



# ENVIRONMENTAL ECONOMICS

R E S E A R C H   S T R A T E G Y



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# FOREWORD

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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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# ACKNOWLEDGMENTS

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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

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

## OFFICE OF RESEARCH AND DEVELOPMENT SCIENCE COUNCIL:

May 2003, Subhas Sikdar, Lee Mulkey, Lead Reviewers

## EXTERNAL PEER REVIEW:

EPA Science Advisory Board, Environmental Economics Advisory Committee,  
November 17, 2003

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# GLOSSARY OF TERMS AND ACRONYMS

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

**EERS**      **Environmental Economics Research Strategy**

## **EPA Offices**

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Suboffices listed under Office

- Projects or Programs listed under suboffice with responsibility

**OAR**      **Office of Air and Radiation**

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**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**

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**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**

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**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**

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

**ORD Office of Research and Development**

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- 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**

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

**OW Office of Water**

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- 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**

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

# ABSTRACT

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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

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## 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**

<b>Research Topics</b>	<b>Rank Based on Long Term</b>	<b>Rank Based on Short Term</b>	<b>Rank Based on Number of Offices Requesting</b>	<b>Number of Offices Requesting Research</b>
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.<sup>1</sup> 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

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<sup>1</sup> 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.<sup>2</sup> 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 SO<sub>2</sub> 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.

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<sup>2</sup> 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.<sup>3</sup> *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

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<sup>3</sup> 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**

<b>Research Category</b>	<b>Rank<sup>1</sup></b>
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**

<b>Research Category</b>	<b>Rank</b>
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

<sup>1</sup> Based on averaging across EPA offices.

**TABLE 2.3 NUMBER OF OFFICES REQUESTING RESEARCH PRIORITIES TOPICS**

<b>Research Category</b>	<b>Number of Offices</b>
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.<sup>2</sup> 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);

<sup>2</sup> 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 agencies<sup>1</sup> 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.

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<sup>1</sup> 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.

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# CHAPTER 4

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## 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**

<b>Research Tools</b>	<b>Time To Produce Results</b>	<b>Influence on Research Progress</b>	<b>Quality or Level of Peer Review</b>	<b>Basic vs. Applied</b>	<b>Generalizability of Results</b>
<b>Contracts</b>	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
<b>Intramural Research</b>	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
<b>Cooperative Agreements</b>	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
<b>Grants</b>	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 SO<sub>2</sub> 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**

<b>Research Priority Category</b>	<b>Related Long-Term NCEE Project</b>
<b>Valuation of Morbidity Benefits</b>	Drinking Water Arsenic Valuation Survey
	How households value risk reductions to children
	Estimation of WTP to reduce asthma episodes for adults and children
<b>Environmental Behavior and Decision-Making</b>	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
<b>Valuation of Ecological Benefits</b>	Ecological Benefits Assessment Strategic Plan
<b>Benefits of Information Disclosure</b>	Short-term projects only at this time
<b>Valuation of Mortality Benefits</b>	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
<b>MM&amp;Is, Other Than Trading</b>	Methodology for evaluation of effectiveness of voluntary programs
<b>Green Accounting/Trade/Finance</b>	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
<b>MM&amp;Is, Trading</b>	EJ in SO <sub>2</sub> 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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## NEEDS ASSESSMENT

Research team members interviewed economists, users of economics, managers, and other scientists with an interest in economics in as many parts of the Agency as possible. These staff members represent some of the primary customers of research provided by ORD and NCEE. Before interviews, NCEE and NCER sent letters to all of the Office Directors and Deputy Regional Administrators to identify potential users of economics research results. The research strategy team also used internal EPA lists, such as membership in EPA's Economics Forum, and past programmatic reviewers for NCER economics and decision science grants.

For Offices (Assistant Administrator level) with economists in several suboffices (Office Director level or lower), meetings were generally held with groups of economists and others at the Office Director level. The team held face-to-face meetings when possible. When in-person meetings were not possible, team members conducted interviews through conference calls and e-mail. Virtually all meetings had at least two strategy team members present—one from NCEE and one from NCER. Trained facilitators led meetings when there were large numbers of interview subjects.

The research strategy team held 21 interview meetings with 75 participants, including respondents participating via telephone or e-mail. The program offices that participated in interviews included:

- The Office of Air and Radiation (OAR),
- The Office of the Chief Financial Officer (OCFO),
- The Office of Children's Health Protection (OCHP),
- The Office of Enforcement and Compliance Assurance (OECA),
- The Office of Environmental Information (OEI),
- The Office of International Activities (OIA),
- The Office of Policy, Economics, and Innovation (OPEI),
- The Office of Prevention, Pesticides, and Toxic Substances (OPPTS),
- The Office of Research and Development (ORD),
- The Office of Solid Waste and Emergency Response (OSWER), and
- The Office of Water (OW).<sup>1</sup>

<sup>1</sup> Because they acted as leads for the development of this strategy, no NCEE or NCER staff members participated in the interviews reported in Chapter 2, although other representatives from OPEI and ORD did participate. Some NCEE staff members participated in a pretest interview.

Each interview session began with an open-ended period of brainstorming in which participants described all relevant economic research needs for their offices. Participants then ranked these research needs, and results were used to create the scores in Tables 2.1 to 2.3.

Larger groups voted for individual research priorities using a multivote approach,<sup>2</sup> but groups of one or two simply assigned weights (percentages) to the different research needs. The research strategy team provided separate voting opportunities for both short-term (defined as having results in 3 to 5 years) and long-term (defined as having results in more than 5 years) research needs. The strategy team then prepared lists of research needs with the associated weights, along with other information about the meeting.

The EERS team coded each research idea from EPA staff interviews into topical categories at two different levels of detail. The first level has the broadest categorization, but the second level is more detailed. Table A.1 shows the more general categorization scheme, and Appendix 2 contains the more detailed categories.

**TABLE A1.1 GENERAL RESEARCH NEEDS (ALPHABETICAL)**

Benefits Valuation, Ecological
Benefits Valuation, Morbidity
Benefits Valuation, Mortality
Benefits Valuation, Other Endpoints
Environmental Behavior and Decision-Making
Cost/Impact Analyses
Cross-Regulation Interaction
Discounting/Intergenerational Equity
Environmental Justice (EJ)
Government Performance and Results Act (GPRA) Analysis/Strategic Planning
Green Accounting/International Trade/Finance
Market Mechanisms and Incentives (MM&Is), Other Than Trading
MM&Is, Trading
Risk and Uncertainty, Risk Assessment Techniques, Integration With Valuation, Other

<sup>2</sup> Each participant received three short-term votes and three long-term votes and could distribute these to the priorities developed in the brainstorming session in any fashion (i.e., all on one research priority or across two or three priorities for both short and long term).

# APPENDIX 2

## REQUESTS FOR ANALYTICAL SUPPORT

As noted in Chapter 2, although for the most part participants in the needs assessment were able to focus on research priorities, some respondents requested analyses or other products that are addressed better through guidance or a group such as the Economics Forum (a forum of economists from around the Agency). Three categories of priorities were eliminated from the presentation in Chapter 2 for this reason, including GPRA Analysis/Strategic Planning, Cost Analyses, and Impact Analyses. These categories were determined to be more analytical than research in nature because the specific requests from the programs and regions were for short-term or rule-specific analytical results. The tables presenting research priorities from Chapter 2 are reproduced here with those categories added. The tables are then followed by category descriptions for these three additional categories.

**TABLE A2.1 GENERAL RESEARCH PRIORITIES—SHORT TERM**

Valuation of Mortality Benefits	1.19
Environmental Behavior and Decision-Making (especially compliance)	1.06
GPRA Analysis/Strategic Planning	1.00
Valuation of Reduced Morbidity Benefits	0.96
Benefits of Information Disclosure	0.89
Cost Analyses	0.83
Impact Analyses	0.71
Valuation of Ecological Benefits	0.64
MM&Is, Trading	0.60
MM&Is, Other Than Trading	0.58
Discounting/Intergenerational Equity	0.38
Green Accounting/International Trade/Finance	0.32
Risk and Uncertainty, Risk Assessment Techniques, Integration With Valuation, Other	0.11
EJ	0.06
Cross-Regulation Interaction	0.03

**TABLE A2.2 GENERAL RESEARCH PRIORITIES—LONG TERM**

Valuation of Reduced Morbidity Benefits	1.27
Environmental Behavior and Decision-Making (especially compliance)	1.25
Valuation of Ecological Benefits	1.15
GPRA Analysis/Strategic Planning	1.00
Cost Analyses	0.89
Valuation of Information Disclosure	0.80
Valuation of Mortality Benefits	0.60
MM&Is, Other Than Trading	0.60
Green Accounting/International Trade/Finance	0.51
MM&Is, Trading	0.48
Discounting/Intergenerational Equity	0.22
Risk and Uncertainty, Risk Assessment Techniques, Integration With Valuation, Other	0.22
Impact Analyses	0.21
Cross-Regulation Interaction	0.13
EJ	0.09

**TABLE A2.3 NUMBER OF OFFICES REQUESTING RESEARCH PRIORITIES TOPICS**

MM&Is, Other Than Trading	7
MM&Is, Trading	6
Valuation of Reduced Morbidity Benefits	6
Environmental (Compliance) Decision-Making	5
Valuation of Ecological Benefits	5
Impact Analyses	5
Green Accounting/International Trade/Finance	4
EJ	4
Cost Analyses	4
Risk and Uncertainty, Risk Assessment Techniques, Integration With Valuation, Other	3
Discounting/Intergenerational Equity	3
Valuation of Mortality Benefits	3
Cross-Regulation Interaction	2
Valuation of Information Disclosure	2
GPRA Analysis/Strategic Planning	1

## GPRA/STRATEGIC PLANNING

As with environmental information, one office, OCFO, placed all of its research emphasis on one study objective, identifying the benefits and costs of achieving the objectives outlined in the Agency's new strategic plan. As noted above, a cross-agency workgroup is trying to address this issue in response to a request from the Office of Management and Budget (OMB). The results of this workgroup will be used to help identify research areas later in the implementation of this strategy. The area does not seem to provide particularly fertile ground for high-quality original research that would be generalizable to other situations. That is, it would benefit more from application of other research (e.g., valuation, cost, compliance behavior) rather than from original economics research. Implementation of the EERS will enhance the Agency's ability to estimate the costs and benefits of all of EPA's strategic objectives, which reflects EPA's regulatory agenda to a significant degree.

## COST ANALYSES

The primary request in this category was for cost estimates that could be used for specific rule-makings. Another request was for further guidance on translating private costs into social costs. This topic is considered in the *Guidelines*, and discussions on this topic are appropriate for the Economics Forum. As discussed in the footnote to the Impact Analyses category, these are not appropriate for this document. One research topic is how learning over time affects cost estimates, that is, testing the hypothesis that compliance costs decrease over time as facilities adapt to new regulations.

## IMPACT ANALYSES

The category of impact analyses reflects an aggregation of two subcategories:

- Facility or firm-level impacts and
- Market, aggregate, or computable general equilibrium (CGE) impacts.

Respondents placed the major emphasis in this category on methods to calculate impacts (facility or firm-level and market, aggregate, or CGE) and the "Other" category, which they used primarily to request assistance for rule-specific cost estimates.<sup>1</sup>

Some requests could be either research or analysis. OAR, OW, OECA, OPPTS, and OPEI requested general research on the economic impacts of regulations on firms and markets, although specific ideas are quite varied across the offices. OW and OPEI requested guidance (see footnote) on the proper tools to analyze the impact of regulations on small businesses and nontraditional industries such as agriculture. These two offices also requested retrospective analyses of the impacts of rules or government investments. Other offices requested a variety of analyses or improved models, including:

- Retrospective comparisons of economic growth in attainment versus nonattainment areas;

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<sup>1</sup> Requests for rule-specific costs or impacts are categorized more appropriately as analysis than research and will not be addressed in this document unless they have widespread generalizability. Similarly, although guidance is an important contribution to improving economic analysis, it is not research but an application of research results.

- Incorporation of regulation-induced product quality changes into market analyses;
- Development of CGE models that can be used in regulatory decision-making;
- Measurement of the relationship between environmental and financial performance;
- Refinement/improvement of agricultural sector models to accommodate regulatory impacts;
- Updates of reports on the cumulative impact of regulation on business; and
- Development of models that can be used to analyze the environmental effects of trade.

There is no apparent unifying theme to the analytical needs in this area, suggesting that more investigation into the highest priority impact area is needed to determine which approach can make the greatest contribution—guidance, literature reviews, or more specific applications. Several respondents requested guidance that could be updated through existing groups (the Economics Forum and a Small Business Regulatory Enforcement Fairness Act [SBREFA] review group) through NCEE. *Note:* NCEE has acted on both of these suggestions and currently (2004) is updating the Guidance for Economic Analyses and coordinating an SBREFA review group.

## APPENDIX 3

# RELATIONSHIP TO OTHER PLANS, STRATEGIES, AND DOCUMENTS

### PRIOR ENVIRONMENTAL ECONOMICS RESEARCH PLANNING

This effort follows directly from a 5-year-old needs assessment conducted by a predecessor group to NCEE (McClelland et al., 1999). In that effort, EPA staff and external experts on EPA's SAB EEAC described and ranked the research areas that they considered to be most important. This prior research planning effort has been used for the past several years to focus STAR grant solicitations on valuation and MM&Is, and as a source of ideas for in-house research conducted by NCEE economists. Given the passage of time, EPA believes the time is right to update and formalize the research planning process through this EERS.

### AGENCY STRATEGIC PLAN

In 2003, EPA revised the Agency's Strategic Plan (U.S. EPA, 2003). The structure of the plan evolved from its previous version with 10 strategic goals to its current version with 5 strategic goals. With the plan revision, OMB is requiring EPA to include the "social costs" of achieving EPA's strategic objectives. An Agency-wide group of economists and others are working to define and measure these "social" benefits and costs. EPA economists anticipate that it will take several years to develop methods and data that will allow the Agency to completely and accurately characterize the benefits and costs of achieving its strategic goals. The research developed in response to the EERS will provide some basis for estimating these benefits and costs and make the EPA strategic plan more responsive to OMB requests.

### ORD STRATEGIC PLAN

The 2001 ORD Strategic Plan sets out five strategic organizational goals. This Research Strategy should further achievement of all of these goals.

#### 1. Support the Agency's Mission

By proceeding from a basis of problem-driven research priorities derived by clients from across EPA and outside the Agency, the EERS clearly supports the Agency across all programs and regions when there is a well-recognized, critical need for additional economic information to accomplish its mission.

#### 2. Be a High-Performing Organization

The EERS attempts to systematically incorporate all of ORD's economics research activities and integrate them with NCEE's, other EPA and external economics research, and research from other scientific disciplines. This effort will maximize the exposure and effectiveness of ORD and EPA economics research.

#### 3. Be a Leader in the Environmental Research Community

Research sponsored by the STAR grant program and conducted or sponsored by NCEE and ORD laboratories is recognized as some of the most important environmental economics research developed anywhere. The EERS will further this reputation by supporting cutting-edge and practical research that will affect the course of future environmental policy.

#### 4. Integrate Environmental Science and Technology To Solve Environmental Problems

A sizable share of the research conducted by NCEE, ORD laboratories, or externally through STAR grants comprises multidisciplinary teams of economists and other scientists, such as psychologists, ecologists, epidemiologists, engineers, and health scientists. Sponsored environmental economics research uses a vast array of technological, financial, physical science, and biological science information to analyze environmental policies. Several ORD laboratories and centers are working closely with NCEE and the programs to integrate economic analysis with human health and ecological risk assessment. This EERS will improve and formalize support for this trend.

#### 5. Anticipate Future Environmental Issues

This Research Strategy will help develop a capacity to predict how economic forces and trends will affect future environmental conditions.

### RELATIONSHIP OF EERS TO THE NATIONAL CENTER FOR ENVIRONMENTAL ECONOMICS

NCEE conducts and supervises research and development on economic analytic methods; leads production of cross-Agency economic reports; provides guidance for performing economic analysis; and promotes consistency in the preparation and presentation of economic information in the Agency. NCEE prepares economic analyses under its own direction and functions as an internal resource for other Agency offices seeking information on benefit-cost research and techniques, economic impact models and measures, and economic incentive mechanisms. NCEE also performs a regulatory review function for the Agency by reviewing the economic analysis underlying significant regulatory actions.

The EERS will enhance NCEE's ability to perform its primary functions in several ways.

**Putting Theory Into Practice:** NCEE is responsible for assisting EPA's offices in applying sound economic science in the preparation of economic analyses. The EERS will inform NCEE regarding the economics research needs of its client offices.

**Improving EPA's Economic Tools:** NCEE develops data and methods for benefit-cost assessments through research aimed at filling priority needs common to many programs in the Agency. By better understanding the gaps in the existing economics research, and which research needs are most important given Agency priorities, NCEE's work in economic methods development can be better targeted at these identified needs.

**Gateway for Academic Research:** NCEE communicates EPA's research priorities to economics professionals across the Nation. NCEE helps academicians identify topics pertinent to the Agency's needs and funds research in those areas through grants and cooperative agreements with universities. Through these efforts, as well as seminars, workshops, and a Web site with online resources, NCEE serves as a gateway for academic research. The research needs identified in the EERS allow NCEE to better engage the research community when seeking outside assistance with its research activities.

**Linking Science and Policy:** NCEE works to identify better ways to link the natural and social sciences to help improve risk assessments and benefit-cost analyses. NCEE works to provide risk assessment information that can be fed easily into economic analyses. The goal is to improve EPA's ability to evaluate its

progress in addressing risks to public health and the environment. Therefore, by understanding the Agency's economics research needs, NCEE is positioned to assess the underlying science, policy, and data needs required to make the priority economics research as effective as possible in fulfilling the goals and mission of the Agency.

**Exploring Emerging and Crosscutting Issues:** The Center explores the changing nature of environmental problems that face EPA and the Nation. This work includes identifying a wide range of emerging issues, trends, and challenges; assessing their potential impacts on the environment; and positioning the Agency to respond. The EERS will help NCEE prepare to meet these emerging challenges by focusing attention on the economics research that is most needed by the Agency to better evaluate future environmental issues and trends. Furthermore, because NCEE is not connected with any one media or program, the EERS enhances NCEE's unique capability to address crosscutting issues.

## OTHER ORD STRATEGIES AND PLANS

Because it focuses on behavior, environmental economics spans all of EPA's environmental protection activities. The ORD Strategic Plan (U.S. EPA, 2001) notes that one of the trends likely to have the greatest impact on ORD research is the need to integrate "environmental research so that the findings of economics, sociology, psychology, and other social sciences can be incorporated into decision-making." Implementation of other ORD strategic plans will ultimately depend on a better understanding of "individuals' behavior as consumers, commuters, and property owners." Some particularly relevant strategies to the EERS include the ecological research strategy, pollution prevention research strategy, human health risk assessment research strategy, asthma research strategy, and global change research strategy.

### NCEA—Global Change

EPA's Global Change Research Program in NCEA is an assessment-oriented program with primary emphasis on understanding the potential consequences of climate variability and change on human health, ecosystems, and socioeconomic systems in the United States (U.S. EPA, 2004). This includes assessing adaptation options to improve society's ability to effectively respond to the risks and opportunities presented by global change as they emerge. The program's health assessments go beyond basic epidemiologic research to develop integrated health assessment frameworks that consider the effects of multiple stresses, their interactions, and human adaptations including economic responses. The Global Change Research Program also is investigating the effects of global change on (1) aquatic ecosystems (including lakes, rivers, streams, wetlands, estuaries, and coastal ecosystems); (2) invasive nonindigenous species; and (3) ecosystem services. These efforts are closely related to ecosystem valuation research.

