number of Offices
MM&Is, Other Than Trading	7
MM&Is, Trading	6
Valuation of Reduced Morbidity Benefits	6
Environmental Behavior and Decision-Making	5
Valuation of Ecological Benefits	5
Green Accounting/International Trade/Finance	4
EJ	4
Risk and Uncertainty: Techniques, Integration With Valuation	3
Discounting/Intergenerational Equity	3
Valuation of Mortality Benefits	3
Cross-Regulation Interaction	2
Benefits of Environmental Information Disclosure	2

Valuation of Reduced Morbidity Benefits

Four media offices (OAR, OW, OSW, and OPPTS), ORD, and OCHP requested improved valuation of reducing morbidity risk from environmental causes. Although the strategy team further subcategorized morbidity (into asthma, skin lesions, etc.), most of the requests were very general. Offices requested either a long list of endpoints or generic noncancer health endpoints. Because the economic literature does not provide values for a large number of health endpoints, research could make significant contributions in this area. Although EPA will need further clarification to set priorities for research to develop morbidity values, the implementation of this EERS will address this issue directly (see Chapters 3 and 4). Program economists mentioned some specific health endpoints, including earaches, headaches, coldlike illness, gastrointestinal upset, reproductive and developmental effects, asthma, developmental disorders (e.g., attention deficit hyperactivity disorder, autism, mental retardation), and cancer-related morbidity effects. OAR and OW requested health endpoints caused by toxics exposure, whereas OSWER and OPPTS both mentioned lead-related illnesses as priority research topics. Several offices mentioned a need for values for special subpopulations, especially children, and two offices suggested research to evaluate quality-adjusted life-years (QALYs) or some other framework as a potential tool for estimating and transferring benefit values.

Environmental Behavior and Decision-Making

The general category of Environmental Behavior and Decision-Making can be subdivided into three more detailed research topics:

- Why and how do facilities perform well environmentally, or comply or not comply with environmental rules or policies?
- What policies or approaches will effectively induce compliance or improved environmental performance?

- How effective are voluntary programs?

The first two questions are closely related. EPA needs to understand individual or corporate environmental behavior both with and without government intervention to adopt a cost-effective combination of approaches (for both the regulators and the regulated) that will improve environmental quality. Five offices requested research in this area: OAR, OW, OSW, OECA, and OPPTS. Of these, OECA put the highest weight on this research topic. These offices are trying to understand how corporations and other regulated entities view compliance and how they will react to regulations, enforcement actions, and other interventions. They also want to understand what organizational characteristics foster improved environmental performance and compliance, and how these characteristics influence behavior.

Although OECA's interest is general, the four program offices that place a priority on this research area have more specific interests:

- OAR wants to understand facility location decisions.
- OW wants research into how drinking water purveyors decide what technologies to select to comply.
- OPPTS is interested in how farmers and applicators select pesticides and application programs (i.e., which pesticide to use and how much).
- OSW wants to understand how firms make onsite versus offsite hazardous waste disposal decisions, and how leaking underground storage tank and potentially responsible party (under Superfund) owner-operators make decisions about mothballing or revitalizing sites.

Interest in research on the effectiveness of and participation in voluntary programs also is broad. OW, OSW, OECA, and OPPTS want to know what induces participation in voluntary programs and what changes in environmental outcomes result from participation. They also would like to understand the conditions under which a voluntary program might be superior to a regulatory program.

Valuation of Ecological Benefits

Expressed needs for ecological benefits research tend to be both general and pervasive across programs. ORD and the four media offices (OAR, OW, OSW, and OPPTS) requested research to improve the valuation of ecological benefits. Moreover, the Assistant Administrator for Water made this topic his office's highest research priority.² A great degree of uncertainty is associated with this topic, both because a large number of ecosystem or ecological services (or benefits) are not valued and because economists do not fully understand how people consider and make choices regarding (value) ecological services.

Two offices, as part of their responses, identified a need for frameworks to understand and value ecological endpoints. There were some slightly more detailed requests for research, including estimation of the values of:

- Water quality changes (two offices requested estimates for changes caused by agricultural pollution and one requested a basis for national estimates);

² This will be accounted for during implementation of the strategy, but the survey results were not altered in response to the OW Assistant Administrator's preferences.

- The sensitivity of water values based on stream size and uses;
- Ecological impacts from air pollutants;
- Introduced versus native species;
- Avoided groundwater contamination;
- Ecosystems' impacts from hazardous wastes;
- Avian species; and
- Ecological endpoints from reducing toxic pollutants.

Valuation of Other Endpoints, Including Benefits of Environmental Information Disclosure

A number of program offices identified valuing environmental changes other than direct ecological or human health endpoints as a high priority. We have categorized such research priorities under Benefits Valuation, Other Endpoints. These endpoints include all environmental changes that are not direct ecological or human health endpoints.

Several offices placed a high short- and long-term priority on research on the value of environmental information disclosure. For example, OEI placed most of the weight of its preference on this single category, and OPPTS and OW-OGWDW requested value-of-information research. There is currently no generally accepted method to estimate or monetize the benefits of information disclosure, for example, from the Toxics Release Inventory (TRI) or consumer confidence reports. Anecdotal and other evidence suggests that companies or facilities may change behavior after information announcements are made, and that the change in behavior affects exposure as well as the behavior of the potentially exposed population. This valuation research category is closely related to one on the effectiveness of information programs. Other important research questions include:

- Are potential cost savings identified when disclosure is made?
- How is the value of information linked to the amount or toxicity of the pollutant? (e.g., a corollary about food is that the value of information about fat content is not strictly correlated with the amount of fat); and
- How can the benefits of information disclosure be transferred among situations?

Valuation of Mortality Benefits

The issue of mortality valuation has historically been of great interest to EPA economists. This interview exercise indicates that the topic is still important, in part due to OMB's interest in using QALYs or other alternatives to EPA's customary measure of the value of mortality risk reduction, the value of a statistical life (VSL). OW, OPPTS, and OCHP placed priority on this research topic. The survey results showed a strong interest in how mortality valuation varies by age. Many of the studies used to generate EPA's central estimate

of VSL are based on wage-risk studies and apply to working adults (U.S. EPA, 2000a), so there is a need for complementary values for children and the elderly. A related need is how individual values for their remaining years (or a similar concept such as QALYs) vary by the age of the affected individual.