### NCEA—Cincinnati

To improve the utility of ecological risk assessment in the decision-making process, economists and ecologists in NCEA's Cincinnati laboratory are evaluating the application of models, landscape characterization methods, and economic analyses to formulate alternative approaches for protecting and restoring water quality and critical habitats and to forecast the ecological, economic, and human health outcomes of alternative solutions. The team of ecologists and economists also is exploring the relationship between indicators of ecosystem conditions and a selected set of high-priority environmental management problems in the Missouri, upper Mississippi, or Ohio River basins. The products of this effort will be a set of problem-specific reports

that will include conceptual models of sources, stressors, and both ecological and economic endpoints related to each problem.

### **NRMRL—Cincinnati**

Economists in NRMRL are working with engineers and ecologists to design and analyze market approaches for environmental systems management, including a program of tradable credits for impervious surface for controlling urban stormwater runoff, with a focus on stream quality and combined sewer overflows, a serious problem in many regions. This team also is working on construction of a basic theory of sustainable systems using principles from ecology, physics, law, and economics to uncover the underlying principles of sustainable systems and provide guidance on the viability of different environmental systems management strategies.

### **ORD—Capacity Needs White Paper**

ORD recently developed an assessment of the social science capabilities that the organization will need in the future. All of the potential strategic directions involved integrating economics and other social sciences with engineering, physical, and biological sciences. Among several suggestions for integrating social, life, and "hard" sciences was that ORD should develop an integrated capacity where co-location of multiple disciplines would be essential to improved research. NCEE has followed a similar strategy.

## **OTHER PLANS AND ACTIVITIES**

### **Ecological Benefits Assessment Strategic Plan**

Simultaneous with the development of the EERS, NCEE is working with the rest of the Agency, particularly ORD laboratories and centers and OW, to develop a strategic plan for estimating ecological benefits. This effort is patterned after a successful 2-year collaboration between NCEE and NCEA to improve estimation of health benefits.

Development of the *Ecological Benefits Assessment Strategic Plan* involves both ecologists and economists from across EPA and will try to find common metrics for understanding ecological and economic processes upon which to base sound estimates of values. Interviews for the Strategic Plan will involve both economists and ecologists and will focus solely on ecological valuations. As a result, they will provide different and more detailed results than the EERS surveys. The *Ecological Benefits Assessment Strategic Plan* will identify research needs in ecology and related fields that are necessary to enhance the valuation of ecological benefits. As noted below, EPA's programs perceive the inability to conduct ecological valuation as a key weakness in EPA's estimates of the benefits and costs of environmental protection, and they have consistently raised this issue as a priority research area. NCEE and ORD will therefore use the results from the *Ecological Benefits Assessment Strategic Plan* to further focus research in the ecological benefits area.

### **National Research Council (NRC) Report on Air Pollution Benefits**

The NRC recently issued a report (NRC, 2002) on the estimation of the benefits of air pollution regulations. This report contained several recommendations, including some that require further research to implement,

such as incorporating uncertainty in benefits estimation. ORD and NCEE are collaborating with OAR to provide whatever research support is necessary to respond to the NRC report.

### **Program Office Research Plans**

Several program offices are developing and implementing research/analysis plans of their own, focusing on important program-specific issues. Both OA and OW have initiated research plans.

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## APPENDIX 4

# RELATIVE ADVANTAGES OF RESEARCH TOOLS

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### CONTRACTS

Contracts are intended for the acquisition of services for EPA's direct use, rather than assistance to support more general purposes related to the Agency's mission. EPA programs use economic contracts for a range of specific tasks, often to estimate the costs and benefits of specific regulatory options. Contracts are generally more suitable for analysis than research. An economic analysis work assignment under a contract can be executed quickly if a relevant contract is already in place, which makes contracts particularly suitable for analyses that are needed immediately. Contractual analyses tend to be program or project specific, involve mostly secondary data sources, and rarely provide the original contributions needed to be published in peer-reviewed journals.

### EPA INTERNAL RESEARCH

In-house research is arguably the fastest way to produce research results if qualified staff is in place and no other barriers exist. However, if the Agency is missing the needed research capabilities, the time and resources required to initiate research can be considerable. EPA's personnel system requires considerable effort to hire new staff. To make new hires an efficient research approach, EPA would have to require the new personnel's skill set continually over the long term.<sup>1</sup> In addition, economic studies frequently use some form of survey or questioning of individuals or industry to gather information. Internal research that gathers information directly from individuals or firms is subject to the requirements of the Paperwork Reduction Act (PRA), one of which is that OMB must review and approve any survey instrument. The time and resources necessary to undertake the Paperwork Reduction Act review process may be significant.

Conversely, intramural research is particularly well suited to providing research results that are needed specifically by EPA programs. Also, conducting research internally gives EPA the greatest amount of influence regarding methods, hypotheses to test, and the level of effort devoted to the research. Moreover, in-house research gives EPA the flexibility to adjust the level of rigor and peer review based on an assessment of clients' needs. Some research conducted by EPA is original, and other research is meta-analysis of research results. Some economic analysis is appropriate for program-level consideration of options, whereas other research is published in the best peer-reviewed journals. EPA research also can range from theoretical to applied research, although there is a greater tendency toward applied research for which EPA programs have a direct need.

### COOPERATIVE RESEARCH AGREEMENTS

Cooperative agreements are joint research efforts between EPA scientists and researchers at other institutions. Cooperative agreements and grants are both "assistance" agreements, which can be used only to support research of general interest that is related to EPA's mission. They may not be used to generate research results that primarily benefit EPA in its day-to-day activities. As something of a hybrid between grants and internal research, they share the advantages and disadvantages of both. EPA staff participates in and has more control over the direction and timing of research efforts, but all facets of research results, resources,

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<sup>1</sup> Visiting academics and research fellows might provide temporary or project-specific research skills.

and timing must be negotiated with co-investigators from outside the Agency. Cooperative agreements that use surveys or experiments are generally subject to PRA requirements and OMB review. Cooperative agreements often generate high-quality publications that researchers submit to peer-reviewed journals. Results can be either program-specific or generalizable to a range of programs or circumstances.

## GRANTS

Like cooperative agreements, grants are assistance agreements and are focused to an even greater degree on research questions of broad academic or public interest. The grant-making process (from solicitation development, through peer review and award, to final results) can take up to 5 years. Grants give external researchers the greatest amount of discretion and, conversely, give EPA the least amount of influence over research results. In the STAR program, research proposals are received in response to criteria set forth in published solicitations. The proposals are peer reviewed, and only the highest quality proposals are eligible for funding. As well focused as a solicitation might be, investigators have considerable flexibility in responding to it. EPA's influence over research topics, approaches, or timetables is limited largely to deciding whether to fund a proposal. Grants produce high-quality, peer-reviewed results for which academics are typically rewarded, while also forwarding the state of the science. They tend to be quite generalizable and benefit EPA programs only incidentally, although several programs might use adaptations of their results.

# APPENDIX 5 DETAILED INTERVIEW RESULTS

This appendix shows the short-term (ST) and long-term (LT) stated research needs of program offices, program suboffices, and individuals. It comprises largely unedited raw data taken from focus group meetings with EPA staff. These data provide the fundamental building blocks for the research objectives in the Strategy but include many additional topics that EPA's available research resources will not be able to address. However, the data provide many ideas for academic and other researchers interested in policy-relevant topics.

## OAR/OAQPS Meeting 4-29-02

**ORD:** Matt Clark

**NCEE:** Chris Dockins

**OAQPS:** Aaiysha Khursheed, Larry Sorrels, Bryan Hubbell, Virgis Brown, Tyler Fox, Ron Evans, Lillian Bradley, Lawrence Pope, Linda Chappell, Eric Crump, Lisa Conner, Nancy Mayer

Topic	Votes	
	ST	LT
How the technology learning curve affects future year compliance costs	3	
Incorporating economic and behavioral responses (averting behavior) into epidemiologic studies		6
How and when firm value (e.g., stock prices) is affected by changes in environmental information		
Linking water-quality changes to economic endpoints (aquatic vegetation, nutrients, fish populations, economic endpoints)	3	3
Ecological, economic, and health effects related to systems of agricultural production	2	
Economic and health-effect studies on sensitive subpopulations (EJ)	1	1
Spatial economic growth models for emissions projections, critical pollutants, and toxics: distribution of economic growth	2	3
Quantification of emissions to provide the basis for trading, better and more monitoring, or equivalents; gross emissions within and across compounds and source categories (point and nonpoint)	3	2
Value of noncancer health endpoints of air toxics		3
Linking environmental indicators with economic endpoints so that they can be used in analyses	2	2
Approach for determining appropriate air pollution control emissions fee and alternative payment/fee	4	1
Indepth analysis comparing economic growth in attainment and nonattainment areas; retrospective/prospective to identify key growth factors	2	1
Modeling emissions trading for non-utility sectors; single/multiple pollutants, cross-industry, cross-pollutant, local/regional	3	
Alternative (to quality-adjusted life-years [QALYs]) cost-effectiveness measures that capture acute and chronic health and ecological effects		

continued ►

Topic	Votes	
	ST	LT
Use Tiebout model to examine migration between attainment and nonattainment areas based on health and other environmental effects (who and why?)		
Incorporate regulation-induced new product development and product quality changes into market (equilibrium) analyses	4	1
Estimating existence values for cultures (tribes)	1	5
New air- or water-quality models: need reduced-form surface models for off-the-shelf runs (practical, updatable, policy-relevant versions)	1	2
Emissions tracking or banking systems that streamline transaction costs (environmental impact of trades)		1
Residential visibility valuation	1	1
Uncertainty characterization: integrate uncertainty analysis from dose-response to valuation to cost impacts	2	1
Objective way to determine location of EJ communities with respect to sources	1	1
<b>Total Votes</b>	<b>35</b>	<b>34</b>

**OAR/OPAR Meeting 6-10-02**

**ORD:** Will Wheeler

**NCEE:** Brian Heninger

**OAR:** Jim DeMocker

Topic	Votes (%)	
	ST	LT
Value of ecosystem services that are potentially relevant for air; develop paradigm for ecosystem valuation and define ecosystem service flows to satisfy both ecologists and economists	33.3	33.3
Morbidity risks: wider endpoint coverage, more subpopulations (e.g., childhood asthma), use of QALYs (or other methods) to transfer values	33.3	33.3
Other welfare benefits, more endpoints, more population coverage (household visibility, different agriculture crops, other species of timber)	33.3	33.3
Mortality		
Benefits transfer methods to get better coverage of endpoints		
Indirect (productivity) benefits		
Actual discount rates; rate or return on investment		
CGE models		
Learning curve for reducing compliance costs, especially important for regulatory phase-ins		
<b>Total</b>	<b>100</b>	<b>100</b>

**OPAA/OCFO Meeting 5-16-02**

**ORD:** Matt Clark

**NCEE:** Ann Wolverton

<b>Topic</b>	<b>Votes (%)</b>	
	<b>ST</b>	<b>LT</b>
Research that improves the inclusion of social costs in EPA's strategic planning		
Characterize benefits aligned with Government expenditure information from OCFO so that relative values of expenditures can be determined; estimates of both public and private costs		
Prospective benefit-cost analysis for each strategic objective	100	100
Desire rigorous peer-reviewed journal articles estimating the social costs of achieving EPA's strategic goals (e.g., costs and benefits of climate change)		
<b>Total</b>	<b>100</b>	<b>100</b>

**OCHP Meeting 5-8-02**

**ORD:** Will Wheeler

**NCEE:** Lanelle Wiggins

**OCHP:** Ed Chu

<b>Topic</b>	<b>Votes (%)</b>	
	<b>ST</b>	<b>LT</b>
Age-specific values for mortality valuation (children and elderly)	50	50
Are QALYs theoretically appropriate for environmental policy use?	10	
Age-specific values for chronic health effects, such as asthma, developmental disorders (attention deficit hyperactivity disorder, autism, mental retardation), and health effects associated with cancer both during the disease and during remission (effects from cancer treatment)	40	50
Economic indicators of the environment (what does pollution cost the economy?)		
<b>Total</b>	<b>100</b>	<b>100</b>

**OECA/OPPAC Meeting 5-9-02**

**ORD:** Will Wheeler

**NCEE:** Ann Wolverton

**OECA-OPPAC:** Jon Silberman

Topic	Votes (%)	
	ST	LT
How and why do compliance and enforcement interventions, assistance, incentives and monitoring (e.g., inspections, information collection requests), and civil and criminal enforcement actions affect corporate behavior, decision-making, compliance, and performance? <sup>1</sup>	45	45
What are the impacts and cost-effectiveness of environmental management systems (EMSs) in achieving compliance and improving corporate efficiency (e.g., average or marginal costs of reducing units of pollution, energy savings, improved competitiveness, compliance over the short and long term)	15	15
What organizational characteristics (e.g., centralized or decentralized, EMSs, performance appraisal, reward, and compensation policies) foster improved environmental performance and compliance?	15	15
What is the relationship between environmental and financial performance? How/why do compliance and environmental performance correlate with or affect financial performance (cost increases and reductions; value creation [tangible and intangible worth])? How does public disclosure of compliance and performance information affect future environmental and financial performance (e.g., stock values, bond ratings, insurance rates, profitability)?	8	8
What compliance and enforcement interventions most effectively ensure accountability for the generation of credits and allowances in market-based effluent discharge and air emissions trading programs?	9	9
How does participation in voluntary incentive or recognition programs affect beyond-compliance behavior, corporate efficiency, and earnings/profitability?	8	8
<b>Total</b>	<b>100</b>	<b>100</b>

<sup>1</sup> This topic includes subissues: (1) Increasingly, EPA and the states are employing integrated compliance strategies that rely on multiple compliance and enforcement interventions (a tool that may be applied sequentially, simultaneously, or both). How can we maximize and measure the synergistic impacts of such strategies? (2) What motivates companies in their decision-making processes, and how do compliance and enforcement interventions compare with other incentives companies may have to change their behavior? (3) What are the effects/results of sector-based compliance and enforcement interventions?

**OECA/ORE Meeting 5-28-02**

**ORD:** Will Wheeler  
**NCEE:** Brian Heninger  
**ORE:** Jonathan Libber

Topic	Votes (%)	
	ST	LT
Understanding deterrence: What is the private discount rate for corporations? What kind of financing do they use (equity, weighted average cost of capital, other instruments)? How do firms make decisions with respect to discount rates?	60	
How do responsible environmental officials view compliance, and how do they react to regulations? If enforcement is not real, will they comply?	40	85
Do the same factors that motivate compliance in the United States apply elsewhere?		15
<b>Total</b>	<b>100</b>	<b>100</b>

**OEI Meeting 6-11-02**

**ORD:** Will Wheeler  
**NCEE:** Brian Heninger  
**OEI:** Christine Augustyniak, Cody Rice

Topic	Votes (%)	
	ST	LT
Value of information to corporations, labor, consumers. Currently, there is no way to monetize the benefits of information provision (e.g., Toxics Release Inventory [TRI]) to compare against costs.	80	80
How information is used in decision-making: Do companies change behavior? People choose where to live, work (include all subcategories)?	20	20
What are the internal cost-savings identified when a TRI report is prepared? Value of information to companies?		
What are the ecological and health benefits from reduced pollution?		
Is emphasis on information programs (e.g., Design for the Environment) a good way to go? Are they effective?		
Prioritize expansion of TRI (industries, chemicals, threshold quantities): What is the highest value? What order? What is the marginal value of the next aspect of the program?		
How is value of information linked to lbs. of pollutant? (e.g., regarding fat content, value of information is not correlated strictly with amount of fat). Lead is an example.		
How to use benefits transfer to get value from another situation		
<b>Total</b>	<b>100</b>	<b>100</b>

**OIA Meeting 4-28-02**

**ORD:** Will Wheeler

**NCEE:** Brian Heninger

**OIA:** Paul Cough

Topic	Votes (%)	
	ST	LT
Tools for measuring environmental effects of trade agreements, including changes in terms of trade, location of production, or means of production (if changes have environmental consequences); linking economic models with pollution intensity and effects	30	30
How different rules (e.g., banning methyl tertiary butyl ether) affect foreign investment, product movements/flows	2.5	2.5
Finance: How do we pay to provide safe drinking water to developing countries? How should environmental improvement be paid for (domestic vs. international finance, public vs. private, end-of-pipe vs. other methods)?	2.5	2.5
Environmentally preferable green products: How do you adjust incentives to promote their use/production in accordance with trade laws (e.g., shade-grown coffee, voluntary or mandatory labeling)?	22.5	22.5
Corporate environmental stewardship: Will people appreciate trade more if companies are good citizens (e.g., private international agreements on pollution prevention [P2])?	22.5	22.5
How trade affects environmental regulation	20	20
<b>Total</b>	<b>100</b>	<b>100</b>

**OPEI/OEPI Meeting 6-3-02**

**ORD:** Will Wheeler

**NCEE:** Brian Heninger

**OEPI:** Katherine Dawes, Pamela Kogan

Topic	Votes (%)	
	ST	LT
How trading actually works in practice (water, nonpoint source pollution): flexible permitting, performance-based, across-media trades	50	40
Water infrastructure, aging of publicly owned treatment works (POTW); could cost a lot, so how to invest?		40
Do innovative programs (e.g., flexible permitting) lead to disparities even if there is superior performance? EJ aspects (e.g., hotspots), how do you avoid this?	10	
Incentives for beyond-compliance performance (is compliance assistance a good incentive?); e.g., the Environmental Results Program in Massachusetts. Demonstrating cost-effectiveness and environmental soundness for other states	20	
Retrospective analyses of innovative programs: POTW, bioreactors, P2 permitting pilots, more successful "eXcellence and Leadership" (XL) projects		

continued ►

Topic	Votes (%)	
	ST	LT
Expanding markets for metals recycling/recovery (Resource Conservation and Recovery Act [RCRA])	20	
P2 for small businesses		20
<b>Total</b>	<b>100</b>	<b>100</b>

**OPEI-Small Business Division Meeting 7-22-02**

**ORD:** none

**NCEE:** Julie Hewitt, Ann Wolverton

**Small Business Division:** Tracy Mattson, Larry Tessier, Jim Malcolm, Tom Nakley, Daniel Eddinger, William Crosswhite, Elsa Bishop

Topic	Votes (%)	
	ST	LT
Literature search for relevant small business economic research; would help program offices to do better SBREFA analysis	25	
Cost to implement EMSs to large vs. small businesses: What works? What does not work? What motivates small businesses to implement? (Sometimes large firms require suppliers to have an EMS to stay on the bidding list.)	25	
Measurement of true costs for small businesses (get a better idea of the economic impact; small businesses are a different animal from large businesses and are motivated by different factors). Is the type of economic analysis we are doing appropriate in this context (e.g., use of profit margin instead of revenues)?	25	30
Incorporation of unique characteristics of small businesses into economic analysis	25	30
Update cumulative impact report completed in 1988		40
Data collection: building a database that accurately reflects revenues, costs, and profits of small businesses; geographical breakdown; labor differences, capital investment, etc.		
What motivates small business behavior?		
Evaluation of past rules to identify gaps/where we could have done better in our analysis (over- or underestimation of universe affected, costs, etc.), and what we are missing		
<b>Total</b>	<b>100</b>	<b>100</b>

**OPPTS/IO Meeting 5-6-02**

**ORD:** Matt Clark

**NCEE:** Brian Heninger

**OPPTS:** Sandy Evalenko

Topic	Votes (%)	
	ST	LT
Value of information to the public; requiring companies to provide use and exposure information has costs, but what are the benefits?	30	
Human health valuation for nonmonetized endpoints: How do you consider nonmonetized benefits? Values for endocrine disruptors, values for special populations (e.g., farm workers)? Lead a specific need.	30	25
Ecological valuation for nonmonetized endpoints: endocrine disruptors and lead	15	35
Expand literature on latency issue	25	
Children's health valuation for specific endpoints		30
Market mechanisms/voluntary programs (e.g., technical assistance)	10	10
<b>Total</b>	<b>110</b>	<b>100</b>