MM&Is, Other Than Trading

OEI, OAR, OW, OSW, OECA, OPPTS, and OPEI requested additional research in this category. Several offices suggested research on the effectiveness of environmental information programs in achieving improved environmental outcomes and when these programs might be more cost-effective than regulatory programs. These are largely voluntary programs and are distinguished from mandatory information *disclosure* programs such as the TRI. The voluntary information programs include eco-labeling, recognition, publicity programs, and content information, among others. *Note:* SAB reviewers suggested more extensive MM&Is research into various incentive-based instruments, such as pollution taxes, abatement subsidies, scrappage schemes for old cars, and deposit-refund systems. Although these programs might not be used much by the federal government, states and international bodies use a number of them.

MM&Is, Trading

Six offices—OAR, OW, OSW, OPPTS, ORD, and OPEI—requested research on emission permit trading, primarily for "Trading in Practice" and "Trading in New Contexts." Some trading programs set up by EPA and other governments have been remarkably successful, saving billions of dollars in regulatory costs (U.S. EPA, 2001b; Ellerman and Montero, 2002). Other types of trading programs have not been as successful to date. Trading-related research should ultimately result in the implementation of efficient trading programs in areas in which trading programs have not yet been established.

OW, as well as OAR and OPEI, requested empirical research on "Trading in Practice." OW is particularly interested in exploring experience to date with total maximum daily load (TMDL) water quality discharge trades. The TMDL program sets maximum pollutant loads for water bodies and would seem an ideal candidate for a trading program. However, existing attempts at TMDL trades have been difficult to establish and have not always been successful. TMDLs provide situations that are less clearly defined than the successful air pollution trades, both in terms of monitoring and with respect to pollutants. A TMDL trading program could involve multiple pollutants, a mixture of point and nonpoint sources, institutional constraints, monitoring difficulties, and spatial differentiation. These complications impose transaction costs and additional constraints on trades. Research could improve the prospects for successful trading programs in these situations by providing a better understanding of the existing constraints, as well as information requirements for efficient markets.

"Trading in New Contexts" identifies research needs for the design of trading programs for sectors or pollutants where they do not currently exist. The four media offices (OAR, OW, OSW, and OPPTS) requested research to explore trades in drinking water, pesticides, and hazardous waste, areas in which little trading effort exists.

In accordance with EPA policy, external experts in the field of environmental economics reviewed a draft of the *Environmental Economics Research Strategy*. The peer review panel identified several areas in which they thought that additions to the environmental economics literature could improve environmental policy and decision-making. The reviewers' suggestions have been incorporated into Chapter 3. Chapter 3 will address how to compare the priority research needs with the existing body of research to identify those gaps in which EPA research can be most beneficial.

APPROACH

To make the transition from a needs assessment to an implementable research strategy, the research team identified existing research in the priority research areas and gaps between what is needed and what already exists. It is not possible to address all of the research needs, so the team focused on the highest priority research identified by the programs and regions and supplemented these with suggestions from peer reviewers.

The highest priority research falls into five major areas:

1. Valuation of human health benefits;
2. Valuation of ecological benefits;
3. Environmental behavior and decision-making, particularly compliance behavior;
4. MM&Is, particularly pollution trading; and
5. Benefits of environmental information disclosure.

Some research, and in some cases, a substantial amount of research, has been conducted in each of these areas. However, the perception among informed Agency economists who rely on this information is that existing research is insufficient to provide a thorough basis for environmental policy decisions. The EERS team supplemented these anecdotal assessments with assessments of recent literature reviews in several of the topical areas. The SAB EEAC peer reviewers determined that the major research areas identified by EPA are the most important priority areas for focusing additional research, and suggested filling in gaps within these five areas (see Appendix 6). Throughout this chapter, EPA has incorporated research areas suggested by the SAB EEAC. Further consultation with experts and additional evaluations of the remaining subject areas will help determine where EPA-sponsored research could have a notable payoff.

CRITERIA FOR IDENTIFYING PRIORITY RESEARCH

To assess priority research areas, the EERS team considered the criteria for selecting research topics (paraphrased from ORD's Strategic Plan, U.S. EPA 2001a, and augmented). Research must:

- Be useful to EPA, states, or other clients;
- Fill a gap in the existing knowledge base;
- Be scientifically feasible and potentially of high quality;
- Be likely to provide useful answers within 5 to 10 years, and
- Be related to EPA's mission in a policy-relevant context.

EXISTING LITERATURE IN PRIORITY TOPICS

Each of the five research areas will be discussed relative to these criteria, which will be used to determine implementation approaches in the next chapter. In several cases, the existing research base seems somewhat sparse. That is, the uncertainty or lack of knowledge in the topical area is pervasive.

Human Health Benefits

EPA has reasonably current assessments of the state of the science regarding valuation of morbidity (nonfatal) and mortality risk reductions. These assessments come from recent cross-Agency reviews of the literature, largely in support of guidance development for applied benefit-cost analysis.

Morbidity Benefits

To assess the current science on morbidity valuation, EPA's Science Policy Council, comprised of scientific administrators from across the Agency, sponsored a study in 2000 that provided guidance on how to estimate the value of reducing noncancer (nonfatal) risk. This study resulted in the development of the *Handbook for Non-Cancer Health Effects Valuation* (U.S. EPA, 2000b). This document contains an extensive literature review on existing valuation methods and morbidity endpoints for which values have been derived, including a large annotated bibliography. A key finding in this handbook is that willingness-to-pay (WTP) estimates of specific nonfatal endpoints are limited, especially for chronic or long-term health effects. Further, some potentially useful research results are difficult to use in applied analysis because they fail to control carefully for severity, duration, and frequency. The value of a specific nonfatal health effect may vary significantly with changes in severity and duration.

Another source assessing a subset of the literature is the *Children's Health Valuation Handbook* (U.S. EPA, 2003a), a peer-reviewed reference to complement EPA's *Guidelines*. This handbook includes a bibliography of the empirical literature on valuing reduced health risks in children and comes to the general conclusion that there is very little information available to EPA analysts on this subject. However, this is changing as researchers respond to recent EPA STAR grant solicitations in this area.

The research strategy team considered the endpoints and methods covered in both handbooks and determined that further research should focus on measures of the WTP to avoid illness, using empirically and theoretically sound methods rather than more limited measures such as cost of illness (COI). WTP measures are theoretically superior to suggested alternative measures that do not reflect how people actually would make choices about health-related expenditures. In the case of children's health risks, research also should consider the role of household composition on value. The EEAC recommended adding appropriate COI measures to WTP measures to arrive at a measure of the total value of avoiding illness.

As noted in Chapter 2, EPA program economists identified this area to be generally important but pinpointed few specific morbidity endpoints for conducting benefits research. As a result, the implementation process will identify specific health endpoints through further discussion with programs and regions, review past analyses that were unable to value particular endpoints, and consider EPA's regulatory and policy agendas and the likely health endpoints that these agendas will affect.

An initial conclusion of the EERS is that the large number of specific health endpoints that could be valued dwarfs the limited resources available to conduct valuation research. In response, a long-term strategy might be to develop methods that generate cost-effective and theoretically plausible values for multiple health endpoints, such as valuation of symptoms, or health status indices, and improved methods for benefit transfer. A goal of this Strategy is to develop a comprehensive study to elicit WTP estimates for a large number of environmentally influenced health endpoints. In preparation for this effort, ORD is undertaking a project to identify the health endpoints most adversely affected by environmental causes.

Mortality Benefits

The issue of mortality benefits has received a great deal of attention from EPA, in no small part because environmental management measures often generate large reductions in mortality risks, estimated to be on the order of several billion dollars annually (U.S. EPA, 1997; U.S. EPA, 1999a). EPA recently completed a current literature review of the benefits of reducing premature mortality as part of the *Guidelines* development process. The *Guidelines* themselves contain a brief summary of the state of the science in empirically characterizing the effect of population and risk on valuation, and the SAB EEAC peer-reviewed the *Guidelines*.

In a related but separate exercise, the EEAC reviewed an EPA white paper assessing the literature on the subject of valuing reduced premature mortality from cancer (Chestnut et al., 1997; U.S. EPA, 2000c; U.S. EPA, 2002b).

In short, these literature reviews and the EEAC's comments regarding them suggest that more research is needed on how the value of mortality risks varies with the age and health status of the individual, the co-morbidity associated with the mortality risk (e.g., illness from cancer), and risk characteristics such as the degree to which the risk is voluntarily taken.

EPA also has sponsored a significant amount of research in valuing mortality reductions, much of which was summarized in a recent EPA workshop. Proceedings of this workshop can be found on the STAR grant Web site. Some recent EPA-sponsored research addresses EPA's priority mortality valuation issues, such as age- and debility-related valuation issues (DeShazo and Cameron, 2003; Krupnick et al., 2004).

EPA continues to explore and develop research in this area and is in the process of evaluating revisions to existing guidance on the topic of valuing reductions in premature mortality. Moreover, EPA and Resources for the Future, along with other federal agencies¹ sponsored a major conference on health evaluation in Washington, DC, in February 2003 (Resources for the Future, 2003). The purpose of the conference was to bring together researchers and practitioners of various disciplines related to health and risk valuation. These include medical researchers engaged in health-related quality-of-life measures such as QALYs and disability-adjusted life-years, and economists who primarily employ and develop WTP measures. To date, these two broad disciplines have not interacted to a great extent to develop health valuation estimates. EPA and the other organizers expect this conference to lead to greater communication and cooperation across disciplines, which should be especially informative for identifying mutual research gaps.

¹ The National Institutes of Health, Occupational Safety and Health Administration, Food and Drug Administration, Department of Transportation, Department of Health and Human Services, and U.S. Department of Agriculture.

EPA will use the results of this conference, the assessments developed with the *Guidelines* and current efforts to revise guidance, and the results of current research to further define the mortality research areas that should be pursued. At minimum, EPA expects to support further investigations into key areas of uncertainty already identified, such as the role of age, physical condition, and risk characteristics on WTP, for preventing premature mortality.

Ecological Benefits

As with human health benefits, EPA developed an appraisal of ecological benefits estimation. The Science Policy Council sponsored a study, *A Framework for the Economic Assessment of Ecological Benefits* (U.S. EPA, 2002a), which summarized approaches for ecological benefits estimation. This document provides a thorough overview of the methods and issues involved in estimating the benefits of ecological improvement.

Ecological benefits estimation is often problematic because ecosystems provide a wide range of essential services, but people frequently do not understand the services provided. Some of these services can be priced in markets, and others are strictly nonmarket goods that require alternative valuation approaches. To value nonmarketed ecological services, people must be familiar with them, which can require complex valuation approaches that combine education and value elicitation to obtain reliable WTP measures. Not all of these approaches are universally accepted. Some noneconomists have proposed alternative valuation measures based on energy balances or replacement costs (Odum, 1996; Costanza et al., 1997). To date, these approaches have met with little acceptance among economists because they violate the most basic and well-developed tenets of economic theory (Bockstael et al., 2000). EPA programs appear to want conventional WTP measures for ecological services that would survive the rigor of the rule-making review process.

As with morbidity valuation, programs were generally vague about the specific ecological endpoints they want valued. EPA has conducted or sponsored a large number of ecological valuation studies through grants, cooperative agreements, and internal research, at a cost of several million dollars. Moreover, the Environmental Valuation Resource Inventory, a benefits-transfer database developed by EPA and Environment Canada and maintained by Environment Canada, contains approximately 500 water-related valuation studies, many of which estimate ecological values (Environment Canada, 2004). It is critical to further focus research in this topic to address the highest priorities that states and federal environmental agencies will need to value.