**OPPTS/OPP Meeting 4-23-02**

**ORD:** Becki Clark, Matt Clark, Will Wheeler

**NCEE:** Julie Hewitt

**OPP:** David Widawsky, John Faulkner, Jihad Alsadek, Carole Battle, Tim Kiely, Steve Smearmann, Alan Halvorson, Istanbul Yusuf, Arthur Grube, Philip Villanueva, T.J. Wyatt, F. Hernandez

Topic	Votes	
	ST	LT
Valuing aquatic impacts from pesticide use		9
Extending Zilberman-type work on tradeable permits for pesticides	2	
Quantifying benefits		3
Measuring the impact of the Food Quality Protection Act on growers and consumers; refining and improving agriculture sector models (Agricultural Simulation Model, U.S. Agricultural and Resource Model) to accommodate pesticide regulatory models	9	
How do pesticide users decide which pesticide/product to use (including price, rate of return) and how much?	4	3
Pesticide usage on nonagricultural sites (residential, school)	1	
Value of avian species		1
Evolution of chemical industry; change to sustainable agriculture, biotechnology		1
Valuation of human health impacts by pesticide class	5	3
Effects of biotechnology on chemical use	1	
Integrating risk assessments with valuation	1	

continued ►

Topic	Votes	
	ST	LT
Risk perception and valuation; how consumer risk perceptions (e.g., organics) affect behavior; how fear of remote risks (e.g., biotechnology) affects valuation; effects of green labels on consumer and farmer behavior		1
Combine usage information into a user-friendly software	6	
Discounting; what rate to use (time stability)		
Burden on the health care system as a consequence of pesticide use		
How regulatory decisions have affected the agricultural industry		
EPA's role in communicating risks and benefits		1
Comparative evaluation of pesticide regulations; efficiency gains		2
Risk analyses (acre treatments vs. percentage of crop treated)	1	
Improve major vendor's pesticide data for usage data (targeting)	4	
Regulatory impacts under market distortions		
How timing of regulatory decisions affects outcome	1	1
Appropriate use of cost-benefit analysis		
Institutional restrictions on pesticide use/usage (keeping a subsidy for a specific crop, lending requirements)		
Economics of reducing expected risk vs. regulated risk (safety factors)	1	2
Impacts of global warming on pesticide use		4
Managing global climate change on pesticide use		3
<b>Total Votes</b>	<b>36</b>	<b>34</b>

**OPPTS/OPPT Meeting 5-08-02**

**ORD:** Will Wheeler, Matt Clark

**NCEE:** Ann Wolverton

**OPPT:** Bob Lee, Gary Cole (summarizing rest of office)

Topic	Votes (%)	
	ST	LT
Incentives for voluntary programs (both business and consumer-related): What induces a firm's/consumer's decision to participate? How do these systems work? What change in behavior results from the provision of new information to consumers (e.g., labeling)? When is a voluntary program a good strategy in relation to a regulatory program?	50	50
Benefits from informational rules: Do real improvements occur as a result of information provision? Do we solve market failures with these kinds of rules?	30	30
Discounting/intergenerational equity		20
Value of statistical life-years/QALYs	20	
<b>Total</b>	<b>100</b>	<b>100</b>

**ORD Meeting 6-6-02**

**ORD:** Matt Clark, Will Wheeler

**ORD:** Anne Grambsch, Randy Bruins, Lynn Papa, Matt Heberling, Betsy Smith, Haynes Goddard, Hale Thurston, Beth Lemberg

Topic	Votes (%)	
	ST	LT
How can nonmarket values be used to prioritize ecological restoration projects or inform other choices (as in ecological risk assessment)?	15	6.66
Develop scenarios of technical and regional economic change and how these will affect environmental quality	16.67	
Retrospective study of environmental restoration costs vs. prevention	8.33	
Incorporating nonmonetized values of ecosystems or other ways to value ecosystems		20
New or novel approaches to link quantified morbidity effects of air pollution with economic values		13.33
Economic value of ecosystem services: How does this change by level of aggregation? Spatial-temporal scales?	16.67	16.67
Important health metrics when valuing health risks and types of information that risk assessors can provide to economists	10	10
What behavioral modifications can individuals take to adapt to climate change and how can they be activated?	6.67	6.67
Investment strategies to manage nonpoint water quality problems and habitat restoration (including stormwater)	16.67	16.67
Can market-based mechanisms guide these investments? What type of market structure/ institutional arrangements would achieve efficiency within explicit ecological constraints?	10	10
<b>Total Votes</b>	<b>100</b>	<b>100</b>

**OSWER/OERR Meeting 4-30-02**

**ORD:** Will Wheeler

**NCEE:** Julie Hewitt

**OERR:** John Harris (Dave Slutsky, contractors)

Topic (SUPERFUND)	Votes (%)	
	ST	LT
Identifying, quantifying, monetizing existence and use (including passive use recreation) values of open-space lands	50	30
Understanding both landowner and nonlandowner potentially responsible parties' (PRPs) behavior. Why do PRPs mothball sites? Why do PRPs cooperate and why don't they? What leads to site reuse? Compliance disincentives for cooperative behavior?	30	
What is the optimal solution when there are multiple sites in a geographic area?	20	

continued ►

Topic (SUPERFUND)	Votes (%)	
	ST	LT
Appropriate discount rate for intergenerational flows		40
Monetizing ecosystem service values		20
How to value messes not made or voluntary cleanup (i.e., the bigger picture benefits of Superfund program). What is the appropriate methodology for capturing these as indirect benefits?		10
What portion of the health benefits of cleanup is capitalized into property values? Can we be certain there is no double-counting?		
How to compare and value alternative re-uses of contaminated sites		
Why isn't there more of a market for environmental insurance? Are there adequate mechanisms to bottle risk for transfer?		
Why are states in a race to the bottom? Are they competing for business?		
How to measure cultural values		
EJ questions in economics terms		
Is there a catalytic impact to resolving a National Priorities List site? What does it trigger?		
Is there a value to permanent solutions over temporary (30 years) solutions? To clean it up and haul it away, or to contain it?		
Cleanup level is often tied to next use. Are there intergenerational impacts to this? Are there financial tools to remedy this?		
Cross-program interactions (State Implementation Plan in air)		
Groundwater: Clean up the aquifer or pump and treat? Law says the former, but is the latter more rational?		
Multicriteria analysis		
Value of EPA information being organized and presented differently to the market		
Stigma: Is it attached to Agency action or to existence of contamination in the first place?		
How to meaningfully communicate a cost-benefit analysis to noneconomists		
<b>Total</b>	<b>100</b>	<b>100</b>

**OSWER/OSW Meeting 4-24-02**

**ORD:** Becki Clark, Matt Clark, Will Wheeler

**NCEE:** Lanelle Wiggins

**OSW:** Lyn Luben, Mark Eads, Glenn Farber, Gary Ballard, Jan Young

Topic	Votes	
	ST	LT
Cost issues related to a technology learning curve: How much and how does technology become cheaper to operate (and to buy) every year?	3	
Price elasticity of demand for hazardous waste as a fuel	1	
Benefits, primarily from reduced lead exposure in children and adults; look at threshold effects	1	
How can economics stimulate and measure progress in solid waste recycling, solid waste energy recovery, and retail product stewardship? Economic incentive approaches to waste reduction in the realm of corporate decision-making?		1
How can economics play a role in industrial ecology approaches to solid waste management?		
What role/direction can economics provide to OSW's RCRA 2020 vision?		
Valuation of avoided contamination of groundwater (specifically address non-use values)	1	1
Valuation of avoided acute events (explosions, toxic gas clouds, fires, major spills)		1
Effects of RCRA regulations on private-sector recycling decisions	1	
Success of extended product responsibility		1
Tools and database to cross-walk cost/sales to economic impacts (firm closures, profit reductions)		
Guidance or tools for translating engineering/out-of-pocket costs to social costs	1	1
How do sociological values affect corporate or individual economic decisions?		1
Intergenerational equity issues: What premium does society place on future generations?		1
Valuation of ecological services: ecosystems, groundwater, biodiversity	3	2
Tradable permit program for hazardous waste		1
Nonconstant or differential (between benefits and costs) discount rates	3	
Additional benefits from P2 (versus remedial activities)		1
When is it cost-effective to segregate waste by retrofitting a facility rather than shipping commingled waste offsite?		
Liability thresholds for onsite waste management		
Understand social cost of using virgin materials vs. reuse	1	1
Sustainability analysis (renewables vs. nonrenewables)		2
Looking at ways to fortify existing hazardous waste markets; improve profitability, improve participation/coverage; achieve with incentives, regulatory, and nonregulatory programs		
Equity and EJ		1
<b>Total Votes</b>	<b>15</b>	<b>15</b>

**OSWER/OUST Meeting 08-5-02**

**ORD:** Will Wheeler

**NCEE:** Chris Dockins

**OUST:** Maricruz Magowan

Topic	Votes (%)	
	ST	LT
Average cost of an Office of Underground Storage Tanks cleanup (preferred by state or by region)	40	
What is the average cost of training one inspector? Ideal number of inspectors? Ideal frequency of inspection?	20	
Benefits of revitalization of sites/underground storage tank fields	10	15
Database: age of tanks	5	
Economic evaluation of leaks: frequency and causes	5	10
Evaluation of the Leaking Underground Storage Tank Trust Fund financial assurance formula	20	15
Benefits of increased expenditures on cleanup		10
What economic factors drive owner and operator decisions? What opportunities would be more profitable and/or increase compliance?		15
Database: location of tanks		35
<b>Total</b>	<b>100</b>	<b>100</b>

**OW/IO Meeting 4-25-02**

**ORD:** Matt Clark, Will Wheeler

**NCEE:** Chris Dockins

**OW:** John Powers, Mahesh Podar, Ron McHugh

Topic	Votes	
	ST	LT
A framework for ecological service valuation to comprehensively estimate benefits	3	
Water quality/quantity interactions; cause climate change on quantity (feeds into ecological valuation)		2
Monetization of QALYs/disability-adjusted life-years (DALYs)		
Monitoring technologies that make trading feasible and improve assessments	2	
Institutional constraints (transaction costs) affecting transition from technology-based regulations to an incentive-based regulatory system (e.g., from effluent limit guidelines [ELGs] to tradable limits—total maximum daily loads [TMDLs]); this transition is difficult because institutions support existing structures.	2	
CGE models that can be used in regulatory decision-making		2
Systematic framework for valuing mortality/morbidity	2	
Integrated regional assessments of watersheds (e.g., hypoxia in Gulf)		

continued ►

Topic	Votes	
	ST	LT
Trading in the context of TMDLs, multipollutant and multi-TMDL (scale); also between rivers		3
Creating markets for multiple service flows between stakeholders		2
Systematic strategy for environmental priority-setting		
<b>Total Votes</b>	<b>9</b>	<b>9</b>

**OW/OGWDW Meeting 2-28-02**

**ORD:** Matt Clark, Will Wheeler

**NCEE:** Brian Heninger

**OW:** John Bennett, Tricia Hall, Becky Allen, Ephraim King

Topic	Votes	
	ST	LT
Cost-effectiveness analysis, especially regarding life-years or QALYs as a subset (how to respond to a request for these analyses). How much dose-response information (by age) do you need for a life-years extended analysis?	2	1
Reproductive and developmental valuation (e.g., miscarriages and stillbirths)	1	2
Focus on treatments costs; need social costs of regulations	1	2
OGWDW uses a decision tree to predict technology adoption and cost estimation; discovered tree was inaccurate (facilities adopt management practices or get new sources in lieu of treatment; treat for taste and odor; install technologies at the same time). How to improve understanding of decision processes; retrospective studies are one avenue.	3	
Integration of the Safe Drinking Water Act and Clean Water Act/interaction of treatment cost savings	2	4
Valuation of leisure time		
Value of gastrointestinal (GI) distress incidents (U.S. Department of Agriculture uses cost-of-illness [COI] approach.)	1	
Data needs for QALYs		
Application of qualitative endpoints when national incidence is not known		
Characterization of uncertainty in benefits estimates		
Valuation of health endpoints for children and the elderly	1	1
Variation in mortality value (willingness to pay [WTP] for cancer death vs. accident; age; voluntariness; dread, etc.)	1	1
Alternative risk-reduction measures (e.g., seat belts vs. drinking water contamination): If risk reductions come from different budgets, how do you compare them?		2
Costs to parents of a child's illness		
MM&Is in a drinking water context	1	
Life-years cost-effectiveness analysis	2	2
<b>Total Votes</b>	<b>15</b>	<b>15</b>

**OW/OST Meeting 5-7-02**

**ORD:** Becki Clark, Matt Clark, Will Wheeler

**NCEE:** Lanelle Wiggins

**OW:** Chris Miller, Bill Anderson, Nick Bouwes, James Covington, Renee Johnson, Kristen Strellec

Topic	Votes	
	ST	LT
Defining new water quality uses (guidance on widespread economic impacts for states, regions)		
Valuation of noncancer morbidity effects from toxic pollutants	1	1
WTP values that reflect latency period so they can be applied at time of exposure	2	1
EJ: How do our rules affect communities? Benefits of improved EJ		2
How do you incorporate growth factors into impact analysis? Incentives for smart growth	3	
Tradable permits; TMDLs vs. water-quality standards vs. ELGs: How do you design them to work? Focus on market mechanism issue (add development credits)	1	2
Intergenerational impacts; how discounting affects future generations: Should it be done?	1	
A retrospective study; how ELGs affected industries/small businesses that have been regulated		2
Cancer mortality risks (better link between risk and human health/mortality) with dose-response function		1
WTP to avoid risk of various health endpoints from major pollutants		
Guidance on assessing financial impacts to individual firms/facilities (e.g., consistency/ what to use depending on kind of data/industry)	1	2
Measuring impacts on nonpoint/agricultural sources, other nontraditional industries; little guidance available on impacts to noncorporate structures	2	2
Ecological valuation; impacts from removal of nutrients/total suspended solids	2	1
Valuation of avoided pathogen exposure to humans, wildlife, agriculture	2	
QALYs	2	
Environmental ethics (e.g., EJ, QALYs, impacts on nonhumans, intergenerational)		1
Benefits from reduction in ammonia and hydrogen sulfide air emissions		
Environmental accounting/impacts linked to environmental accounts		1
Effectiveness of voluntary programs (e.g., an EMS)	1	2
<b>Total Votes</b>	<b>18</b>	<b>18</b>

**OW/OWM Meeting 4-29-02**

**ORD:** Will Wheeler, Matt Clark

**NCEE:** Julie Hewitt

**OWM:** Laura Palmer, Ginny Kibler

Topic	Votes	
	ST	LT
Documenting market failures based on a lack of information about the environment or about how their actions affect the environment		2
Agricultural impacts: <ul style="list-style-type: none"> <li>■ Value of impacts from agricultural pollution on groundwater and surface water</li> <li>■ Health and ecological effects of agricultural pollution on groundwater and surface water quality</li> <li>■ Impact of aquatic animal production (aquaculture) on surface water quality: When is benefit transfer okay?</li> </ul>	1	
Issues in water quality valuation: <ul style="list-style-type: none"> <li>■ Do people value water that is not new to them?</li> <li>■ Valuation of small vs. large streams; small streams that feed into large streams</li> <li>■ Are water-quality values sensitive to recreational or other uses?</li> </ul>	1	1
Value of produced species relative to natural species (invasive threat, substitution benefit)	1	1
Management practices: <ul style="list-style-type: none"> <li>■ How to measure cost-savings from improved management of collection system (i.e., sewer)</li> <li>■ Tradeoff of operation and maintenance vs. future capital</li> <li>■ What are the costs and benefits of improved management practices?</li> </ul>	2	
WTP or COI values of avoiding specific illnesses (earaches, headaches, coldlike, non-GI, GI) with different durations		1
QALYs		
Replacement for Mitchell-Carson study approach for large national rules		1
How to account for baseline closures		
How to handle 1-year (or limited) data in a cyclical industry		
<b>Total Votes</b>	<b>5</b>	<b>6</b>

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PEER REVIEW COMMENTS

United States  
Environmental  
Protection Agency

EPA Science Advisory  
Board Staff Office (1400F)  
Washington DC

EPA-SAB-04-007  
July 2004  
[www.epa.gov/sab](http://www.epa.gov/sab)



**Review of the Environmental  
Economics Research Strategy  
of the U.S. Environmental  
Protection Agency**

**A Report by the  
EPA Science Advisory Board  
Environmental Economics Advisory  
Committee**



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

OFFICE OF THE ADMINISTRATOR  
SCIENCE ADVISORY BOARD

July 9, 2004

EPA-SAB-04-007  
The Honorable Michael O. Leavitt  
Administrator  
U.S. Environmental Protection Agency  
1200 Pennsylvania Avenue, NW  
Washington, DC 20460

Subject: Review of the *Environmental Economics Research Strategy* of  
the U.S. Environmental Protection Agency; A Report by the  
EPA Science Advisory Board

Dear Administrator Leavitt:

This letter transmits the advice of the U.S. EPA Science Advisory Board (SAB) Environmental Economics Advisory Committee (Committee) on the U.S. EPA's *Environmental Economics Research Strategy*. The Agency asked the SAB to consider a number of issues, including whether the Research Strategy adequately characterized the major research gaps in key areas and addressed the issues of greatest scientific uncertainty; whether the research was feasible and likely to generate high quality results in a timely manner; what valuation methodology research should be investigated, whether the agency had missed any issues of overriding importance, and how best to communicate the research needs to the wider research community.

The Committee focused on five key areas of research; valuation of human health and ecological benefits of environmental improvement, environmental behavior/decision-making, market methods/incentives, and benefits of environmental information disclosure.

In general, the Committee concluded that the Research Strategy adequately characterizes the major research gaps in the literature for the benefits of human health and ecological risk reduction and that the research could generate high quality, useful information in a reasonable time frame. The Committee noted that valuation of human health risk reduction benefits should consider the reliability of existing estimates of the value of

statistical life and that research should also be conducted on the issue of marginal versus non-marginal risk valuation. In addition, the Committee emphasized that to be most valuable, there must be a high level of interaction between economists and ecologists in the area of ecological benefits research.

The Committee noted that in spite of the focus of the academic literature on nonmarket valuation methodologies, some areas of valuation still would not receive appropriate funding without EPA attention and interest. The Committee listed a number of examples of methods research that would be of importance for the agency.

The Committee provided information on several environmental compliance and decision making issues and noted that this is one of the most important research topics for the agency. They strongly urged that research should focus on overall environmental behavior, not just compliance. The Committee stated that the ultimate goal in this area is to understand why firms differ in the amount of pollution they create (or “in pollution intensity.”) A number of additional research topics were identified by the Committee.

In the area of market mechanisms and incentives, the Committee believed that the Agency has identified some extremely important areas for future research and that the research could lead to high quality results. However, the Committee judged the proposed research to be too limited in its focus and they identified some additional areas for Agency consideration.

The Committee agreed with the Agency on the importance of environmental information disclosure and agreed that there is no generally accepted method for estimating the benefits of these programs. A first step in estimating the benefits of such programs is to accurately estimate their impacts on emissions and ambient pollution. Additional research in this area is certainly required. The Committee also suggested that the agency contrast the cost-effectiveness of environmental information disclosure with the cost-effectiveness of traditional approaches to pollution regulation. The Committee noted that studies of the effectiveness of information disclosure under the Emergency Preparedness and Community Right-to-Know Act of 1986 could provide valuable information regarding the viability of such policies to reduce the environmental component of terrorism risk.

Finally, the Committee recommended 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.

We appreciate the opportunity to review, and to provide you with advice on, the EPA's draft *Environmental Economics Research Strategy*. We look forward to your response to this report.

Sincerely,

/Signed/

Dr. William H. Glaze, Chair  
EPA Science Advisory Board

/Signed/

Dr. Maureen Cropper, Chair  
Environmental Economics Advisory Committee  
EPA Science Advisory Board

## NOTICE

This report has been written as part of the activities of the EPA Science Advisory Board, a public advisory committee providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names or commercial products constitute a recommendation for use. Reports of the EPA Science Advisory Board are posted on the EPA website at: <http://www.epa.gov/sab>.