NCEE, ORD, and EPA's program offices have drafted a new *Ecological Benefits Assessment Strategic Plan* as a collaborative effort between EPA ecologists and economists to determine long-term critical research needs in this area (U.S. EPA, 2004a). Furthermore, ORD/NCEA is conducting several pilot projects with economic and ecological researchers to develop frameworks for future assessments. An initial conclusion of these efforts is that, given the large number of specific ecological endpoints that could be valued in comparison with the limited resources that are likely to be available, a cost-effective strategy might be to investigate methods that generate theoretically sound values for multiple endpoints, such as the valuation of ecological indicators or indices and improved methods for benefit transfer. The SAB recommended more collaborative ecologist-economist research efforts. The SAB also recently formed a panel on Valuing the Protection of Ecological Systems and Services to "provide advice to strengthen EPA's approaches for assessing the costs and benefits of environmental programs that protect ecological systems and services, to identify research needs to improve how ecological resources are valued, and to support decision-making to protect ecological resources."

Environmental Behavior and Decision-Making

Interest in environmental behavior research has increased in recent years among both practitioners and academics. However, even EPA staff's preference for environmental behavior and decision-making research is quite diverse. Each program desires research about the compliance-related decision-making processes of its relevant regulated communities. These processes could be quite varied because the regulated communities in question include different combinations of individuals, firms, government agencies, and municipal corporations, and the regulations differ greatly in form and intent.

One seemingly common factor among these regulated communities is the influence of costs on decision-making and the need for cost minimization in the manufacturing, farming, and service sectors. However, research has shown that perceptions of environmentally related costs differ among firms, organizations, and individuals. For example, although some firms or individuals may base operating and capital investment decisions solely on accounting costs, others more strongly weigh the transaction costs of dealing with regulatory agencies, potential liability costs, costs of adverse publicity, potential cost savings of pollution prevention, costs associated with dealing with local communities, and even loss of sales (market share). Consideration of all of these types of costs, as well as the ability of firms to adapt through process changes and innovations, suggests that the engineering cost approach used by many EPA programs might not fully reflect the costs these entities consider regarding all environmentally related factors of production.

EPA and others need research that is focused on how individuals, businesses, and facilities decide to meet environmental obligations, how they determine their degree of compliance with environmental regulations or initiatives, and how they consider the range of potential costs. Although traditional notions of costs have been researched extensively, relatively little research has been done on the actual role of complex environmental cost concepts in firm and individual decision-making.

For instance, what is the most effective way to set environmental fines to encourage increased compliance? EPA's current practice requires firms found not complying with environmental regulations to pay fines equal to the profits they earned as a consequence of their violations. Research is needed to assess the optimality of this method and to compare its effectiveness with other methods such as a resource-based optimal compensation in lieu of fines or nonmonetary penalties such as restoration or enhancement activities.

Likewise, EPA needs research that considers an interactive model of compliance and enforcement, under which regulators and regulated parties work together to identify pollution sources and the means to address them. Public-private partnerships are often undertaken at the federal and state level to improve environmental compliance. Such partnerships can encompass monitoring, technology sharing, regulatory relief, and other options to achieve improved environmental performance for a firm, locale, or sector. Research on compliance and enforcement has traditionally treated the policy process as linear. Researchers assume that the regulators first design and impose a policy (e.g., water quality levels, emissions limits), then an enforcement strategy (e.g., an audit frequency and penalties for noncompliance), and then the polluting firm decides whether or not to comply. Such assumptions are often not realistic or valid and may reduce the accuracy of behavioral predictions. This research area should attempt to identify the factors and design characteristics that would make public-private partnerships cost-effective.

Finally, EPA needs environmental behavior research from multiple disciplines—economics, business administration, political science, sociology, and decision theory—that rely on distinctly different research approaches. Theory, methods, and empirical data in environmental behavior research are all somewhat incomplete. There is a great need to refine the behavioral theory to identify the factors that motivate different classes of environmental actors, whether their objectives are cost minimization, improved reputation, increased market share, and decreased transaction costs with neighbors and regulators. A variety of research approaches—case studies, theoretical models, experimental methods, interviews, surveys, retrospective financial and environmental performance data analysis, and geospatial analysis—can all make unique contributions to this broad area of study. EPA and the research community need to integrate these research approaches effectively to improve understanding of environmental decision-making.

EPA is in a unique position to make contributions to this research area because there are few other commensurate sources of research interest and funding. However, the beneficiaries of such research include many state and local governments, as well as other federal agencies and foreign governments. A question of increasing importance to EPA that is closely related to compliance decisions is how and why facilities or firms decide to participate in voluntary programs or standards, whether initiated by government or industry. Such programs typically have costs and benefits for the firm that are not captured in traditional financial analyses.

Market Mechanisms and Incentives

Commensurate with the interest from program offices, regions, and elected officials, EPA is conducting internal research and supporting extramural research in the MM&I area. For EPA staff, the most important focal areas are empirical research on the practical results of trading programs and research into the feasibility of new trading programs where none currently exist. For more ex-post empirical research to be feasible, trading programs have to be established and operated for several years. Where no trading markets exist, ex-ante research must focus on theoretical and experimental design, as well as modeling using empirical values. The EEAC peer-review panel suggested that it is important to evaluate other incentive-based instruments, such as pollution taxes, abatement subsidies, scrappage schemes for old cars, and deposit-refund systems. Adding these focal areas makes sense because they are environmental policy tools used by state and local governments, although currently they are not used extensively at the federal level.

The SAB EEAC also suggested further investigation into the issue of the effects of preexisting tax distortions on the costs and benefits of policy instruments. EPA programs mentioned but did not elevate this category of research to a priority status.

The STAR program has supported 25 academic research projects in this topical area, including a number of experimental market studies, theoretical models that have identified the efficiency effects of alternative tradable permit allocation schemes, and the definitive empirical analysis of the CAA cap and trade program. Both NCEE and ORD/NRMRL have conducted incentive-related research and are planning more. NCEE published an assessment of the savings potential of incentive-based approaches in lieu of traditional regulations, identifying more than \$40 billion per year if all possible programs were implemented (U.S. EPA, 2001b).

ORD/NRMRL is designing and analyzing market approaches for environmental systems management, including a program of tradable credits for controlling urban stormwater runoff, with a focus on stream quality and combined sewer overflows. Stormwater is a significant source of water quality problems across the country,

and market approaches have not been widely applied to stormwater, although EPA is pursuing the idea as a viable option (Thurston et al., 2003; U.S. EPA, 2004b).

EPA hosted a symposium on research results and the state of the science in MM&I research in May 2003 (U.S. EPA, 2003b). EPA will use the results of this workshop to further refine NCEE and ORD's MM&I research plans for 2005–2008. In general terms, EPA recognizes that, to realize the cost savings of MM&I programs, well-designed programs have to be developed and implemented for new pollutants, media, and geographical areas. EPA will continue to conduct research to extend current validated results and use lessons learned from existing programs and experimental and theoretical assessments to design and predict the outcomes of new MM&I programs.

As with other research areas, it is important to distinguish true MM&I research from analytical applications. Research results should provide new theoretical developments or approaches that can be generalized to other circumstances or geographical areas. The lack of existing theory and the complexity of MM&I applications to different media and situations offer a wide range of potential extensions. For example, using tradable water quality permits to resolve rural nonpoint water problems is complicated by existing agricultural subsidies, lack of monitoring, and cultural resistance to enforcement—all of which present the potential for new theoretical and empirical extensions. Similarly, some basic theoretical questions with significant policy implications, such as how marketable permits interact with existing taxes, still do not have satisfactory answers and are not easy to test empirically. The uncertainty among theorists must progress to empirical testing so that some questions can be answered and extended in fruitful directions (i.e., toward facilitating efficient trading program design or emissions tax levels). Other questions that affect market design, such as balancing demand and supply in a newly created market and developing self-correcting and flexible markets, also need further study. Furthermore, policymakers can benefit from additional research on the relative efficiency and feasibility of fees (prices) and cap and trade permits (quantities) in different circumstances. The applications are so diverse, the range of potential extensions so extensive, that the MM&I area is likely to be a source of useful behavioral research for some time.

Benefits of Environmental Information Disclosure

As noted in Chapter 1, EPA operates under several statutes that require the disclosure of environmental information to regulators, consumers, or communities. Most notable are the Community Right-to-Know Act requirements that facilities disclose releases of toxic substances through the TRI, and the Safe Drinking Water Act requirement that water purveyors disclose chemicals contained in domestic water through annual consumer confidence reports.

Although several studies have examined the effect of TRI disclosure on stock prices and firm behavior or have studied firms' participation in voluntary programs that include information disclosure or voluntary emissions reductions, none have directly estimated the economic benefit or impact from using disclosure rules, compared with alternatives such as direct regulations (Hamilton, 1995; Khanna et al., 1998). The range of benefits and the number of methods for estimating them could both be considerable. Ultimately, the principal benefits to the public would be reductions in damages to ecosystems or human health that can be estimated. However, the reputed value of an information disclosure approach is that it can achieve these reductions at a lower cost or more equitably than other approaches, such as regulation or market incentives.

How to calculate these benefits is unclear. However, there are a number of pertinent questions, including:

- Are markets working more efficiently as a result of information disclosure, as economic theory would suggest?
- Are there health and ecosystem benefits that would be unrealized if not for the information disclosure requirements?
- Are there lower costs associated with firms acting on their own to avoid having to disclose seemingly adverse environmental results?
- Are there benefits to the firm to discovering pollution-prevention cost savings?
- Are there implementation and enforcement savings for state and federal government agencies as a result of information disclosure?
- Are communities better informed and therefore more active in protecting their local environment through torts or negotiations with facilities? If so, what damages are reduced or savings realized?

These and other questions have been addressed inadequately to date. There is a clear need for more empirical information, as well as development of improved theory about how environmental information affects choices. Furthermore, it is likely that EPA can make a significant contribution to this literature, as it has with the valuation for children's health risk reduction, simply because there is so little existing research.

SUMMARY

EPA understands that filling the research gaps in these five priority environmental economics research topics is a daunting task. Nonetheless, implementation of this Research Strategy will make valuable advances to the state of knowledge, given existing and expected resources. Already, EPA-conducted or -sponsored research has had a significant impact on valuation methods and market-oriented approaches for environmental policy. Addressing the remaining research gaps over the coming years will extend this successful track record.

CHAPTER 4

RESEARCH STRATEGY IMPLEMENTATION

OVERVIEW OF IMPLEMENTATION PROCESS

The EERS is a framework for producing research that clients within and outside EPA can use to achieve cost-effective environmental protection. ORD and NCEE and their clients—programs, regions, states, local and tribal governments, academic researchers, nonprofits, and for-profit enterprises—need a number of different types of research-derived information. Some information, such as accurate data and assessments of the state of existing research, are prerequisites to original, useful, and high-quality research results. This chapter discusses the different types of research that EPA and its clients need, the tools available for developing this research, and the comparative advantages of various EPA organizations for providing them. It then articulates a flexible implementation approach that suggests a division of responsibilities but allows for adaptation to changing circumstances.

Note: Neither this chapter nor the EERS in general is intended to proscribe research that programs, laboratories, or regions believe they need. Rather, this chapter will describe what the organizations principally responsible for implementing this strategy, NCEE and ORD, plan to do to provide research identified as a priority across EPA.

The types of information needed to implement this strategy include:

1. Research results in the five areas described:
 - a. Value of reducing environmental risks to health endpoints;
 - b. Value of reducing environmental risks to ecological services;
 - c. Environmental behavior and decision-making, particularly expanded considerations of costs and compliance behavior;
 - d. MM&Is; and
 - e. Benefits of environmental information disclosure;
2. Infrastructure for information access and communication, including databases of environmental values, firm and facility characteristics, and past research data;
3. Periodic assessments of the state of existing research; and
4. Specific analytical guidance as needed.

RESEARCH TOOLS—COMPARATIVE ADVANTAGES

EPA's research support tools differ in their suitability for providing information. The available tools include: intramural EPA research, cooperative agreements between EPA researchers and research institutions, grants

to research institutions, and contracts to economic consultants. The EERS team compared these tools on the basis of:

- Their ability to generate results in the short versus long term;
- EPA's ability to influence research products and outcomes;
- The typical quality of research results, with the "best" research defined as those findings published in the most respected peer-reviewed academic journals;
- The specific nature of the research (i.e., basic or applied);
- The general applicability of results (i.e., whether specific to one medium or program or generalizable to other programs, industries, or locales); and
- The degree to which original research is needed, as opposed to program-specific applications of research results.