**U.S. Environmental Protection Agency  
Science Advisory Board  
Environmental Economics Advisory Committee  
Advisory Panel on the Environmental Economics Research Strategy**

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**Mr. Thomas Miller**, U.S. EPA Science Advisory Board Staff Office, Washington, DC

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**Review of the *Environmental Economics Research Strategy* of the U.S.  
Environmental Protection Agency: A Report by the  
EPA Science Advisory Board**

## 1. INTRODUCTION

### 1.1 Background

This report transmits the advice of the U.S. EPA Science Advisory Board (SAB) on the EPA's *Environmental Economics Research Strategy*. This report was prepared by the Environmental Economics Advisory Committee subsequent to its review which began during November, 2003. The review was announced in the *Federal Register* (see 68FR61206).

### 1.2 Charge to the Science Advisory Board

The Environmental Economics Advisory Committee (EEAC) was requested to review EPA's Environmental Economics Research Strategy. Specifically, the EEAC was asked to address the following charge questions:

1. For each of the major subject areas described in the EERS, EPA has attempted to articulate the research questions most relevant to EPA that can be effectively addressed given the available tools and resources. In this context, please address the following for the key research questions identified in the EERS in each of the subject areas.
  - a) Is the characterization of each of the major research gaps in the literature for the key subject areas of relevance to EPA's economic sciences, as identified in the EERS, adequate? Will these priorities and implementation approaches effectively address the areas of greatest scientific uncertainty?
  - b) Given the implementation strategy laid out in the EERS;
    - To what extent is this research scientifically feasible at a high level of quality?
    - How successful is this research likely to be in answering policy-relevant questions for EPA within the next 8-10 years?
  - c) What improvements in the design and implementation of the EERS would make each research project more useful to EPA and other environmental management agencies?
2. What methodological research needs in valuation should EPA investigate as a complement to the needs derived from the strategy interviews? In the valuation areas, EPA's expressed needs are primarily practical: better values for ecological and human health impacts of environmental policies. However, most grant proposals (and most journal articles) investigate practical questions as well as methodological or other questions (e.g. incentive

compatibility or elicitation methods in stated preference or more refined models of behavior in revealed preference). EPA does not expect that researchers will propose to estimate only the practical values that EPA needs, but will also propose to investigate methodological issues. Since the research strategy interviews did not elicit methodological needs, and EPA believes that improving methodology while generating practical values provides useful synergy, further input on prioritizing methodological issues from the EEAC would be useful.

3. Can the SAB identify by consensus any environmental economics issues of overriding importance to EPA that the EERS has missed, and that EPA should address provided that more resources would be available for Environmental Economics Research? Could the SAB explain why this (these) issue(s) should be of high concern to EPA's research programs.
4. What is the best way for EPA to communicate the results of the research strategy and plans for achieving its long-term research goals to the wider research community, and other potential users?

In addressing these questions the committee focused on the five key areas in which EPA identified additional research needs:

- a) Valuation of the human health benefits of environmental improvements
- b) Valuation of the ecological benefits of environmental improvements
- c) Environmental behavior and decisionmaking
- d) Market methods and incentives
- e) Benefits of environmental information disclosure

### **1.3 Format of this Report**

The Science Advisory Board's answers to Charge Questions 1 and 2 are presented by research area. The discussion begins by summarizing EPA's research priorities in each area, and then answers Charge Questions 1 and 2. Charge questions 3 and 4 are answered at the end of document.

## 2. ANSWERS TO CHARGE QUESTIONS 1 AND 2

### 2.1 Valuation of Human Health Benefits of Environmental Improvements

#### 2.1.1 Characterization of Research Gaps and Priorities

*Is the characterization of each of the major research gaps in the literature adequate? Will these priorities and implementation approaches effectively address the areas of greatest scientific uncertainty?*

Most of the literature on human health valuation has focused on mortality valuation—measuring what individuals will pay for small reductions in their risk of dying in a specified time period. As the EERS notes, much less effort has been invested in measuring what people will pay to avoid episodes of acute illness or to reduce their risk of contracting a chronic illness (morbidity valuation).<sup>1</sup> As a result, many health endpoints are not monetized in Regulatory Impact Analyses; or their value is measured by productivity gains and avoided medical costs, which are a lower bound to the appropriate measure of value. In the area of morbidity valuation, the EERS (p. 10) calls for valuation of non-cancer endpoints; earaches, headaches, colds, gastrointestinal upsets, reproductive and developmental effects (e.g., Attention-Deficit Disorder, autism), and cancer-related morbidity effects. On p. 15 of the research strategy, more emphasis is put on chronic health effects. The EERS notes that it is important to allow valuation to depend on severity, duration and frequency of symptoms. Emphasis is also put on valuing children’s health.

According to the EERS, the main needs in mortality valuation (p. 16) focus on the impact of age on the Value of a Statistical Life (VSL) and on the impact of the health status of the individual and co-morbidity (illness preceding death) on the VSL.

The committee agrees with the Agency’s assessment on the lack of estimates of the value of morbidity risk reduction benefits. Willingness to pay (WTP) estimates are indeed unavailable for many cancers, as well as for risks of heart attacks and strokes. WTP estimates for the other health endpoints noted in the first paragraph are also lacking. In many cases, the productivity losses and medical costs associated with illness are not born by the individual. If this is the case, estimates of productivity losses (the so-called indirect costs of illness) and medical costs (the direct costs of illness) must be added to WTP estimates. Estimating these illness costs is itself a research task whose importance should not be underestimated.

Regarding the Agency’s priorities in the area of mortality valuation, the impact of age on the VSL is an important, policy-relevant topic. Any environmental regulation that saves lives in proportion to the age distribution of deaths in the U.S. will primarily extend the lives of older people. (Fifty percent of the deaths in the U.S. occur after age 75.) Regarding the impact of health status and co-morbidity on the VSL, the important issue here is whether environmental pollution causes chronic illness or simply increases mortality risk for people

<sup>1</sup> WTP estimates exist for reduced risk of chronic bronchitis and for some cancers, as well as for asthma attacks, restricted activity days and symptom days.

who have pre-existing chronic conditions. When environmental contaminants cause a disease, it is theoretically desirable to value the risk of contracting the illness (such as cancer) which will entail both morbidity and a reduction in life expectancy. If pollutants differentially affect mortality risk for those with a pre-existing condition (e.g., cardiovascular disease), then efforts should be put on measuring the impacts of the health state on the value of increasing life expectancy.

There are three topics in the area of mortality risk valuation that the committee believes deserve attention even though they are not mentioned in the EERS. The first concerns the reliability of existing estimates of the VSL, which rely on labor market and on stated preference studies. The Agency has recently commissioned re-analyses of data from compensating wage studies (Black, Galdo and Liu 2003) and of data from contingent valuation studies of mortality risks. Examination of these results may suggest that emphasis should be placed on developing newer, more reliable estimates of the VSL.

The second research topic concerns the issue of marginal versus non-marginal risk valuation. Emphasis in the literature is on valuing small changes in risk of death, on the order of 1 in 10,000 per year or smaller. The agency, however, uses these estimates to value regulations that, together, account for much larger risk reductions. To illustrate, *The Benefits and Costs of the Clean Air Act 1970-1990* (USEPA 1997) predicted that air quality regulations issued between 1970 and 1990 reduced mortality by 200,000 lives in 1990. When a VSL of \$4.8 million (1990 USD) was applied to these statistical lives, the WTP in 1990 for mortality risk reductions occurring in that year was estimated to be approximately \$16,000 (1990 USD) for a family of four.<sup>2</sup> This was because the VSL was applied to a non-marginal reduction in risk of death (on average, a 1/1,000 reduction). Similarly large benefit estimates may arise when one adds together WTP for the risk reductions associated with the 1990 Clean Air Act Amendments, the Tier II Emissions standards, the Heavy Duty Engine Diesel Rule, the Off-Road Diesel Rule and Clear Skies. In short, while a single regulation may confer marginal risk reduction benefits, the set of environmental regulations evaluated over a 10-year period may confer non-marginal benefits, and should be evaluated accordingly.

The third research topic concerns the impact of income on the VSL. Historically EPA has adjusted future values of the VSL to allow for income growth. Such adjustments require estimates of the income elasticity of WTP for mortality risk reductions. We believe that this is a topic that requires additional research.

### **2.1.2 Research Feasibility**

*Given the implementation strategy laid out in the EERS; --To what extent is this research scientifically feasible at a high level of quality? --How successful is this research likely to be in answering policy-relevant questions for EPA within the next 8-10 years?*

<sup>2</sup> The total value of the statistical lives saved, \$1 trillion, when divided by the population of the U.S. in 1990, implies a WTP of approximately \$4,000 per person.

There are several criteria to consider in formulating a research strategy for morbidity valuation:

- a) The approach taken should be able to evaluate a large number of health endpoints.
- b) It should, ideally, value the *risk* of avoiding chronic illness rather than avoiding the illness with certainty.
- c) The definition of health endpoints should take into account the severity, duration and frequency of symptoms.
- d) The health endpoints valued should correspond to those linked to environmental pollutants in the epidemiological literature.

An important question, related to mortality valuation, is whether chronic morbidity and mortality should be valued as part of the same package. For example, should people value the risk of developing congestive heart failure as the risk of experiencing a series of hospital episodes, recurring discomfort and shortened life span? Or, should the impact of air pollution on the morbidity associated with congestive heart failure be valued separately from the impact of air pollution on the mortality associated with congestive heart failure? The answer to this question depends crucially on the point articulated in item 'd' above. If the epidemiological literature suggests that air pollution increases risk of death due to congestive heart failure (and other forms of heart disease), but does not link air pollution to increased incidence of the disease, then valuation should mirror this approach. For diseases where environmental contaminants may actually increase the risk of contracting the disease (e.g., for some cancers) then, assuming that people can comprehend both the risk of the disease and its sequelae, the goal should be to value the morbidity and mortality risks as a single package.

Regarding the number of health diseases to be valued, a possible approach to dealing with the point articulated in item 'a' above is to have people value functional limitations (characterized by severity, duration and frequency) which, in turn, are related to illnesses. This is likely to work best for chronic illnesses and less well for acute illnesses. Obtaining reliable values for the *risk* of an illness will remain a challenge. One potential area of research is to examine whether it is possible to use information contained in measures of health preference, such as quality adjusted life years (QALYs), that are used in other public-health domains to provide a method for transferring benefit estimates from one health endpoint to another.

Regarding estimates of the value of mortality risk reductions, it would seem that stated preference methods are the main candidates for studying the impact of age and health status on WTP, although it may be possible to use revealed preference methods for the impacts of age in the context of auto safety. (Labor market data probably cannot be used to estimate WTP for ages greater than about 65 because of the relatively small fraction of the elderly who are employed (Viscusi and Aldy 2003)). The use of both stated and revealed preference methods to value reductions in risk of death is advisable. Regarding the issue of valuing non-marginal risk changes, this is certainly feasible using stated preference approaches. Recent advances in dealing with the identification problem in hedonic markets suggests that this should also be feasible in a revealed preference context (Heckman, Matzkin and Nesheim 2003).

The committee believes that progress in the area of health valuation can be made, with appropriate funding, within the next 8-10 years. We believe that for these efforts to be successful, and to yield high-quality research, it is essential that the economists conducting the research work together with epidemiologists to ensure that health effects valued match up with those examined in the epidemiological literature, and with physicians to ensure that any health status indices that are used to facilitate evaluating a large range of health endpoints are appropriate to the task

### **2.1.3 Usefulness of the Research**

*What improvements in the design and implementation of the EERS would make each research project more useful to EPA and other environmental management agencies?*

The committee believes that it is important to measure the impact of household characteristics on WTP for both morbidity and mortality benefits. This is important if the Agency is to examine the distributional impacts of environmental policies. It is also the case that certain air pollution epidemiology studies distinguish health effects by socioeconomic status (e.g., Pope et al. 2002). Making these distinctions in terms of valuation would make it possible to further refine the distributional impacts of air pollution control strategies.

## **2.2 Valuation of Ecological Benefits of Environmental Improvements**

### **2.2.1 Characterization of Research Gaps and Priorities**

*Is the characterization of each of the major research gaps in the literature adequate? Will these priorities and implementation approaches effectively address the areas of greatest scientific uncertainty?*

The EERS identifies a number of endpoints for which valuation of ecological services will be useful. These endpoints include water quality changes, ecological impacts of air pollution, introduced versus native species, avian species, etc. While this way of thinking about the benefits of ecosystem improvement is consistent with how economists view the valuation of many goods, this single endpoint focus is not generally consistent with how ecologists view ecosystem functioning. For research in ecological benefits to be most valuable, there must be a high level of interaction between economists and ecologists. To begin, there must be a broad understanding of the way in which ecologists view ecosystem functioning. For example:

- a) The research plan refers to “outcomes” as if ecosystems are mechanical,” i.e., when the level of an insult increases the ecosystem has predictable new equilibrium outcomes. This characterization of ecosystem dynamics may be appropriate in some cases, but this is not the way ecologists think about ecosystem responses generally. Rather, they tend to think of ecosystems as constantly changing, with different levels of insult affecting the course of change. Even if there is an equilibrium, the equilibrium may not be reached for

decades or a century, so outcomes have to be thought of in a more dynamic way. On the other hand, ecologists do think of the services provided by well functioning ecosystems as something that can be characterized and assessed. This may be the point at which ecologists and economists can best find common ground.

- b) Ecologists are more concerned with thresholds and irreversibilities in ecosystems than in the pros and cons of changing from one equilibrium to another. One of the effects of a change may be that the ecosystem is less resilient to the next insult, so alternative scenarios of future insults need to be explored, not one-time changes.
- c) This brings us back to earlier efforts to tackle cumulative effects. Ecologists do not think of stresses as being separable. Hence they are more “conservative” than economists who are comfortable with the assumption that stresses are separable and hence can be considered “on the margin.” For ecologists, the order of stresses also can be important. The earlier efforts of economists to understand cumulative impacts should probably be reviewed as a starting point for moving forward in this respect.

While it would be nice if ecologists could simply provide predictions of ecosystem behavior to meet economists’ specifications of what they need, the fact of the matter is that ecologists are the experts on ecosystems. Implying that the economists need something that is contrary to the expertise of ecologists may not be a good starting point for what has to be a joint project. The research strategy should address how economists and ecologists in the Agency can learn more about what each other knows and how they can develop shared understandings, language, and models. Rather than valuing changes in a single service from an ecosystem, e.g., increased avian species or increased fish catch, it may be appropriate to work with ecologists to value the entire bundle of service changes associated with a change in an ecosystem from one state (perhaps one with a low level of function generally) to another (one that supports on average more species diversity, more resilience to external shocks, etc.).

Research on the benefits of ecological systems and services will necessarily need to be ecosystem specific. While “outcomes” for human health effects are many and are probably sensitive to the age at which the problem occurs, they are going to be pretty much true whether a person lives in Phoenix or Philadelphia. For ecosystems, while there are classifications of ecosystem types that will prove helpful, there are going to be a considerable number of types. The condition of the ecosystem for which an additional stress is being considered also will be important. Of course, the conditions of people experiencing an environmental stress are also important, but the stress is generally experienced by a large population of people whose conditions can be understood in statistical terms. Decisions on ecosystems will much more likely be taken one system at a time.

The EERS recognizes the large reliance the agency places on benefits transfer and the likely need to continue this reliance. They suggest that a “cost-effective strategy may be to investigate methods that generate theoretically sound values for multiple endpoints.” The

committee generally agrees with the logic of this idea, but the Agency should consider that the highly contextual nature of ecosystem services may make transfers even more challenging than when single endpoints can be focused upon. Benefits transfer in the case of ecosystems is exceptionally challenging.

One important issue noted in the document is the fact that ecosystem services and functioning are not well understood by the general public, thus complicating the process of valuation. In addition to eliciting the value of ecosystem changes, the valuation process usually requires some education of the public. This has important implications for the resulting values and for the resulting use of benefits transfer.

The relationship between physical measures of ecosystem functioning (pollution concentrations in water or air, number of species present in a land area, etc), features of an ecosystem that people perceive and the perception of the ecosystem by people is poorly understood. Since this linkage is critical for valuation, this is an area of research that might yield high returns to EPA and other agencies.

The inherent uncertainties in ecosystem functioning make the need to characterize uncertainty in the valuation process particularly important when ecosystem values are sought. This is an area where additional work could be focused. Likewise, additional work on the implications of the “precautionary principle” and cost-benefit analysis when irreversibility and uncertainty is present may prove beneficial. Another feature that merits focus is the implication of threshold effects and valuation of large rather than marginal changes. Valuation for dynamic systems and the consequences of valuing changes in ecosystem services under very long time scales are also issues that EPA may wish to consider. Again, these features may be unique to ecosystem valuation as distinct from health endpoints or other nonmarket goods.

Among nonmarket values for ecosystem services, nonuse values are the poorest understood, yet they have the potential to be very large in magnitude. This implies that research that focuses on nonuse values may have the highest returns.

Some committee members felt that materials damage and losses of visibility from pollution should also be included among environmental benefits to be studied.

### **2.2.2 Research Feasibility**

*Given the implementation strategy laid out in the EERS; --To what extent is this research scientifically feasible at a high level of quality? --How successful is this research likely to be in answering policy-relevant questions for EPA within the next 8-10 years?*

The committee sees considerable return on research in the area of ecosystem valuation. With adequate funding, the Agency is likely to see information that is very relevant for policy questions being produced.

### 2.2.3 Usefulness of the Research

*What improvements in the design and implementation of the EERS would make each research project more useful to EPA and other environmental management agencies?*

Many of the ecological benefits measures needed by EPA would also be of value to other government and public agencies. Specifically, the U.S. Army Corps of Engineers, USDA, Forest Service, and many Nongovernmental Organizations and state agencies would find ecological benefits work to be highly valuable. EPA should find ways to share research results as well as consider jointly funding and identifying needed research on ecological benefits.

One of the needs identified in the report is for valuation of reductions in pesticides in water, but in many parts of the country, nutrients are as much or significantly more of an issue. Nitrogen is a clear problem for hypoxia, while phosphorous and other nutrients are important for local water quality problems in much of the Midwest.

A centralized team of economists in Washington D.C. may not be the ideal configuration of economists for undertaking research that is going to be inherently more contextual than other types of environmental economic research. More economists are probably going to be needed in the regional offices to carry out ecosystem valuation effectively. This activity could also be enhanced by the use of non-EPA economists (outside of Washington) with expertise in ecosystems analysis.

### 2.3 Valuation Methodologies

*What methodological research needs in valuation should EPA investigate as a complement to the needs derived from the strategy interviews?*

As noted in the Research Strategy much of the academic literature in nonmarket valuation focuses on methodological development. While this implies that a substantial amount of methodological work may be produced without impetus from EPA or other agencies, there are some areas of valuation where the needed methodological refinements may not be as forthcoming as others. In particular, some areas may not be viewed to be as methodologically interesting as others, but may still be critical to improving the accuracy of nonmarket valuation in the context of ecosystem services. The committee identified the following topics as being of particular value to EPA programs:

- a) Improved methodologies and tools for benefits transfer as well as increased understanding of the range of uncertainty associated with the transfer of values from one study site to another. Given the enormous reliance that EPA and other agencies make on the transfer of benefits to perform benefit-cost analysis, considerable gains from additional understanding of this process may be possible.
- b) Increased understanding of the appropriate extent of the market when taking welfare estimates from individual values and aggregating them to the full population (this is

particularly important for nonuse values). There is both the issue of having the appropriate sampling frame from which to compute per household benefits (e.g., a random population survey versus a sample of people visiting a shopping mall) and the issue of how much of the general population to apply these values to (e.g., households in close proximity to the impacted resource, all households in a certain political jurisdiction, all households in the world?).