Table 4.1 shows how the research tools generally compare on the basis of these characteristics. Appendix 4 discusses these tools and criteria in more detail.

TABLE 4.1 CHARACTERISTICS OF RESEARCH TOOLS

Research Tools	Time To Produce Results	Influence on Research Progress	Quality or Level of Peer Review	Basic vs. Applied	Generalizability of Results
Contracts	Short, if contract vehicle in place	Maximum influence, directed by EPA	Generally not peer reviewed; unpublished literature; not original research	Applied	Specific to rule or industry
Intramural Research	Short, if staff present; longer, if hiring required	Highly flexible; EPA manages research; research for direct EPA use	Low to high, depending on project and purpose	Either; greater tendency toward applied	Mixed; some program specific, some broader applications
Cooperative Agreements	Up to several years; bidding and coordination issues	Less flexible; some research influence; trade-offs and compromises; not for direct EPA use	Generally high quality	Mostly applied	Mixed; some program specific, some broader applications
Grants	Several years from initiation of award process to results	Little influence once award is made; not for EPA direct use	High quality; original research	Basic or applied research	Generally, broadly applicable methods or theory

ROLES AND ACTIVITIES OF EPA PROGRAMS, CENTERS, LABORATORIES, AND REGIONS

The research capabilities of EPA actors involved with implementing the Research Strategy differ according to their respective missions and their relative access to the research tools described on pages 4-1 and 4-2. In general, EPA media programs perform analysis of media- or industry-specific issues; regions and states implement policies and regulations; and ORD and NCEE provide support to programs, regions, and states and communicate research results. It is efficient for ORD and NCEE to conduct in-house or extramural research that can be applied across programs or to maintain expertise that can be used on a continuing basis by different programs (e.g., designing valuation surveys, integrated scientific research projects, or peer-review capabilities).

EPA Programs and Regions

With some exceptions, EPA programs conduct analyses that use and apply existing research findings to specific issues. Most programs have economic staff on board to conduct economic analyses and are supplemented by contractual support from economic consultants. In some instances, programs have had sufficient need for results that could be applied across rules or policies to justify maintaining true research capabilities. More often than not, however, the programs have turned to NCEE (for economics) or ORD (for other scientific disciplines or multidisciplinary research) for basic or applied research support. Regions generally have used contracts for specific projects and have relied on the research offices or programs to provide research or analytical support. As noted in Chapter 2, regions frequently have different research and analytical needs than do the programs and are more involved in implementation issues.

National Center for Environmental Economics

NCEE has the Agency's largest concentration of environmental economists on staff, making it uniquely qualified to conduct in-house analysis and research in support of programs or high-priority cross-program projects. NCEE also uses contracts, cooperative agreements, and grants in various ways to support program or cross-program research objectives. Generally, NCEE funds research and uses a significant part of its staff capacity for short-term projects, although it also conducts longer term (3-5 year) research projects that are of direct importance to EPA.

Over the years, NCEE has received feedback on the Agency's economic research needs from its client offices via their requests for assistance with various economic topics. NCEE has produced research and published guidance on a wide variety of economic issues in response to these requests. The Center also has sponsored workshops and seminars that have served to disseminate economic research as well as identify holes in the existing body of economic research in specific subject areas pertinent to the Agency's mission.

The EERS will enable NCEE to direct staff research time toward economic issues that are likely to be in high demand in the coming years. NCEE will address key methodological issues, data needs, and other gaps specified by the participants in this survey. By better understanding gaps in the environmental economic research, NCEE will be able to provide guidance and assistance with economic analyses and promote consistency in the economic analyses being carried out throughout the Agency. In addition, NCEE will be better able to encourage outside researchers to focus on issues of interest to the Agency through its allocation of funding for extramural research, seminars and workshops directed at priority topic areas, support of visiting scholars, collaboration with outside researchers, and communication of critical economic data.

NCEE is involved in a number of long-term projects related to specific research questions that program offices mentioned as a priority in interviews for the EERS. A number of shorter term projects also are under way that fall within these research subject areas, but they are not discussed here.

NCEE has a number of projects under way related to valuation of reductions in morbidity. The Drinking Water Arsenic Valuation Survey collects data on the WTP for reduced exposure to arsenic in drinking water and examines how these values are affected by the provision of information on arsenic risks, as well as the implied valuation measure for children's health. NCEE also is involved in designing surveys for the State of Minnesota to address how households value risk reductions to children, and in conducting a study to examine the WTP to reduce asthma episodes for adults and children.

In the subject area of environmental behavior and decision-making, particularly compliance-related behavior, NCEE is involved in designing the Pollution Abatement and Cost Expenditures (PACE) survey and in conducting a Chesapeake Bay watershed analysis to estimate the economic impacts of direct and indirect compliance. NCEE also has maintained access to and expertise in the Regional Economic Modeling Inc. (REMI) model and the Impact Analysis for Planning (IMPLAN) model for use in regulatory and impact analysis on a regional and/or industry level. In addition, research is ongoing related to the location and emission decisions of TRI plants. Future work related to the location decisions of electric utilities also is planned. Finally, NCEE is developing a highly disaggregated model of emission factors, referred to as the Trade and Environmental Assessment Model (TEAM), that can be used to translate changes in output resulting from trade liberalization or other exogenous regulatory decisions into environmental impacts.

NCEE, working with ORD and the media programs, is taking the lead on developing an Ecological Benefits Assessment Strategic Plan to establish a dialogue between economists and ecologists in the Agency to identify information gaps and establish a more detailed research agenda for the measurement of ecological benefits (see Appendix 3).

NCEE has several long-term projects associated with benefits valuation related to mortality. A risk-risk survey for valuing cancer risk reductions addresses issues related to age, latency, timing, and morbidity. Another NCEE study examines prices paid for bicycle helmets to estimate the WTP for mortality risk reduction across different age groups. NCEE also is funding research on the use of the preference calibration approach for mortality risk valuation and is participating in a survey project to elicit values for mortality risk reductions to older individuals across countries.

Currently, NCEE has one long-term project related to MM&Is other than trading. Researchers are conducting studies to develop a methodology useful for evaluating the effectiveness of voluntary programs as a regulatory tool. NCEE has a more active research agenda in the area of trading. Research projects, both ongoing and planned, include an examination of the EJ implications of SO₂ emissions trading; an evaluation of plant productivity and costs under trading; a project related to operationalizing groundwater trading; and research related to the Region 10 trading pilot project.

In the area of trade and green accounting, NCEE is developing TEAM. Two models, the U.S. Agricultural and Resource Model (USARM) and the Agricultural Simulation Model (AGSIM), also are being modified to examine regulatory impacts in agriculture, including those related to trade. NCEE will make these models and the expertise needed to use them available to the programs for analytical projects as resources permit.

Table 4.2 briefly describes NCEE’s long-term projects by subject area.

TABLE 4.2 RESEARCH PRIORITY-RELATED NCEE PROJECTS

Research Priority Category	Related Long-Term NCEE Project
Valuation of Morbidity Benefits	Drinking Water Arsenic Valuation Survey
	How households value risk reductions to children
	Estimation of WTP to reduce asthma episodes for adults and children
Environmental Behavior and Decision-Making	PACE Survey
	Chesapeake Bay Watershed Analysis
	Access and expertise in both the REMI and IMPLAN models
	Location decisions of TRI plants
	Development of TEAM
	Location decisions of electric utilities
Valuation of Ecological Benefits	Ecological Benefits Assessment Strategic Plan
Benefits of Information Disclosure	Short-term projects only at this time
Valuation of Mortality Benefits	Risk-risk survey for valuing cancer reductions
	WTP for mortality risk reduction: the case of bicycle safety helmets
	Preference calibration approach for mortality risk reduction
	Survey project eliciting values for mortality risk reductions to older individuals across countries
MM&Is, Other Than Trading	Methodology for evaluation of effectiveness of voluntary programs
Green Accounting/Trade/Finance	Retention of access and expertise in the Global Trade Analysis Project/Computable General Equilibrium (CGE) modeling
	Investment in USARM and AGSIM models of agriculture sector
	Development of TEAM
MM&Is, Trading	EJ in SO ₂ emissions trading: evidence from the electric utilities industry
	An evaluation of plant productivity and costs under trading (future project)
	Survey of water-based trading programs
	Region 10 trading pilot project (future project)

Office of Research and Development

ORD-sponsored research attempts to provide methods or models that are broadly applicable and will facilitate or improve economic analysis. ORD conducts internal integrated economic research, collaborates with NCEE on integrated economic and risk assessment research, and administers STAR, the Agency's extramural research grant program. Many of ORD's research projects are focused on single media or issues. Priorities for research are based on relative risk to human health and ecosystems (U.S. EPA, 2001a). However, the economic tools developed as a result of this strategy typically will not be limited to single risks but will be used by economists across EPA, in other federal agencies, and in state and local governments to address a broad spectrum of issues.

ORD's research planning process addresses overarching research questions through a series of interrelated solicitations or multidisciplinary research projects. Among the long-term goals that ORD will pursue are the priorities discussed above. ORD will support this research through STAR grants and other multidisciplinary laboratory and center research projects.

STAR Grants (National Center for Environmental Research)

NCER will use this Strategy to set long-term goals for research planning purposes. These long-term goals will be used to target STAR RFAs and to evaluate specific applications for funding. The STAR grant program has four newly revised long-term economic research goals based on the priorities suggested by the program offices at EPA in the EERS. Implementation of this Strategy will concentrate on the three standing solicitations—Valuation for Environmental Policy, Corporate Environmental Behavior and the Effectiveness of Government Interventions, and Market Mechanisms and Incentives. However, NCER also funds economic research under other occasional solicitations and in integrated RFAs and will use these vehicles when appropriate to address issues of importance that do not fall under the umbrella of the standing solicitations. NCEE and program economists will continue to provide invaluable input to NCER by writing RFAs and evaluating proposals to ensure that funded research continues to meet EPA's needs.

Valuation for Environmental Policy (VEP)

NCER's current VEP RFA is an outgrowth of two previous RFAs: Decision-Making and Valuation for Environmental Policy and Valuation of Environmental Impacts to Children's Health. The 2003 VEP RFA had two parts: Human Health Valuation and Ecological Valuation, whereas the 2004 VEP RFA focused exclusively on ecological benefits valuation, and the 2005 VEP RFA is expected to focus on valuing the benefits of morbidity reduction. The relative focus of specific RFAs will vary from year to year.

An initial goal of the VEP RFA will be to fund investigations into the use of benefit transfer for human health and ecological valuation. A preliminary step might be to undertake studies that are designed to understand the frameworks underlying valuation. The focus on benefit transfer is necessary given the large number of human health and ecological endpoints for which programs requested valuation research. The STAR program does not have the resources to provide grants for all of these endpoints, but the development of transfer methods might be a cost-effective approach to this problem. After funding research into methodological development, NCER expects to fund original studies that can be used to provide values for transfer.

Environmental Behavior and Decision-Making (EB&D)

Programs exhibited a surprising amount of interest in a better understanding of how regulated entities made process, disposal, and location decisions that affect environmental quality. A 2003–2004 EB&D solicitation was focused on specific applications of this issue. A related focus solicited investigations into what firms and facilities actually consider (capital and operation and maintenance, transactions, reputation, market share) when estimating environmental management costs.

MM&I for Environmental Management

The MM&I solicitation will focus initially on two priorities, trading in practice and trading in new markets, but might expand to address fees, taxes, deposit-refunds, and other incentive systems. One objective will be to learn from experience in previous emissions trading markets and apply these lessons in either new or redesigned markets. The purpose of focusing on past trades will be to answer the two following questions: Have emissions trading markets led to environmental quality that is equal or superior to traditional regulations? What savings have been achieved, compared with regulations? The second objective will be to use theory-based models and experimental economics to better predict the success of new markets and to determine the considerations that should be incorporated into program design to make new markets both more efficient and more effective in accomplishing environmental objectives. Similarly, both empirical and theoretical models will be solicited to evaluate the effectiveness of other incentive programs.