- c) Further study of the WTP-WTA divergence literature. In many cases a strong argument may exist for the use of a WTA valuation rather than WTP based on explicit or implicit property rights.
- d) Increased understanding of the appropriate valuation of the opportunity cost of time in revealed preference studies. This concern relates primarily to recreation demand studies, where different assumptions about the value of time can yield differences in the estimates of welfare changes by a factor of two or more.
- e) Improved bid design methods for stated preference surveys. Discrete choice stated preference surveys require the researcher to define the bid distribution for respondents. Potential bias and inefficiency from suboptimal bid design are not well understood.
- f) While a growing literature in the valuation field combines stated and revealed preference information to jointly estimate the parameters of welfare measures, there may be substantial gains to EPA and other agencies from furthering work in this area. The combination of stated and revealed preference data enjoys the prospect of grounding welfare estimates in observable behavior while allowing for a much broader category of benefits to be studied with the inclusion of stated preference information.

## 2.4 Environmental Compliance Behavior and Decision-Making

### 2.4.1 Characterization of Research Gaps and Priorities and Usefulness of Research

*Is the characterization of each of the major research gaps in the literature adequate? Will these priorities and implementation approaches effectively address the areas of greatest scientific uncertainty?*

*What improvements in the design and implementation of the EERS would make each research project more useful to EPA and other environmental management agencies?*

This topic is one of the most important research priorities faced by the EPA. Judging from the survey of EPA program offices, this topic is tied with "Valuation of Reduced Morbidity Benefits" for the highest priority. Several research questions are highlighted, including: a) Why and how do facilities comply; b) What policies or approaches increase compliance; and c) How successful have voluntary programs been? The Committee offers the following comments on the research goals:

a) Previous EPA funded results. It would be helpful to assess how successful the previous Science To Achieve Results (STAR) competitions on Corporate Environmentalism have been.

b) Breadth of research area. This research priority area is termed *Environmental (Compliance) Behavior and Decision-making*. It is unclear whether the focus is limited to compliance-related behavior or whether this priority area is intended to include broader issues relating to environmental behavior. Some of the specific questions raised in this context (e.g., location, technology adoption, and pesticide use) do not involve compliance directly. They are questions about how firms make decisions that have environmental implications. The Committee believes that this is the correct perspective on this issue. Ultimately, EPA's goal should be to understand why some firms pollute more (per unit of input or output) than others. This may depend on the nature or environmental regulations and their enforcement, but will also depend on the costs of reducing emissions.

If the focus is on compliance alone, then it is not clear why the questions relating to voluntary programs are included, since by definition voluntary programs do not entail "compliance" with existing rules or regulations. The study of voluntary programs would fit more closely with the research about information disclosure. Alternatively, if this priority area is intended to be broader, then the research on information disclosure could be folded into this priority area.

c) Feedback from regulated industries. Traditionally, research on compliance and enforcement has treated the policy process as linear. The regulator first designs and imposes a policy, then an enforcement strategy (e.g., an audit frequency and penalties for non-compliance), and then the polluting firm decides whether or not to comply. Some research on enforcement and compliance might benefit from considering a more interactive model, under which regulators and regulated parties work together to identify pollution sources and means to address them. Monitoring and information generation are key parts of such a strategy. One example is EPA's Clean Charles 2005 Initiative. (Again, this suggests that the research priority area on information disclosure is closely linked to this priority area.)

d) Public sector compliance. Most of the compliance and enforcement literature studies private-sector polluters. Other sources, such as municipalities, have received relatively little attention. Yet in some contexts these constitute the primary pollution sources (e.g., water pollution). Thus, the scope of the research priority should be sufficiently broad to include not only decisions by private polluters but also by public sources.

e) Unobserved determinants of behavior. The existing literature has understandably focused on easily observable determinants of environmental decisions: firm size, industry group, etc. However, less easily observable motivational factors may be more important in explaining the environmental behavior of a particular firm. Information about these factors comes primarily from case studies, which are often

viewed as anecdotal. Therefore, it seems appropriate for EPA to fund research that seeks to provide statistical evidence regarding firm decision-making, as well as more in-depth case studies of the behavior of individual firms.

f) Market incentives. A key question that needs to be addressed (statistically and through case studies) is whether market incentives for environmental protection (e.g., from consumers, communities, suppliers, or investors) are sufficiently strong. Again this relates closely to the effect of information disclosure, since information disclosure is likely to increase these pressures. Instead of thinking about voluntary approaches and information provision as substitutes for more traditional regulations, they may be thought of as complements.

g) Cost-effectiveness. Most studies focus on accounting costs of compliance, and ignore things like the transactions costs of dealing with regulators, liability costs, and adverse publicity. It would be worth considering these broader definitions of costs.

h) Market structure. Regulations may have different effects on industries with different market structures.

i) Appropriate fines. The EPA's current practice requires firms caught violating environmental regulations to pay fines equal to the profits they earned as a consequence of their violations. It is an open research question whether this is in any way optimal. Research could also be conducted on the use of resource-based compensation in lieu of fines. Sometimes violators can avoid fines by undertaking restoration or enhancement activities of great value than the fine. The desirability and effectiveness of non-monetary penalties need to be better understood.

j) Ex-ante versus ex-post estimates of compliance costs. *Ex-ante* estimates are typically higher. This may be due to strategic industry overstatement of costs, or because technological improvements are not foreseen. Research on the difference between *ex-post* and *ex-ante* estimates would be useful to researchers assessing future proposed regulations.

k) Data. Several researchers noted that state variation in approaches, fines, monitoring, etc., can be used to study these issues, but that state data are difficult for individual researchers to collect. A useful role for EPA may be to encourage states to collect data in a standardized way and to assist in compiling the data.

#### **2.4.2 Research Feasibility**

*Given the implementation strategy laid out in the EERS; --To what extent is this research scientifically feasible at a high level of quality? --How successful is this research likely to be in answering policy-relevant questions for EPA within the next 8-10 years?*

In general, Committee members felt that EPA researchers have identified an important area for research, and one that could lead directly to improvements in EPA efficacy, reductions in regulatory costs, and improvements in environmental quality. Key tasks for the EPA include: defining the scope of the research objective, assessing prior EPA funded research, and assisting with the unification and publication of monitoring and enforcement data.

In addition, the Committee noted that any research in this area will have to deal with the following problems:

- a) Enforcement actions are widely understood to be targeted at likely violators, and hence endogenous. Researchers cannot estimate the effect of inspections and enforcement on the probability of violating environmental laws without simultaneously estimating the effect of violations on enforcement. This task is difficult without knowing the procedures EPA or the states use to decide which facilities to inspect. For a seminal paper on this topic, see Magat and Viscusi (1990).
- b) A second empirical problem, noted by Harrington (1988), is that given the low probability of any particular firm being inspected, or punished given an observed violation, the overall level of compliance is surprisingly high. Some other phenomenon aside from regulatory enforcement must explain compliance: public relations, citizen suits, NGO actions, etc.
- c) A third empirical problem involves the availability of data. Much of the empirical literature focuses on the pulp and paper industries, due to the availability of water pollution enforcement data via the Permit Compliance System (PCS).
- d) Finally, this section of the research strategy asks to what extent voluntary pollution reduction programs such as the "33-50" program have succeeded. Answering this question requires facing another simultaneity problem: firms that have unobserved tendencies to reduce pollution are more likely to volunteer to do so. To accurately assess the efficacy of these voluntary programs, a researcher will need some exogenous variation in the programs, or some instrument for program participation. The Agency needs to be particularly attentive to opportunities to exploit exogenous variation in eligibility for particular programs so that valuable chances to assess the consequences of "natural experiments" are not missed. Labor economists have sensitized the discipline to the desirability of natural experiments for program evaluation. In particular, the Agency needs to be watchful whenever there are boundaries in some dimension (time, firm size, space) across which the assignment of firms to regulatory regimes is randomized by arguably external factors.

## 2.5 Market Methods and Incentives

### 2.5.1 Characterization of Research Gaps and Priorities and Usefulness of the Research

*Is the characterization of each of the major research gaps in the literature adequate? Will these priorities and implementation approaches effectively address the areas of greatest scientific uncertainty?*

*What improvements in the design and implementation of the EERS would make each research project more useful to EPA and other environmental management agencies?*

The Research Strategy combines the research priority “Market Mechanisms and Incentives [MMI], Trading” with the priority “Market Mechanisms and Incentives, Other than Trading” in its final list of research gaps (p. 19). The proposed research emphasis from the Office of Research and Development will be on “trading in practice and trading in new markets” (p. 29). These specific areas are mirrored in the identified research gaps on p. 19. Especially regarding “trading in practice,” the key questions that are identified are the environmental effects of trading and estimating the resulting cost savings. For new applications, the key questions are predicting the success of new markets and designing the markets to achieve both environmental and cost-reduction goals.

Some specific possible research areas that are mentioned include using market approaches for urban storm water management; programs for new pollutants and media; the complexities of tradable water quality permits in a world of multiple market distortions, lack of monitoring, and “cultural resistance to enforcement” (p. 20); the interactions of marketable permits with existing taxes; and market design questions.

The Committee believes the Research Strategy identifies some extremely important areas for future research but is too limited in its focus. The following are also areas worthy of inclusion in the MMI research program.

- a) Market mechanisms other than trading are notably absent from the discussion of research gaps. Exceptions include the brief mention of “environmental information programs” (p. 12) and “Methodology for evaluation of effectiveness of voluntary programs” (p. 26), which are already the subject of research priorities identified elsewhere in the EERS. The exclusion of other MMI instruments, or more generally incentive-based instruments, such as pollution taxes, abatement subsidies, scrappage schemes for old cars, and deposit-refund systems, unduly limits the policy approaches that merit study. For example, current environmental policy relies heavily on legal liability for environmental contamination, which is an incentive-based policy. The empirical effects of these policies are not well understood but are a promising area for future research because data exist from recent experience.

Although the language in the Strategy does not rule out study of mechanisms other than permits, the absence of their mention does not encourage it either. Research has shown that different market-based instruments vary in, for instance, their effects on technological change, their total costs to pollution sources, their effects on entry and exit in an industry, the potential for “double dividend” effects, and the political or social acceptability of the instruments. Exploration of the relative merits of other instruments would be a valuable area of study.

- b) The spatial and temporal effects of MMI also need further attention. For many, if not most, pollutants, the kind of cap-and-trade program exemplified by the acid rain program differs from the design of a trading program identified in economic theory because the spatial and temporal distribution of pollution determines pollution damages. For efficiency, the marginal damages at any given locale or time need to be considered. Even in the absence of information on marginal damages, a cost-effectiveness measure should take spatial and temporal effects into account, due to requirements in environmental laws to achieve site-based environmental targets (such as the National Ambient Air Quality Standards under the Clean Air Act). There has been little ex post assessment of the spatial effects of uniform trading ratios in cap and trade systems such as the 1990 Clean Air Act Amendments, the Ozone Transport Region’s NO<sup>x</sup> budget program, and the NO<sup>x</sup> SIP call trading program.

The spatial and temporal effects of MMI are important components for design of future programs as the nation addresses mercury and ozone as atmospheric problems and the use of TMDLs in water quality. Simple trading designs, such as a cap-and-trade system for marketable effluent permits, may not achieve environmental targets in all places. On the other hand, incorporating transfer coefficients, limiting trading regions, or otherwise accounting for spatial and temporal effects limits trading opportunities and thus reduces potential cost savings. Research should evaluate the tradeoff between achieving environmental goals and achieving cost reductions, and the administrative and scientific difficulties involved in more theoretically correct trading systems.

- c) The implications of monitoring and enforcement for the design of MMI policies should be an important part of the MMI priority. Monitoring can take at least two forms: one form measures actual environmental outcomes (e.g., ambient air or water quality), and another form ensures that the emissions or other factors for which a market is developed are measured at the source. Adequate monitoring of ambient measures can help tremendously in ensuring the success of MMI programs in achieving environmental goals in all locales. Research into ambient monitoring and the interaction with MMI requires involvement of environmental scientists, for example, to help identify the efficient placement and number of monitoring sites for achieving ambient goals. Monitoring of source behavior is necessary for the success of the markets: for example, if it is easy for sources to emit more than the number of permits they own, then the permit market as well as environmental quality will suffer.

- d) An important and controversial aspect of MMI programs has been the emergence of trading without a cap on aggregate emissions. Such programs have been labeled “open market trading programs” because they allow for new participants who may identify low-cost opportunities for emission reductions to enter the program. These programs have been widely criticized because of the absence of a strict emission cap, and the difficulty in observing and monitoring emission reductions. However, this generic approach has a broad application in the Clean Development Mechanism and Joint Implementation aspects of international efforts to reduce greenhouse gases, and it continues to be suggested at the state level in the US for control of conventional pollutants. Open market trading should be studied to identify its weaknesses (so that programs can be designed to avoid them), its track record, and its role as a transition to cap-and-trade programs.
- e) Another important area of study is the use of market approaches on indirect measures of the environment. For instance, it is typically almost impossible to measure nonpoint source pollution from a source, because the runoff cannot be observed. Instead, pollution policies are sometimes proposed for related goods, such as fertilizer use or Best Management Practices. Other examples include taxing gasoline instead of auto emissions and pay-at-the-pump auto insurance. When market instruments are applied to indirect measures, the environmental effects are much less understood; indeed, it is possible that adverse environmental outcomes might arise from unexpected substitutions or other unexpected effects.
- f) The interaction of MMI with existing taxes and other policies (such as agricultural programs) is an important area that deserves study. The General Theory of the Second Best suggests that improving one market in a world of multiple distortions may not improve welfare; hence, it is worth understanding whether the use of MMI might lead to adverse effects in unexpected ways and how the design of policies can be improved in this light. We would accord priority to three particular manifestations of the second best and the importance of pre-existing policies that have been found to be very significant in previous research.

One has to do with policies or subsidies for such areas as agriculture or energy, outside EPA’s jurisdiction, whose potentially significant environmental effects sometimes conflict with the goals of environmental policy. Other programs may have beneficial effects, and EPA may be able to learn from experience of programs in these other areas. For instance, the use of environmental targets in the USDA’s Conservation Reserve Program deserves study as an important application of subsidies promoting, or consistent with, environmental objectives of the EPA. This program and its Environmental Benefits Index might be modified to target water quality and achievement of TMDLs. Generally, there could be significant environmental and financial gains from greater cooperation and coordination of research and policy across agencies.

A second area is pre-existing tax or regulatory policy. EPA has previously funded work on the “tax interaction effect” and found this to be significant. Significant opportunity exists to improve this research by making it more accessible for policy makers and by introducing greater specificity and heterogeneity in the analytical and simulation models that have been employed to date. In general, further research that addresses the value (in a public finance context) and potential uses of revenues from environmental policies would be a very important contribution to policy design in general. For example, mandatory emission fees in severe nonattainment areas can be used to generate revenues to subsidize investment in emission control by firms or in infrastructure improvement that will reduce emissions.

Finally, state-level policies may interact in unforeseen ways with federal programs. For instance, states have adopted renewable portfolio standards (RPS) as a way to influence technology choice and environmental performance in electricity generation. State-level policies, such as RPS or state emission restrictions, when implemented under the umbrella of an aggregate emissions cap at the federal level, could be ineffective for achieving national emission reductions, as state-mandated gains are traded away.

- g) Another important area for future study that is excluded from the EERS is the implication of MMI designs for the perception of equity or fairness, and ultimately political feasibility of environmental policies. Economic research is often oriented toward measures of efficiency, but it also offers the tools to identify the distributional effects of policy. Of special interest and potential contribution is the identification of the distributional effects associated with different types of policy design for a given environmental goal. This research could measure the effects of policies on market value of firms and the distribution of damage from existing environmental burdens (and, implicitly, the distribution of benefits from improvements). Furthermore, ORD should consider an investigation into so-called “risk-risk” trade-offs affecting the various types of costs and burdens imposed on households as a result of environmental controls. Potential cost savings of \$40 billion from greater use of incentive-based regulation, as has been suggested, may be one of the most effective programs for improving public health and the environment, according to the risk literature, and this is a topic that deserves formal study.
- h) The implications of technological innovation in the design of environmental policy were identified by the Committee as a cross-cutting theme in environmental economics research. This topic also deserves special attention in the study of MMI. Important questions remain about the design of MMI policies to promote efficient innovation and technological diffusion. Although there has been important recent work in this area, evolving methodologies make this area fruitful for additional empirical and theoretical study.

- i) Developing methods to estimate the cost savings associated with MMI would be valuable for evaluating the benefits of these programs. Estimating these savings is actually very difficult to do. The process requires modeling of costs under both the market approach and a “traditional” policy with the same environmental goal. While a number of prospective studies of the benefits of market mechanisms compared to traditional approaches exist, there have been few retrospective studies of the benefits of MMI.

### **2.5.2 Research Feasibility**

*Given the implementation strategy laid out in the EERS; --To what extent is this research scientifically feasible at a high level of quality? --How successful is this research likely to be in answering policy-relevant questions for EPA within the next 8-10 years?*

Environmental economic researchers have examined many of these issues at some level, although further work needs to be conducted. It is very likely that high quality and highly policy-relevant work can be conducted in the next 8-10 years.

## **2.6 Benefits of Environmental Information Disclosure**

### **2.6.1 Characterization of Research Gaps and Priorities and Research Feasibility**

*Is the characterization of each of the major research gaps in the literature adequate? Will these priorities and implementation approaches effectively address the areas of greatest scientific uncertainty?*

*Given the implementation strategy laid out in the EERS; --To what extent is this research scientifically feasible at a high level of quality? --How successful is this research likely to be in answering policy-relevant questions for EPA within the next 8-10 years?*

Several statutes under which EPA operates—including the Emergency Planning and Community Right-to-Know Act of 1986 and the Safe Drinking Water Act amendments of 1996—require that information about environmental performance be disclosed to affected communities and/or the general public. EPA states that there is no generally accepted method to estimate the benefits of such information disclosure, although selected anecdotal evidence suggests that information disclosure programs may affect the behavior of entities that are required to provide the information.

EPA is correct that there is no generally accepted method, but it is not clear that one should search for a “general method.” The fact remains, however, that research to date has not estimated the benefits (or the costs) of environmental information disclosure programs. For the most part, the major analytical challenge is not associated with monetizing impacts, but with identifying behavioral responses to information disclosure requirements.

Clearly, there is increasing interest in the United States (and other countries) in the potential role that can be played by information disclosure programs, as substitutes or complements for conventional command-and-control or market-based environmental policy instruments. Much of this interest can be attributed to the success that has been claimed for the Toxics Release Inventory (TRI) program, which requires large manufacturing facilities to report publicly their annual releases of certain chemicals. Since the inception of the TRI program in 1986, reported releases of over 300 regulated chemicals have fallen by more than 45%.

What is needed is analysis of the efficacy of such information disclosure programs by examining the ways in which these programs can—in theory—affect environmental quality and by investigating empirically the ways in which the programs have actually affected pollutant releases. In terms of theory, there are several pathways through which information disclosure might lead to pollution reduction, including: green consumerism, green investing, community pressure, impacts on labor, the threat of future regulation, and organizational limitations of the firm. Better theoretical modeling of firms' production and pollution decisions would incorporate these pathways. Such theoretical frameworks could then be used as the bases for empirical (econometric) analyses of the effects of TRI on facility decision-making. Such research could produce greater understanding of how facilities respond to information disclosure programs such as the Toxics Release Inventory. This is a necessary first step to estimating the benefits of such information disclosure programs.

As EPA notes, there are a variety of other important research questions, including cost-effectiveness comparisons of information disclosure programs with command-and-control and/or market-based environmental policy instruments. In general, EPA's Office of Research and Development has begun funding such research efforts under its category of "Corporate Environmental Behavior: Examining the Effectiveness of Government Interventions and Voluntary Initiatives," part of the Science to Achieve Results (STAR) program.