Benefits of Environmental Information Disclosure

EPA has decided, on the basis of comments from EEAC peer reviewers and resource considerations, to fold this area of research into the environmental behavior and decision-making area. The relevant grant RFA was previously named Corporate Environmental Behavior and the Effectiveness of Government Interventions, or CEB. NCER is proposing a version of the renamed Environmental Behavior and Decision-Making (EB&D) RFA to address the benefits of information disclosure in 2005. NCER intends to use the EB&D RFA to solicit investigations of different interventions in different years; that is, compliance behavior will be addressed in year one, information disclosure in year two, voluntary approaches in year three, and so on.

ORD Laboratories and Centers

Several ORD laboratories and centers (other than NCER) have the capacity to develop integrated economics and risk assessment research projects. In addition, these offices are developing joint projects with NCEE. Laboratories and centers will continue their existing interdisciplinary projects and programs that focus on high-priority economics research areas. For example, an NCEA research project is integrating ecological endpoints and economic valuation, and NRMRL is conducting original research on new trading markets (stormwater runoff for nonpoint water pollution control). The EERS will indicate where future integrated research is needed as these projects are completed.

ORD staff assessed future economic research capabilities needed by the organization. The primary conclusion of this assessment was that ORD needs to increase its ability to integrate social science research and analysis into its existing strengths in human health and ecological research. To the extent ORD can develop the economic research capabilities outlined in the white paper, it will be able to address the needs outlined in this Strategy. In keeping with the white paper, ORD will emphasize integrating economics either in labora-

tories and centers or in cooperation with NCEE, using its expertise in engineering, physical, and biological sciences to address the EERS priorities.

Integration of Social, Biological, and Physical Sciences

Of particular importance for valuation activities, the EPA Administrator recently charged ORD's management to work with NCEE economists to integrate economic with biological and physical science analysis and research, an official recognition of what many in ORD and NCEE (and elsewhere) have known for some time. There is a clear need to better integrate economics and other social sciences with health and ecological assessments. The traditional approach of having physical, biological, and engineering scientists define the research questions and agendas without input from downstream scientists such as economists underutilizes scientific findings at best and, at worst, wastes resources because the research design does not take into account how the findings will be used in a decision context or influence people's behavior. Equally important, economic research conducted without the direct input of the relevant scientific and engineering disciplines runs similar risks if scientific and engineering uncertainties are not explicitly incorporated into the economic modeling and analysis.

There has been extensive discussion on the topic of integration, and ORD/NCEA and OPEI/NCEE have developed a working team to investigate some case studies involving health risk assessment and benefits analysis through the Risk Assessment-Benefits Analysis project. This development represents a promising start. However, the focus of this group has been risk and benefits analysis for regulatory purposes. The research coordination needed to build the underlying science has not been developed. For example, commonly useful data have not been collected, and the required cooperation among different research specialties is not yet evident at the beginning of the hypothesis development and data-gathering phases of research. As a stepping stone, EPA's portfolio of health, ecology, emissions, and economic databases—whether based on geographic information systems or otherwise—should be catalogued and made available for researchers to cross-reference and share.

ORD has some comparative advantages over other parts of EPA for integrating social science and health and ecological research. First, it has a large number of ecologists, health scientists, and engineers available, although it has few social scientists. One solution would be for ORD to establish a policy of using multidisciplinary teams of scientists, engineers, and economists whenever possible to identify research questions, design research strategies, and conduct the indicated research. A combined effort to identify both scientifically valid and economically cost-effective solutions to environmental problems is crucial to prevent environmental protection from being more expensive than necessary.

A scientist exchange program between ORD and NCEE could help EPA social, biological, and physical scientists to collaborate on research projects and could facilitate improvements in data collection and methods. A similar requirement that grant recipients develop multidisciplinary approaches to relevant projects would further advance this goal.

COMMUNICATION OF RESEARCH RESULTS

NCEE and ORD will continue to expand their existing communication efforts to improve communication of economic research results within and outside EPA. The primary outlets available to EPA are conferences and workshops, seminars, summary reports, and research publications. NCEE and NCER jointly organized and

conducted a series of economic research workshops beginning in 1998. So far, seven workshops have presented results of STAR grants and related research. These workshops have been attended by EPA and other federal and state agency staff, academics, and others with interest in the subjects discussed. The SAB EEAC peer review panel suggested that EPA could achieve wider distribution of the results of the research strategy and receive useful feedback from members of the research community by holding workshops in conjunction with the annual meetings of the American Economics Association and the American Agricultural Economics Association and by more aggressively notifying economics departments of upcoming grant RFAs.

Both NCEE and ORD independently hold seminars on economic and other scientific research topics on a regular basis. NCEE uses its position as host to the EPA Economics Forum to invite economists from the programs, laboratories, and regions to attend or listen in by conference call. NCER is currently improving its ability to conference with remote locations via video-conferencing.

NCER has begun to produce research capsules that summarize related STAR research results in a specific area of interest (e.g., stated preference value elicitation methods). NCER will continue to produce these research capsules in topical areas in which related projects have generated a useful compilation of results.

NCER and NCEE also propose to hold an annual economics research workshop for EPA staff to summarize the current research conducted or supported by EPA and to plan research for the coming year (e.g., focusing RFAs on high-priority issues).

NCEE maintains a database of economic reports and regulatory economic and benefit-cost analyses and is in the process of improving the accessibility and usefulness of these reports.

ORD and NCEE, working with other offices, are investigating the establishment of research databases that contain EPA facility-specific data for researchers. In addition, EPA is attempting to improve access to the Environmental Valuation Resource Inventory, a database maintained by Environment Canada to facilitate the transfer of health and economic values from original studies to policy situations.

CONCLUSIONS

EPA, through NCEE and ORD, has evaluated its needs for economic research by interviewing practitioners, reviewing the existing research, and consulting external experts. The EERS sets forth a plan to conduct the research of the highest priority and payoff for the Agency and its customers. The EERS also allocates responsibilities for accomplishing this plan. Some of the activities to be carried out are immediate and clear, whereas others are less certain and therefore require more information and flexibility. When this plan is implemented, EPA and economics researchers should be able to provide the Agency and its clients with suggestions for improving the cost-effectiveness of environmental protection.

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