It is important to distinguish between information disclosure as a complement and as a substitute for other forms of regulation. EPA suggests in places that information disclosure might be a substitute for regulation (as in the third bullet point on page 20). While disclosure requirements might induce pollution reductions, theory suggests that only in a limiting case would these reductions match those under efficiency-maximizing regulation. In the context of the TRI, firms would need to assume that, at the margin, the public-relations cost of pollutant emissions (that is, the negative impact on product demand) were equal to marginal environmental damages. This would only be the case if customers fully internalized the costs of pollution in their purchasing decisions. It seems more likely that information-disclosure requirements will lead only to partial reductions in pollution, relative to the efficient level of reduction.

This suggests that information-disclosure requirements may indeed be a substitute for regulation that is *less* stringent than the efficient amount, but that they are unlikely on their own to yield large enough reductions to correspond to the *efficient* level of pollution-abatement. This also suggests the need for research that examines how information-

disclosure rules and other regulatory approaches will operate jointly. Even when the two instruments — information disclosure and other regulation — are used together, there are potential cost-savings from the information-disclosure component, for example by facilitating monitoring and enforcement activities.

These considerations imply several additional research questions. First, how large is the reduction in pollution induced by information-disclosure requirements, relative to the efficiency-maximizing reduction? Correspondingly, what fraction of the damage from pollution is internalized in the purchasing decisions of consumers, once they are aware of respective pollution? What are the cost-savings from combining information-disclosure requirements with direct regulation, compared with costs under direct regulation alone?

### **2.6.2 Usefulness of the Research**

*What improvements in the design and implementation of the EERS would make each research project more useful to EPA and other environmental management agencies?*

The topic of information disclosure relates closely to another potential area of economic research for EPA that is likely to become more important over time, with increasing concerns about the effectiveness of terrorism risk policies on plant safety and security. In particular, EPA might support econometric analysis of the effectiveness of current and proposed terrorism risk regulations on plant safety and security, drawing upon publicly available data, as well as the Risk Management Plan database housed at EPA's Chemical Emergency Preparedness and Prevention Office, and data collected by local emergency preparedness agencies under the Emergency Planning and Community-Right-to-Know Act.

As noted above, several regulations, beginning in the late 1980s, were designed to reduce the risk of large-scale chemical accidents. The Emergency Planning and Community-Right-to-Know Act of 1986 established disclosure requirements for plants using and storing hazardous chemicals on-site. Section 112(r) of the Clean Air Act Amendments of 1990 requires detailed risk management planning and reporting for all large chemical plants. The International Standard Organization (ISO) developed a set of management practices designed to improve environmental performance, but also likely to reduce risk from chemical use. And in the aftermath of September 11, 2001, the American Chemistry Council, a trade organization representing the largest chemical manufacturing firms, established management practices for enhancing the security of chemical plants.

While most of these programs and policies were not specifically designed to reduce risk from terrorism, studies of the effectiveness of these approaches will provide valuable information regarding the viability of alternative types of policies to reduce the environmental component of terrorism risk. Until now, little empirical research has been conducted to evaluate the relative effectiveness of these regulations on plant and community safety.

### 3. ANSWER TO CHARGE QUESTION 3

#### 3.1 Missing Issues

*Can the SAB identify by consensus any environmental economics issues of overriding importance to EPA that the EERS has missed, and that EPA should address provided that more resources be made available for Environmental Economics Research?*

Within each of the five subject areas discussed in section 2. of this report the Committee has identified topics not originally mentioned in the Research Strategy. For example, under market methods and incentives we have suggested that the agency broaden its purview to consider renewable portfolio standards and incentives other than permit trading. In the case of valuation of environmental benefits we have stressed the importance of valuing non-marginal as well as marginal changes in risk of death and threats to ecosystems. The EEAC, however, believes that that the five subject areas on which the Agency has focused in the EERS are the most important areas of environmental economics research in terms of their importance to the Agency and in terms of gaps in the literature.

There is, however, an additional area of research, namely, the distributional consequences of regulation, to which the Agency might give more attention. We know that it is difficult to attribute the full general equilibrium costs and benefits of any given policy to specific groups of individuals; however, as long as people have only one vote each, and cannot exercise a number of votes in proportion to their perceived individual net benefits from environmental regulations, an awareness of distributional consequences will be important to the political feasibility of environmental regulations. Even a very attractive potential Pareto improvement will not fly if the distributional consequences do not meet with society's approval. The political economy of regulation will be an enduring dimension of successful environmental management. We urge the agency to give more weight to the distributional consequences of regulation in its strategy for benefit valuation. And, to the extent possible, in the measurement of the costs of environmental regulation.

#### 4. ANSWER TO CHARGE QUESTION 4

##### 4.1 Communication of the Research Strategy

*What is the best way for EPA to communicate the results of the research strategy and plans for achieving its long-term research goals to the wider research community, and other potential users?*

One way in which EPA could foster dialog with members of the research community is to hold workshops in conjunction with the American Economics Association and American Agricultural Economics Association annual meetings. These sessions would both give the Agency an opportunity to communicate its long-range research goals and to hear from researchers how these goals might best be met. This would inform the Agency's formulation of Requests for Proposals.

Currently, EPA's requests for proposals are announced 90-120 days in advance, and may be found on EPA's website under "Funding Opportunities—Environmental Research Grant Announcements." [<http://es.epa.gov/ncer/rfa/>] The EEAC suggests that these notices also be sent to the Chairs of Departments of Economics and Agricultural Economics, and that announcements be placed in the newsletters of the Association of Environmental and Resource Economists and American Agricultural Economics Association.

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EPA RESPONSES TO INTERNAL AND EXTERNAL REVIEWS



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON D.C. 20460

October 4, 2004

THE ADMINISTRATOR

EPA-SAB-04-007

Dr. William Glaze  
Chair  
Science Advisory Board  
U.S. Environmental Protection Agency  
1200 Pennsylvania Avenue, N.W.  
Washington, D.C. 20460

Dear Dr. Glaze:

I thank you, the Science Advisory Board, and Environmental Economics Advisory Committee for your review of the Environmental Economics Research Strategy. As we work to ensure that EPA's policies are founded on a solid underpinning of science, peer reviews like this are an important part of our efforts.

Research developed in response to the EERS will be particularly important as we search for better ways to protect the environment. It will lead us to new and more effective environmental management approaches and will help ensure that the policies we adopt are both efficient and fair.

Please be assured that the SAB's comments and suggestions will be used to guide EPA's economics research activities in the future. Because EPA characteristically puts its research into practice, your contributions will truly make a difference.

Again, my thanks to you and everyone at the SAB.

Sincerely,

*/Signed/*

Michael O. Leavitt

## INTRODUCTION

Before being submitted to the SAB for external peer review, the EERS was reviewed by ORD's Science Council. Science Council members had comments on the report organization, such as moving much of the text to appendices to improve readability. These suggestions were largely incorporated. Other Science Council suggestions included increasing the description of linkages between this Strategy and other programs, which was accomplished in Appendix 3, and extending a discussion of QALYs and DALYs, which is accomplished below, in response to SAB comments.

In the rest of this appendix, EPA provides detailed responses to the SAB EEAC comments, found in narrative form in Appendix 6: *Review of the Environmental Economics Research Strategy of the U.S. Environmental Protection Agency*. By itself, EPA may not be able to address all of the SAB's suggestions immediately because of resource constraints. However, the SAB's comments comprise a wealth of potential research topics and should generate a significant amount of additional research by environmental economists in government and academia.

## 2.1 VALUATION OF HUMAN HEALTH BENEFITS OF ENVIRONMENTAL IMPROVEMENTS

### 2.1.1 Characterization of Research Gaps and Priorities

**Charge Question:** Is the characterization of each of the major research gaps in the literature adequate? Will these priorities and implementation approaches effectively address the areas of greatest scientific uncertainty?

Most of the literature on human health valuation has focused on mortality valuation—measuring what individuals will pay for small reductions in their risk of dying in a specified time period. As the EERS notes, much less effort has been invested in measuring what people will pay to avoid episodes of acute illness or to reduce their risk of contracting a chronic illness (morbidity valuation).<sup>1</sup> As a result, many health endpoints are not monetized in Regulatory Impact Analyses; or their value is measured by productivity gains and avoided medical costs, which are a lower bound to the appropriate measure of value. In the area of morbidity valuation, the EERS (p. 10) calls for valuation of noncancer endpoints; earaches, headaches, colds, gastrointestinal upsets, reproductive and developmental effects (e.g., Attention Deficit Disorder, autism), and cancer-related morbidity effects. On p. 15 of the Research Strategy, more emphasis is put on chronic health effects. The EERS notes that it is important to allow valuation to depend on severity, duration, and frequency of symptoms. Emphasis also is put on valuing children's health.

According to the EERS, the main needs in mortality valuation (p. 16) focus on the impact of age on the Value of a Statistical Life (VSL) and on the impact of the health status of the individual and co-morbidity (illness preceding death) on the VSL.

### COMMENT HEALTHVAL 1

The Committee agrees with the Agency's assessment on the lack of estimates of the value of morbidity risk reduction benefits. Willingness to pay (WTP) estimates are indeed unavailable for many cancers, as well as

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<sup>1</sup> WTP estimates exist for reduced risk of chronic bronchitis and for some cancers, as well as for asthma attacks, restricted activity days, and symptom days.

for risks of heart attacks and strokes. WTP estimates for the other health endpoints noted in the first paragraph also are lacking.

**Response:** Noted. This is a factual comment. No response is required.

#### **COMMENT HEALTHVAL 2**

In many cases, the productivity losses and medical costs associated with illness are not born by the individual. If this is the case, estimates of productivity losses (the so-called indirect costs of illness) and medical costs (the direct costs of illness) must be added to WTP estimates. Estimating these illness costs is itself a research task whose importance should not be underestimated.

**Response:** EPA agrees with this comment, and the final EERS has been revised (see Chapter 3) to identify these factors as characteristics of desired research.

#### **COMMENT HEALTHVAL 3**

Regarding the Agency's priorities in the area of mortality valuation, the impact of age on the VSL is an important, policy-relevant topic. Any environmental regulation that saves lives in proportion to the age distribution of deaths in the U.S. will primarily extend the lives of older people. (Fifty percent of the deaths in the United States occur after age 75.)

**Response:** Noted. This is a factual comment. No response is required.

#### **COMMENT HEALTHVAL 4**

Regarding the impact of health status and co-morbidity on the VSL, the important issue here is whether environmental pollution causes chronic illness or simply increases mortality risk for people who have preexisting chronic conditions. When environmental contaminants cause a disease, it is theoretically desirable to value the risk of contracting the illness (such as cancer), which will entail both morbidity and a reduction in life expectancy. If pollutants differentially affect mortality risk for those with a preexisting condition (e.g., cardiovascular disease), then efforts should be put on measuring the impacts of the health state on the value of increasing life expectancy.

**Response:** EPA agrees that the decision to value the mortality and co-morbidity (or incidence and risk of death) of a given health endpoint either together or separately should consider all theoretically relevant factors, including preexisting conditions. The valuation approach should try to capture individuals' WTP for actual changes in health states. (This has been noted in Chapter 3 of the final EERS.) See also Comment HEALTHVAL 9 on the next page.

#### **COMMENT HEALTHVAL 5**

There are three topics in the area of mortality risk valuation that the Committee believes deserve attention, even though they are not mentioned in the EERS. The first concerns the reliability of existing estimates of the VSL, which rely on labor market and on stated preference studies. The Agency has recently commissioned re-analyses of data from compensating wage studies (Black, Galdo, and Liu, 2003) and of data from contingent valuation studies of mortality risks. Examination of these results may suggest that emphasis should be placed on developing newer, more reliable estimates of the VSL.

**Response:** As the SAB reviewers note, EPA has requested an SAB EEAC review of the Black et al. study and the broader literature on mortality valuation. The main goal of this review is to inform EPA's guidance on valuing fatal risk, but the charge to the EEAC also specifically asks about the need for new mortality valuation research. EPA will incorporate suggestions about mortality risk into the EERS implementation plan after this second review. Nothing in the current EERS would preclude this research direction; in fact, it was a high-priority short-term research area.

#### **COMMENT HEALTHVAL 6**

The second research topic concerns the issue of marginal versus nonmarginal risk valuation. Emphasis in the literature is on valuing small changes in risk of death, on the order of 1 in 10,000 per year or smaller. The Agency, however, uses these estimates to value regulations that, together, account for much larger risk reductions. To illustrate, The Benefits and Costs of the Clean Air Act 1970-1990 (U.S. EPA 1997) predicted that air quality regulations issued between 1970 and 1990 reduced mortality by 200,000 lives in 1990. When a VSL of \$4.8 million (1990 USD) was applied to these statistical lives, the WTP in 1990 for mortality risk reductions occurring in that year was estimated to be approximately \$16,000 (1990 USD) for a family of four.<sup>2</sup> This was because the VSL was applied to a nonmarginal reduction in risk of death (on average, a 1/1,000 reduction).

**Response:** EPA agrees that its research portfolio should include studies that either evaluate nonmarginal changes in risk or investigate how to properly "add up" values for marginal changes that, when totaled, become nonmarginal changes. We will consider these issues in future internal research and in the scope of future extramural solicitations.

#### **COMMENT HEALTHVAL 7**

Similarly large benefit estimates may arise when one adds together WTP for the risk reductions associated with the 1990 Clean Air Act Amendments, the Tier II Emissions standards, the Heavy Duty Engine Diesel Rule, the Off-Road Diesel Rule and Clear Skies. In short, although a single regulation may confer marginal risk reduction benefits, the set of environmental regulations evaluated over a 10-year period may confer nonmarginal benefits, and should be evaluated accordingly.

**Response:** Please see the response to Comment HEALTHVAL 6.

#### **COMMENT HEALTHVAL 8**

The third research topic concerns the impact of income on the VSL. Historically EPA has adjusted future values of the VSL to allow for income growth. Such adjustments require estimates of the income elasticity of WTP for mortality risk reductions. We believe that this is a topic that requires additional research.

**Response:** Noted. EPA will consider this topic in future solicitations and internal research.

### **2.1.2 Research Feasibility**

**Charge Question:** Given the implementation strategy laid out in the EERS: To what extent is this research scientifically feasible at a high level of quality? How successful is this research likely to be in answering policy-relevant questions for EPA within the next 8-10 years?

<sup>2</sup> The total value of the statistical lives saved, \$1 trillion, when divided by the population of the United States in 1990, implies a WTP of approximately \$4,000 per person.

**COMMENT HEALTHVAL 9**

There are several criteria to consider in formulating a research strategy for morbidity valuation:

- a. The approach taken should be able to evaluate a large number of health endpoints;
- b. It should, ideally, value the risk of avoiding chronic illness rather than avoiding the illness with certainty;
- c. The definition of health endpoints should take into account the severity, duration and frequency of symptoms; and
- d. The health endpoints valued should correspond to those linked to environmental pollutants in the epidemiological literature.

**Response:** EPA agrees that these are proper criteria in formulating a research strategy for morbidity valuation and will use these criteria in developing future solicitations and research projects in this subject area.

**COMMENT HEALTHVAL 10**

An important question, related to mortality valuation, is whether chronic morbidity and mortality should be valued as part of the same package. For example, should people value the risk of developing congestive heart failure as the risk of experiencing a series of hospital episodes, recurring discomfort and shortened life span? Or, should the impact of air pollution on the morbidity associated with congestive heart failure be valued separately from the impact of air pollution on the mortality associated with congestive heart failure? The answer to this question depends crucially on the point articulated in item (d) above. If the epidemiological literature suggests that air pollution increases risk of death due to congestive heart failure (and other forms of heart disease), but does not link air pollution to increased incidence of the disease, then valuation should mirror this approach. For diseases where environmental contaminants may actually increase the risk of contracting the disease (e.g., for some cancers) then, assuming that people can comprehend both the risk of the disease and its sequelae, the goal should be to value the morbidity and mortality risks as a single package.

**Response:** Please see the response to HEALTHVAL 4. EPA agrees that morbidity and mortality valuation research should follow from research results in the health science research literature. To improve this linkage, EPA also is initiating an effort to incorporate behavioral variables in epidemiologic studies.

**COMMENT HEALTHVAL 11**

Regarding the number of health diseases to be valued, a possible approach to dealing with the point articulated in item (a) above is to have people value functional limitations (characterized by severity, duration, and frequency), which, in turn, are related to illnesses. This is likely to work best for chronic illnesses and less well for acute illnesses. Obtaining reliable values for the risk of an illness will remain a challenge.

**Response:** EPA generally agrees with this suggestion. As noted in the draft EERS, "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." However, any such indices or transfers must be based on theoretically and methodologically sound and empirically valid studies that have been rigorously peer-reviewed by economists.

**COMMENT HEALTHVAL 12**

One potential area of research is to examine whether it is possible to use information contained in measures of health preference, such as QALYs, that are used in other public-health domains to provide a method for transferring benefit estimates from one health endpoint to another.

**Response:** Please see the response to Comment HEALTHVAL 11.

**COMMENT HEALTHVAL 13**

Regarding estimates of the value of mortality risk reductions, it would seem that stated preference methods are the main candidates for studying the impact of age and health status on WTP, although it may be possible to use revealed preference methods for the impacts of age in the context of auto safety. (Labor market data probably cannot be used to estimate WTP for ages greater than about 65 because of the relatively small fraction of the elderly who are employed [Viscusi and Aldy, 2003]). The use of both stated and revealed preference methods to value reductions in risk of death is advisable.

**Response:** EPA agrees that, based on existing mortality studies, stated preference methods are preferred to revealed preference methods for valuing mortality risk outside of the workforce, but that both methods could provide useful information, particularly if new revealed preference approaches are developed that would address the shortcomings of labor market studies for some age groups.

**COMMENT HEALTHVAL 14**

Regarding the issue of valuing nonmarginal risk changes, this is certainly feasible using stated preference approaches. Recent advances in dealing with the identification problem in hedonic markets suggest that this should also be feasible in a revealed preference context (Heckman, Matzkin, and Nesheim, 2003).

**Response:** EPA will consider this as a possible focus in future health valuation research.

**COMMENT HEALTHVAL 15**

The Committee believes that progress in the area of health valuation can be made, with appropriate funding, within the next 8-10 years. We believe that for these efforts to be successful, and to yield high-quality research, it is essential that the economists conducting the research work together with epidemiologists to ensure that the health effects valued match up with those examined in the epidemiological literature, and with physicians to ensure that any health status indices that are used to facilitate evaluating a large range of health endpoints are appropriate to the task.

**Response:** EPA agrees that economists and health scientists should work together on these issues. EPA also agrees that its valuation research will be more effective by focusing on valuing health endpoints that can be identified and measured. However, EPA notes that health risk assessments cannot rely solely on epidemiologists or on physicians' opinions but should also rely on toxicology, biomarkers, and exposure studies. Economists need to work with all of these disciplines to get a full and accurate picture of environmental health effects.

**2.1.3 Usefulness of the Research**

What improvements in the design and implementation of the EERS would make each research project more useful to EPA and other environmental management agencies?

**COMMENT HEALTHVAL 16**

The Committee believes that it is important to measure the impact of household characteristics on WTP for both morbidity and mortality benefits. This is important if the Agency is to examine the distributional impacts of environmental policies. It is also the case that certain air pollution epidemiology studies distinguish health effects by socioeconomic status (e.g., Pope et al., 2002). Making these distinctions in terms of valuation would make it possible to further refine the distributional impacts of air pollution control strategies.

**Response:** EPA agrees that household (and other demographic) characteristics can be important in measuring WTP for morbidity and mortality effects, provided that the ethical considerations underlying this approach are made explicit in each analysis (see SAB Comments MM&I 14 and 15). This approach, or extension, will be considered in developing further health valuation and other environmental economic research.

**2.2 VALUATION OF ECOLOGICAL BENEFITS OF ENVIRONMENTAL IMPROVEMENTS****2.2.1 Characterization of Research Gaps and Priorities**

**Charge Question:** Is the characterization of each of the major research gaps in the literature adequate? Will these priorities and implementation approaches effectively address the areas of greatest scientific uncertainty?

**COMMENT ECOVAL 1**

The EERS identifies a number of endpoints for which valuation of ecological services will be useful. These endpoints include water quality changes, ecological impacts of air pollution, introduced versus native species, avian species, etc. Although this way of thinking about the benefits of ecosystem improvement is consistent with how economists view the valuation of many goods, this single endpoint focus is not generally consistent with how ecologists view ecosystem functioning. For research in ecological benefits to be most valuable, there must be a high level of interaction between economists and ecologists.

**COMMENT ECOVAL 2**

To begin, there must be a broad understanding of the way in which ecologists view ecosystem functioning. For example: The research plan refers to "outcomes" as if ecosystems are mechanical" (i.e., when the level of an insult increases the ecosystem has predictable new equilibrium outcomes). This characterization of ecosystem dynamics may be appropriate in some cases, but this is not the way ecologists think about ecosystem responses generally. Rather, they tend to think of ecosystems as constantly changing, with different levels of insult affecting the course of change. Even if there is an equilibrium, the equilibrium may not be reached for decades or a century, so outcomes have to be thought of in a more dynamic way.

**COMMENT ECOVAL 3**

On the other hand, ecologists do think of the services provided by well-functioning ecosystems as something that can be characterized and assessed. This may be the point at which ecologists and economists can best find meeting points.

**Response to Comments ECOVAL 1-3:** In line with the SAB's suggestion, EPA typically attempts to measure policy-induced changes in structure and function of an ecological system based on ecological studies, and then to estimate changes in the (valuable) service flows that are produced by that ecological system. EPA has

a large number of ecologists in its research and program (regulatory) offices, with whom EPA economists often work closely. EPA also has initiated a number of solicitations for extramural research that requires ecologists and economists to work together, and is developing an Ecological Benefits Assessment Strategic Plan based on sustained interaction between economists and ecologists.

**COMMENT ECOVAL 4**

Ecologists are more concerned with thresholds and irreversibilities in ecosystems than in the pros and cons of changing from one equilibrium to another. One of the effects of a change may be that the ecosystem is less resilient to the next insult, so alternative scenarios of future insults need to be explored, not one-time changes.

**COMMENT ECOVAL 5**

This brings us back to earlier efforts to tackle cumulative effects. Ecologists do not think of stresses as being separable. Hence, they are more "conservative" than economists who are comfortable with the assumption that stresses are separable and hence can be considered "on the margin." For ecologists, the order of stresses also can be important. The earlier efforts of economists to understand cumulative impacts should probably be reviewed as a starting point for moving forward in this respect.

**Response to Comments ECOVAL 4-5:** EPA acknowledges the importance of the divergence in how ecologists and economists view an ecosystem. ECOVAL Comments 4 and 5 are both similar to the issue of visibility valuation, in which one regulatory action alone might not produce a perceptible change in visibility, but two or more regulatory actions together will produce a measurable change that can be perceived and valued. This is analogous to an ecosystem in which one individual ecological stressor might not change the "outputs" from that ecosystem but will change its resilience so that additional future stresses might have a much more profound effect on ecosystem services. A change in an ecosystem's resilience is an attribute that currently is not captured very well. Resiliency is a suitable focus for future research, provided it can be linked to people's observable choices.

**COMMENT ECOVAL 6**

Although it would be nice if ecologists could simply provide predictions of ecosystem behavior to meet economists' specifications of what they need, the fact of the matter is that ecologists are the experts on ecosystems. Implying that the economists need something that is contrary to the expertise of ecologists may not be a good starting point for what has to be a joint project. The Research Strategy should address how economists and ecologists in the Agency can learn more about what each other knows and how they can develop shared understandings, language, and models.

**Response:** See the response to Comments ECOVAL 1-3. It is not the intent of the EERS to imply that EPA believes "economists need something that is contrary to the expertise of ecologists." Generally, EPA would concur that may not be a good starting point for joint projects between ecologists and economists. On the contrary, as the text explains, discussions between economists, ecologists, and other scientists have been ongoing within EPA for some time. Both EPA and EPA-supported external economists and ecologists have expended considerable effort trying to learn more about what each other knows and believes and how they can develop shared understandings, language, and models that can actually be used in the policy evaluation arena.

**COMMENT ECOVAL 7**

Rather than valuing changes in a single service from an ecosystem (e.g., increased avian species or increased fish catch), it may be appropriate to work with ecologists to value the entire bundle of service changes associ-

ated with a change in an ecosystem from one state (perhaps one with a low level of function generally) to another (one that supports on average more species diversity, more resilience to external shocks, etc.)

**Response:** EPA agrees that this would be a notable goal and would be interested in new research to achieve this objective. See also EPA's response to Comments ECOVAL 1-3.

#### **COMMENT ECOVAL 8**

Research on the benefits of ecological systems and services will necessarily need to be ecosystem specific. Although "outcomes" for human health effects are many and are probably sensitive to the age at which the problem occurs, they are going to be pretty much true whether a person lives in Phoenix or Philadelphia. For ecosystems, although there are classifications of ecosystem types that will prove helpful, there are going to be a considerable number of types. The condition of the ecosystem for which an additional stress is being considered also will be important. Of course, the conditions of people experiencing an environmental stress also are important, but the stress is generally experienced by a large population of people whose conditions can be understood in statistical terms. Decisions on ecosystems will much more likely be taken one system at a time.

**Response:** The first part of this comment is true if the point of departure for valuation is a classification of ecosystem "types." However, if ecosystems (e.g., water bodies) are classified according to their uses or their abilities to provide "services," as some ecologists suggest, then the comparability across ecosystem types or indices is more tractable. As with health effects, the value of a boating day would vary pretty much along the same characteristics whether a person lives in Phoenix or Philadelphia, that is, the availability of substitutes, scenic amenities, or the quality of the water as a source for complementary recreation (fishing, swimming, water skiing). It is clear that any transfers of values across ecosystems or ecosystem indices would have to be done on the basis of characteristics common to both ecosystems. The condition of the ecosystem will be important, as the comment notes.

#### **COMMENT ECOVAL 9**

The EERS recognizes the large reliance the agency places on benefits transfer and the likely need to continue this reliance. They suggest that a "cost-effective strategy may be to investigate methods that generate theoretically sound values for multiple endpoints." The Committee generally agrees with the logic of this idea, but the Agency should consider that the highly contextual nature of ecosystem services may make transfers even more challenging than when the focus is on single endpoints. Benefits transfer in the case of ecosystems is exceptionally challenging.

**Response:** EPA agrees with this statement but believes the challenge of transferring (multiple endpoint) index values should be worth the effort, due to the interactive nature of multiple ecosystem services (e.g., wetland effects on water purification, flood risk reduction). Ultimately, transfers may be possible only for individual services, based on these services' characteristics, but that is largely unknown at present.

#### **COMMENT ECOVAL 10**

One important issue noted in the document is the fact that ecosystem services and functioning are not well understood by the general public, thus complicating the process of valuation. In addition to eliciting the value of ecosystem changes, the valuation process usually requires some education of the public. This has important implications for the resulting values and for the resulting use of benefits transfer. The relationship between physical measures of ecosystem functioning (pollution concentrations in water or air, number

of species present in a land area, etc), features of an ecosystem that people perceive and the perception of the ecosystem by people is poorly understood. Because this linkage is critical for valuation, this is an area of research that might yield high returns to EPA and other agencies.

**Response:** Noted. The EERS indicates that this ecosystem "education/preference elicitation" research area is important. EPA has sponsored several studies (see Hoehn et al., 2003) that specifically address people's perceptions of ecosystem services, and will attempt to integrate this consideration into future studies and solicitations.

#### **COMMENT ECOVAL 11**

The inherent uncertainties in ecosystem functioning makes the need to characterize uncertainty in the valuation process particularly important when ecosystem values are sought. This is an area where additional work could be focused.

**Response:** EPA agrees with this statement; the treatment of uncertainty in estimating both benefits and costs is a priority for economic analyses across the Agency.

#### **COMMENT ECOVAL 12**

Likewise, additional work on the implications of the "precautionary principle" and cost-benefit analysis when irreversibility and uncertainty is present may prove beneficial.

**Response:** The comment brings an interesting area of ecological valuation research to EPA's attention that has not been addressed in a systematic way. We will consider how best to incorporate this concept into future research.

#### **COMMENT ECOVAL 13**

Another feature that merits focus is the implication of threshold effects and valuation of large rather than marginal changes. Valuation for dynamic systems and the consequences of valuing changes in ecosystem services under very long time scales also are issues that EPA may wish to consider. Again, these features may be unique to ecosystem valuation as distinct from health endpoints or other nonmarket goods.

**Response:** Noted. EPA will consider these comments in developing future research projects.

#### **COMMENT ECOVAL 14**

Among nonmarket values for ecosystem services, nonuse values are the poorest understood, yet they have the potential to be very large in magnitude. This implies that research that focuses on nonuse values may have the highest returns.

**Response:** Noted. EPA will consider these comments in developing future research projects.

#### **COMMENT ECOVAL 15**

Some committee members felt that materials damage and losses of visibility from pollution should also be included among environmental benefits to be studied.

**Response:** Noted. EPA will consider these comments in developing future research projects.

### 2.2.2 Research Feasibility

Given the implementation strategy laid out in the EERS: To what extent is this research scientifically feasible at a high level of quality? How successful is this research likely to be in answering policy-relevant questions for EPA within the next 8-10 years?

#### **COMMENT ECOVAL 16**

The Committee sees considerable return on research in the area of ecosystem valuation. With adequate funding, the Agency is likely to see information that is very relevant for policy questions being produced.

**Response:** Noted.

### 2.2.3 Usefulness of the Research

What improvements in the design and implementation of the EERS would make each research project more useful to EPA and other environmental management agencies?

#### **COMMENT ECOVAL 17**

Many of the ecological benefits measures needed by EPA also would be of value to other government and public agencies. Specifically, the U.S. Army Corps of Engineers, United States Department of Agriculture (USDA), Forest Service, and many Non-Governmental Organizations (NGOs) and state agencies would find ecological benefits work to be highly valuable. EPA should find ways to share research results as well as consider jointly funding and identifying needed research on ecological benefits.

**Response:** Noted. EPA has initiated efforts to share research with these agencies in areas of mutual interest.

#### **COMMENT ECOVAL 18**

One of the needs identified in the report is for valuation of reductions in pesticides in water, but in many parts of the country, nutrients are as much or significantly more of an issue. Nitrogen is a clear problem for hypoxia, while phosphorous and other nutrients are important for local water quality problems in much of the Midwest.

**Response:** Several EPA offices suggested that valuing the effects of nutrient level changes on ecological conditions should be a research focus (see Appendix 5). EPA will consider these comments in developing future research solicitations.

#### **COMMENT ECOVAL 19**

A centralized team of economists in Washington, DC, may not be the ideal configuration of economists for undertaking research that is going to be inherently more contextual than other types of environmental economic research. More economists are probably going to be needed in the regional offices to carry out ecosystem valuation effectively. This activity also could be enhanced by the use of non-EPA economists (outside of Washington) with expertise in ecosystems analysis.

**Response:** Although it is true that ecosystem research and valuation are likely to have context-specific components, EPA has nationwide policy development and regulatory responsibilities. EPA analyses are typically

conducted at the regional or national level (e.g., for a national rule affecting concentrated animal feeding operations). More economists in the regions might complement a centralized group of economists in EPA. In general, however, economic valuation methodology would not vary by locale, although the data informing the valuation process certainly would. EPA believes there are both economies of scale and synergistic benefits in co-locating a group of economic researchers and analysts who have close ties to academic research; scientists from other disciplines (e.g., ecologists, epidemiologists); and the regulatory process. The benefits of co-location also seem to hold true in most academic economics departments. Through the STAR grant program, EPA is supporting research by external economists and ecologists who have successfully competed for grants. Hiring more economists in the Regions also is outside of the scope of the activities covered by the EERS.

## 2.3 VALUATION METHODOLOGIES

What methodological research needs in valuation should EPA investigate as a complement to the needs derived from the strategy interviews?

As noted in the Research Strategy, much of the academic literature in nonmarket valuation focuses on methodological development. Although this implies that a substantial amount of methodological work may be produced without impetus from EPA or other agencies, there are some areas of valuation where the needed methodological refinements may not be as forthcoming as others.

### **COMMENT VALMETHOD 1**

In particular, some areas may not be viewed to be as methodologically interesting as others, but may still be critical to improving the accuracy of nonmarket valuation in the context of ecosystem services.

### **COMMENT VALMETHOD 2**

The Committee identified the following topics as being of particular value to EPA programs (See comments VALMETHOD 2–7):

1. Improved methodologies and tools for benefits transfer as well as increased understanding of the range of uncertainty associated with the transfer of values from one study site to another. Given the enormous reliance that EPA and other agencies make on the transfer of benefits to perform benefit-cost analysis, considerable gains from additional understanding of this process may be possible.

### **COMMENT VALMETHOD 3**

2. Increased understanding of the appropriate extent of the market when taking welfare estimates from individual values and aggregating them to the full population (this is particularly important for nonuse values). There is both the issue of having the appropriate sampling frame from which to compute per household benefits (e.g., a random population survey versus a sample of people visiting a shopping mall) and the issue of how much of the general population to apply these values to (e.g., households in close proximity to the impacted resource, all households in a certain political jurisdiction, all households in the world?).

**COMMENT VALMETHOD 4**

3. Further study of the WTP-WTA divergence literature. In many cases, a strong argument may exist for the use of a WTA valuation rather than a WTP based on explicit or implicit property rights.

**COMMENT VALMETHOD 5**

4. Increased understanding of the appropriate valuation of the opportunity cost of time in revealed preference studies. This concern relates primarily to recreation demand studies, where different assumptions about the value of time can yield differences in the estimates of welfare changes by a factor of two or more.

**COMMENT VALMETHOD 6**

5. Improved bid design methods for stated preference surveys. Discrete choice stated preference surveys require the researcher to define the bid distribution for respondents. Potential bias and inefficiency from suboptimal bid design are not well understood.

**COMMENT VALMETHOD 7**

6. Although a growing literature in the valuation field combines stated and revealed preference information to jointly estimate the parameters of welfare measures, there may be substantial gains to EPA and other agencies from furthering work in this area. The combination of stated and revealed preference data enjoys the prospect of grounding welfare estimates in observable behavior while allowing for a much broader category of benefits to be studied with the inclusion of stated preference information.

**Response to Comments VALMETHOD 1-7:** EPA has noted its strong interest in developing valid methods for benefits transfer. In addition, EPA has sponsored some research in the areas of: (1) the opportunity cost of time, (2) bid design methodology for stated preference, (3) combined revealed and stated preference, and (4) scope issues in health valuation research. To date, EPA has done relatively little to investigate the discrepancy between WTP and WTA, except as it is integral with time preference studies (see Gregory et al., 2004). EPA is giving serious consideration to the SAB's recommendations and has already begun to incorporate some elements of these suggestions into grant solicitations, as appropriate. EPA will continue this practice for future solicitations.

## 2.4 ENVIRONMENTAL BEHAVIOR AND DECISION-MAKING

(Formerly called "Corporate Environmental Behavior and the Effectiveness of Government Interventions [referred to as CEB]")

### 2.4.1 Characterization of Research Gaps and Priorities and Usefulness of Research

Is the characterization of each of the major research gaps in the literature adequate? Will these priorities and implementation approaches effectively address the areas of greatest scientific uncertainty?

What improvements in the design and implementation of the EERS would make each research project more useful to EPA and other environmental management agencies?

**COMMENT CEB 1**

This topic is one of the most important research priorities faced by EPA. Judging from the survey of EPA program offices, this topic is tied with "Valuation of Reduced Morbidity Benefits" for the highest priority. Several research questions are highlighted, including: (a) Why and how do facilities comply? (b) What policies or approaches increase compliance? and (c) How successful have voluntary programs been? The Committee offers the following comments on the research goals:

**Response:** EPA agrees with this comment; CEB research is a high priority for EPA.

**COMMENT CEB 2**

Previous EPA-funded results. It would be helpful to assess how successful the previous Science To Achieve Results (STAR) competitions on Corporate Environmentalism have been.

**Response:** The STAR grant program undertakes periodic assessments of the success of its supported grant programs. The CEB grant program is young, entering its fifth year in 2004, and broad, covering a range of behavioral topics from compliance effectiveness to voluntary programs to information disclosure. As a result, few compelling results have been demonstrated in any one topical area. However, anecdotal evidence suggests that the STAR CEB program has produced not only numerous publications but also results that corporations, industry associations, and environmental management agencies can use and have used. A research workshop on CEB in April 2004, was well attended and well received by EPA and state agency staff. As the SAB EEAC recommends, a CEB comprehensive program evaluation will be tentatively scheduled for 2005 as part of the Economics and Decision Sciences Research Multiyear Plan.

**COMMENT CEB 3**

Breadth of research area. This research priority area is termed Environmental (Compliance) Behavior and Decision-Making. It is unclear whether the focus is limited to compliance-related behavior or whether this priority area is intended to include broader issues relating to environmental behavior. Some of the specific questions raised in this context (e.g., location, technology adoption, and pesticide use) do not involve compliance directly. They are questions about how firms make decisions that have environmental implications. The Committee believes that this is the correct perspective on this issue. Ultimately, EPA's goal should be to understand why some firms pollute more (per unit of input or output) than others. This may depend on the nature or environmental regulations and their enforcement, but also will depend on the costs of reducing emissions.

**Response:** As described in the EERS, the focus of the CEB research area is broader than compliance behavior, including mandated and voluntary environmental behavior, environmental performance, the motivations for each of these, and the effectiveness of government interventions on each. In addition, the definition of "corporate," as EPA has used it for the past 4 years, encompasses individuals, municipalities, and other organizations or institutions, public or private, whose actions have environmental impacts. Within this umbrella research area, EPA will attempt to address the effectiveness of all realistic alternatives for influencing polluter behavior: enforcement, information, government-industry partnerships, voluntary programs, as well as motives for adopting new "greener" technologies. EPA intends to rotate grant solicitations among these topics over the next few years to build a "weight of evidence" for understanding the efficacy of each of these alternatives.

Nonetheless, compliance behavior specifically arose as EPA's highest priority for research in this area. As a result, EPA is initially allocating resources to this more focused research area to answer some fundamental questions, such as "Why do regulated entities behave as they do?" Variants of this question were ranked highly in interviews with every program office.

In its comments below, the SAB also recommends research on costs. A closely related question—What are the working definitions or conceptions of "compliance costs" for regulated entities?—arose frequently (either explicitly or implicitly) in the survey of EPA program offices. This question includes consideration of transaction costs with government agencies or neighboring communities, potential for gaining a comparative advantage and market share, and liability concerns, all of which figure into many business decisions but are not commonly counted as compliance costs in public or private analyses. The 2003 CEB RFA, developed after the EERS was drafted, solicited research to investigate these questions.

#### **COMMENT CEB 4**

If the focus is on compliance alone, then it is not clear why the questions relating to voluntary programs are included, because by definition voluntary programs do not entail "compliance" with existing rules or regulations. The study of voluntary programs would fit more closely with the research about information disclosure. Alternatively, if this priority area is intended to be broader, then the research on information disclosure could be folded into this priority area.

**Response:** The focus of the CEB area of research is not on compliance alone. Please see the response to Comment CEB 3. The environmental information disclosure research area will be folded into the CEB research umbrella.

#### **COMMENT CEB 5**

Feedback from regulated industries. Traditionally, research on compliance and enforcement has treated the policy process as linear. The regulator first designs and imposes a policy, then an enforcement strategy (e.g., an audit frequency and penalties for non-compliance), and then the polluting firm decides whether or not to comply. Some research on enforcement and compliance might benefit from considering a more interactive model, under which regulators and regulated parties work together to identify pollution sources and means to address them. Monitoring and information generation are key parts of such a strategy. One example is EPA's Clean Charles 2005 Initiative. (Again, this suggests that the research priority area on information disclosure is closely linked to this priority area.)

**Response:** The Reference to a Model: "Under which regulators and regulated parties work together to identify pollution sources and means to address them" implies a public-private partnership. Such partnerships have been attempted as part of both state and federal efforts and therefore also are a focus of the CEB research area. Chapters 3 and 4 of the EERS have been expanded to address public-private partnerships more explicitly. Such partnerships can encompass monitoring, technology sharing, regulatory relief, and other options to achieve improved environmental performance for a firm, locale, or sector. This research will attempt to identify the factors and design characteristics that would make such partnerships cost effective.

#### **COMMENT CEB 6**

Public sector compliance. Most of the compliance and enforcement literature studies private-sector polluters. Other sources, such as municipalities, have received relatively little attention. Yet, in some contexts these

constitute the primary pollution sources (e.g., water pollution). Thus, the scope of the research priority should be sufficiently broad to include not only decisions by private polluters but also by public sources.

**Response:** EPA agrees and has supported research addressing the behavior of municipal sources of water pollution, hazardous waste generation, and brownfields redevelopment. Please see the response to Comment CEB 3.

#### **COMMENT CEB 7**

Unobserved determinants of behavior. The existing literature has understandably focused on easily observable determinants of environmental decisions: firm size, industry group, etc. However, less easily observable motivational factors may be more important in explaining the environmental behavior of a particular firm. Information about these factors comes primarily from case studies, which are often viewed as anecdotal. Therefore, it seems appropriate for EPA to fund research that seeks to provide statistical evidence regarding firm decision-making, as well as more in-depth case studies of the behavior of individual firms.

**Response:** EPA agrees with this comment. EPA has funded and conducted both case studies and statistical analyses of cross-sectional, time-series, and panel (a mix of both) data. Each has its strengths and weaknesses. In combination with each other, and with theoretically based simulation models and experimental approaches, these approaches can provide more varied and robust depictions of actual environmental behavior under different circumstances than any one approach can individually. One element of the CEB component of the research strategy will be to try to piece these approaches together coherently and identify where each, in combination with the others, can most efficiently advance the process of scientific discovery. A description of this element has been added in Chapter 3 of the EERS.

#### **COMMENT CEB 8**

Market incentives. A key question that needs to be addressed (statistically and through case studies) is whether market incentives for environmental protection (e.g., from consumers, communities, suppliers, or investors) are sufficiently strong. Again this relates closely to the effect of information disclosure, as information disclosure is likely to increase these pressures. Instead of thinking about voluntary approaches and information provision as substitutes for more traditional regulations, they may be thought of as complements.

**Response:** Noted. The substance of this comment has been added to the EERS and will be one of the focal areas of the planned RFA on the benefits of environmental information disclosure.

#### **COMMENT CEB 9**

Cost-effectiveness. Most studies focus on accounting costs of compliance, and ignore things like the transactions costs of dealing with regulators, liability costs, and adverse publicity. It would be worth considering these broader definitions of costs.

**Response:** EPA agrees with this comment and has posed this question in the 2003 CEB RFA. Please see the response to Comment CEB 3.

#### **COMMENT CEB 10**

Market structure. Regulations may have different effects on industries with different market structures.

**Response:** Noted. This has been the focus of several funded CEB research projects and will continue to be an area of interest for CEB research. More broadly, EPA would like to identify the range of factors that influence

environmental behavior, including market or industry structure, firm size, ownership, community pressure, and organization.

**COMMENT CEB 11**

Appropriate fines. The EPA's current practice requires firms caught violating environmental regulations to pay fines equal to the profits they earned as a consequence of their violations. It is an open research question whether this is in any way optimal. Research also could be conducted on the use of resource-based optimal compensation in lieu of fines. Sometimes violators can avoid fines by undertaking restoration or enhancement activities of great value than the fine. The desirability and effectiveness of non-monetary penalties need to be better understood.

**Response:** Noted. This comment arose in the development of the EERS but was not a strong enough priority to merit the early application of resources. In response to the SAB's interest, EPA will explore areas where it can fit with other CEB topics so that it can be addressed sooner rather than later.

**COMMENT CEB 12**

Ex-ante versus ex-post estimates of compliance costs. Ex-ante estimates are typically higher. This may be due to strategic industry overstatement of costs, or because technological improvements are not foreseen. Research on the difference between ex-post and ex-ante estimates would be useful to researchers assessing future proposed regulations.

**Response:** EPA agrees with this comment and has invited researchers to explore this question in past RFAs. In the future, EPA will continue to solicit such research, although the Agency recognizes that there might be some practical difficulties. These include the difficulty of obtaining accurate cost and expenditure data voluntarily from private firms or facilities, the common inability of plant managers to discern investments that improve productivity from those that reduce pollution, and the aforementioned issue of what "costs" really means to decision-makers.

**COMMENT CEB 13**

Data: Several researchers noted that state variation in approaches, fines, monitoring, etc., can be used to study these issues, but that state data are difficult for individual researchers to collect. A useful role for EPA may be to encourage states to collect data in a standardized way and to assist in compiling the data.

**Response:** Several offices in EPA, including OECA and OEI, are devoting considerable resources to standardizing the collection of facility-specific data from states. In addition, EPA is exploring approaches to "clean" and document the data it has already collected to improve the ability of researchers and analysts to match information from different data sources, and to understand why and how the data were collected.

### 2.4.2 Research Feasibility

Given the implementation strategy laid out in the EERS: To what extent is this research scientifically feasible at a high level of quality? How successful is this research likely to be in answering policy-relevant questions for EPA within the next 8-10 years?

**COMMENT CEB 14**

In general, committee members felt that EPA researchers have identified an important area for research, and one that could lead directly to improvements in EPA efficacy, reductions in regulatory costs, and improvements in environmental quality. Key tasks for the EPA include: defining the scope of the research objective, assessing prior EPA funded research, and assisting with the unification and publication of monitoring and enforcement data.

**Response:** EPA agrees with this comment and has addressed all of these comments above.

In addition, the Committee noted that any research in this area will have to deal with the following problems.

**COMMENT CEB 15**

Enforcement actions are widely understood to be targeted at likely violators, and hence endogenous. Researchers cannot estimate the effect of inspections and enforcement on the probability of violating environmental laws without simultaneously estimating the effect of violations on enforcement. This task is difficult without knowing the procedures EPA or the states use to decide which facilities to inspect. For a seminal paper on this topic, see Magat and Viscusi (J. Law and Econ, 1990).

**Response:** Noted. A number of sponsored and other research projects have attempted to resolve the endogeneity problem using approaches such as instrumental variables. EPA is aware of this issue and will continue to use rigorous peer review to ensure that sponsored research projects explicitly address sources of bias before funding.

**COMMENT CEB 16**

A second empirical problem, noted by Harrington (JPubE, 1988), is that given the low probability of any particular firm being inspected, or punished given an observed violation, the overall level of compliance is surprisingly high. Some other phenomenon aside from regulatory enforcement must explain compliance: public relations, citizen suits, NGO actions, etc.

**Response:** These are issues that the CEB research area is attempting to address. Researchers are trying to differentiate among firms based on the characteristics mentioned. This topic will be included more explicitly in a future CEB solicitation.

**COMMENT CEB 17**

A third empirical problem involves the availability of data. Much of the empirical literature focuses on the pulp and paper industries, due to the availability of water pollution enforcement data via the Permit Compliance System (PCS).

**Response:** Some of the more recent research projects have looked into detailed data in several other sectors, including iron and steel, oil and gas, chemical manufacturing, and metal processing. These and other research projects also have considered plant-specific air emissions and hazardous waste generation data. EPA collects, and provides researchers access to, facility-specific data on enforcement, inspections, air emissions, hazardous waste disposal, toxic releases, nearby population, and several other factors.

**COMMENT CEB 18**

Finally, this section of the Research Strategy asks to what extent voluntary pollution reduction programs such as the "33-50" program have succeeded. Answering this question requires facing another simultaneity problem: firms that have unobserved tendencies to reduce pollution are more likely to volunteer to do so. To accurately assess the efficacy of these voluntary programs, a researcher will need some exogenous variation in the programs, or some instrument for program participation. The Agency needs to be particularly attentive to opportunities to exploit exogenous variation in eligibility for particular programs so that valuable chances to assess the consequences of "natural experiments" are not missed. Labor economists have sensitized the discipline to the desirability of natural experiments for program evaluation. In particular, the Agency needs to be watchful whenever there are boundaries in some dimension (time, firm size, space) across which the assignment of firms to regulatory regimes is randomized by arguably external factors.

**Response:** First, the assertion that "firms that have unobserved tendencies to reduce pollution are more likely to volunteer to do so" has been at least partially rejected in some recent CEB-sponsored research. King and Lenox (2001) provide some evidence that both high and low performers join voluntary programs but for different reasons (e.g., comparative advantage or free-riding, respectively). The research has progressed somewhat in recent years beyond this question to focus more on the characteristics and requirements of the voluntary programs and how well matched their inherent incentives are to industry and firm characteristics. As mentioned above, the instrumental variables approach has been followed in a number of studies. Second, the comment on EPA trying to exploit the occasions of natural experiments is well taken, and EPA will try to take advantage of such situations.

## 2.5 MARKET METHODS AND INCENTIVES

### 2.5.1 Characterization of Research Gaps and Priorities and Usefulness of the Research

**Charge Questions:**

- Is the characterization of each of the major research gaps in the literature adequate?
- Will these priorities and implementation approaches effectively address the areas of greatest scientific uncertainty?
- What improvements in the design and implementation of the EERS would make each research project more useful to EPA and other environmental management agencies?

The Research Strategy combines the research priority "Market Mechanisms and Incentives [MM&I], Trading" with the priority "Market Mechanisms and Incentives, Other than Trading" in its final list of research gaps (p. 19). The proposed research emphasis from the Office of Research and Development will be on "trading in practice and trading in new markets" (p. 29). These specific areas are mirrored in the identified research gaps on p. 19. Especially regarding "trading in practice," the key questions that are identified are the environmental effects of trading and estimating the resulting cost savings. For new applications, the key questions are predicting the success of new markets and designing the markets to achieve both environmental and cost-reduction goals.

Some specific possible research areas that are mentioned include using market approaches for urban storm water management; programs for new pollutants and media; the complexities of tradable water quality permits in a world of multiple market distortions, lack of monitoring, and "cultural resistance to enforcement" (p. 20); the interactions of marketable permits with existing taxes; and market design questions.

**COMMENT MM&I 1**

The Committee believes the Research Strategy identifies some extremely important areas for future research, but is too limited in its focus. The following are areas worthy of inclusion in the MM&I research program.

**COMMENT MM&I 2**

Market mechanisms other than trading are notably absent from the discussion of research gaps. Exceptions include the brief mention of "environmental information programs" (p. 12) and "Methodology for evaluation of effectiveness of voluntary programs" (p. 26), which are already the subject of research priorities identified elsewhere in the EERS. The exclusion of other MM&I instruments, or more generally incentive-based instruments, such as pollution taxes, abatement subsidies, scrappage schemes for old cars, and deposit-refund systems, unduly limits the policy approaches that merit study. For example, current environmental policy relies heavily on legal liability for environmental contamination, which is an incentive-based policy. The empirical effects of these policies are not well understood but are a promising area for future research because data exist from recent experience.

**COMMENT MM&I 3**

Although the language in the Strategy does not rule out study of mechanisms other than permits, the absence of their mention does not encourage it either. Research has shown that different market-based instruments vary in, for instance, their effects on technological change, their total costs to pollution sources, their effects on entry and exit in an industry, the potential for "double dividend" effects, and the political or social acceptability of the instruments. Exploration of the relative merits of other instruments would be a valuable area of study.

**Response to Comments MM&I 1-3**

In developing the EERS, the Research Strategy team divided the market mechanisms and incentives research area into MM&I, Pollution Trading (existing and new markets) and MM&I, Other Than Trading, to get as specific a breakdown in priorities as possible. Given the SAB's comments, we have decided to treat all research topics related to MM&I as one group.

EPA agrees that the other areas noted by the SAB, such as pollution taxes, abatement subsidies, scrappage schemes for old cars, deposit-refund systems, and legal liability for environmental contamination, are important research topics, particularly for states and local governments. Several of these topics arose as areas of research interest in discussion with EPA staff and managers (see Appendix 4). However, they had a more specific focus than what is suggested by the SAB and did not sort out as high-priority areas for MM&I research across all of the Agency's programs.

Given the SAB's interest in these areas and accompanying rationale, EPA will increase its research emphasis in these areas, incorporating these research areas in future MM&I RFAs and internal research agendas over the next several years to the extent that resources allow. For example, EPA anticipates a CEB solicitation in the next several years that will address the effects of different instruments—economic, mandatory, and voluntary—on technological innovation and change.

**COMMENT MM&I 4**

The spatial and temporal effects of MM&I also need further attention. For many, if not most, pollutants, the kind of cap-and-trade program exemplified by the acid rain program differs from the design of a trading program identified in economic theory because the spatial and temporal distribution of pollution determines pollution damages. For efficiency, the marginal damages at any given locale or time need to be considered. Even in the absence of information on marginal damages, a cost-effectiveness measure should take spatial and temporal effects into account, due to requirements in environmental laws to achieve site-based environmental targets (such as the National Ambient Air Quality Standards under the Clean Air Act). There has been little ex post assessment of the spatial effects of uniform trading ratios in cap and trade systems such as the 1990 Clean Air Act Amendments, the Ozone Transport Region's NO<sub>x</sub> budget program, and the NO<sub>x</sub> SIP call trading program.

**COMMENT MM&I 5**

The spatial and temporal effects of MM&I are important components for design of future programs as the nation addresses mercury and ozone as atmospheric problems and the use of TMDLs in water quality. Simple trading designs, such as a cap-and-trade system for marketable effluent permits, may not achieve environmental targets in all places. On the other hand, incorporating transfer coefficients, limiting trading regions, or otherwise accounting for spatial and temporal effects limits trading opportunities and thus reduces potential cost savings. Research should evaluate the tradeoff between achieving environmental goals and achieving cost reductions, and the administrative and scientific difficulties involved in more theoretically correct trading systems.

**Response to Comments MM&I 4-5:** EPA agrees with the SAB's assessment. Currently, both EPA-sponsored and internal EPA researchers are investigating some of the local distributional effects of trading policies, both spatial and demographic. We will try to expand this effort to more fully address both temporal and spatial effects both as elements of future MM&I solicitations and internal research projects, as resources permit. EPA is planning a solicitation addressing water quality (e.g., TMDL) trading and appropriate trading design, given the complexities of monitoring, market scope, intertemporal issues, and differentiated pollutants.

**COMMENT MM&I 6**

The implications of monitoring and enforcement for the design of MM&I policies should be an important part of the MM&I priority. Monitoring can take at least two forms: one form measures actual environmental outcomes (e.g., ambient air or water quality), and another form ensures that the emissions or other factors for which a market is developed are measured at the source. Adequate monitoring of ambient measures can help tremendously in ensuring the success of MM&I programs in achieving environmental goals in all locales. Research into ambient monitoring and the interaction with MM&I requires involvement of environmental scientists, for example, to help identify the efficient placement and number of monitoring sites for achieving ambient goals. Monitoring of source behavior is necessary for the success of the markets: for example, if it is easy for sources to emit more than the number of permits they own, then the permit market as well as environmental quality will suffer.

**Response:** EPA agrees with this statement. As noted in the EERS, monitoring technologies and regimens can have significant effects on emissions or discharges and can determine the relative advantage of market-based over other policy instruments. In response to the SAB's comments, we have expanded the discussion of monitoring in the EERS, and EPA intends to focus an MM&I RFA on this topic in the near future. Furthermore, recent events have shown that transactions in the emissions trading market also require active monitoring to prevent cheating, which ultimately will have environmental or financial costs, or both.

**COMMENT MM&I 7**

An important and controversial aspect of MM&I programs has been the emergence of trading without a cap on aggregate emissions. Such programs have been labeled "open market trading programs" because they allow for new participants who may identify low-cost opportunities for emission reductions to enter the program. These programs have been widely criticized because of the absence of a strict emission cap, and the difficulty in observing and monitoring emission reductions. However, this generic approach has a broad application in the Clean Development Mechanism and Joint Implementation aspects of international efforts to reduce greenhouse gases, and it continues to be suggested at the state level in the United States for control of conventional pollutants. Open market trading should be studied to identify its weaknesses (so that programs can be designed to avoid them), its track record, and its role as a transition to cap-and-trade programs.

**COMMENT MM&I 8**

Another important area of study is the use of market approaches on indirect measures of the environment. For instance, it is typically almost impossible to measure nonpoint source pollution from a source, because the runoff cannot be observed. Instead, pollution policies are sometimes proposed for related goods, such as fertilizer use or Best Management Practices. Other examples include taxing gasoline instead of auto emissions and pay-at-the-pump auto insurance. When market instruments are applied to indirect measures, the environmental effects are much less understood; indeed, it is possible that adverse environmental outcomes might arise from unexpected substitutions or other unexpected effects.

**Response to Comments MM&I 7-8:** Please see the response to Comment MM&I 6. EPA is planning a future RFA to address the interactions of monitoring and incentives in the design of market-based programs. Based on the SAB's recommendations, it also will consider a broader definition of proxy measures and indicators and their incentive effects, given different market designs, or more broadly, implementation approaches. In addition, EPA will encourage research that evaluates aspects of open market or no-cap trading programs to reduce emissions in future solicitations.

**COMMENT MM&I 9**

The interaction of MM&I with existing taxes and other policies (such as agricultural programs) is an important area that deserves study. The General Theory of the Second Best suggests that improving one market in a world of multiple distortions may not improve welfare; hence, it is worth understanding whether the use of MM&I might lead to adverse effects in unexpected ways and how the design of policies can be improved in this light.

**COMMENT MM&I 10**

We would accord priority to three particular manifestations of the second best and the importance of pre-existing policies that have been found to be very significant in previous research. One has to do with policies or subsidies for such areas as agriculture or energy, outside EPA's jurisdiction, whose potentially significant environmental effects sometimes conflict with the goals of environmental policy. Other programs may have beneficial effects, and EPA may be able to learn from experience of programs in these other areas. For instance, the use of environmental targets in the USDA's Conservation Reserve Program deserves study as an important application of subsidies promoting, or consistent with, environmental objectives of the EPA. This program and its Environmental Benefits Index might be modified to target water quality and achievement of TMDLs. Generally, there could be significant environmental and financial gains from greater cooperation and coordination of research and policy across agencies.

**COMMENT MM&I 11**

A second area is preexisting tax or regulatory policy. EPA has previously funded work on the "tax interaction effect" and found this to be significant. Significant opportunity exists to improve this research by making it more accessible for policy makers and by introducing greater specificity and heterogeneity in the analytical and simulation models that have been employed to date. In general, further research that addresses the value (in a public finance context) and potential uses of revenues from environmental policies would be a very important contribution to policy design in general. For example, mandatory emission fees in severe nonattainment areas can be used to generate revenues to subsidize investment in emission control by firms or in infrastructure improvement that will reduce emissions.

**COMMENT MM&I 12**

Finally, state-level policies may interact in unforeseen ways with federal programs. For instance, states have adopted renewable portfolio standards (RPS) as a way to influence technology choice and environmental performance in electricity generation. State-level policies, such as RPS or state emission restrictions, when implemented under the umbrella of an aggregate emissions cap at the federal level, could be ineffective for achieving national emission reductions, as state-mandated gains are traded away.

**Response to Comments MM&I 9-12:** As the SAB notes, EPA has already sponsored several projects investigating double-dividend and tax interaction effects and anticipates focusing more research in this area in the near future. The EERS now includes a discussion of second-best tax, subsidy, and regulatory interactions to include research in this area. It is important to note that the tax interaction effect literature is controversial and largely theoretical and has not been tested sufficiently in empirical settings (simulation models simply assume the tax interaction effects asserted in this literature). It will be important to test whether the tax interactions asserted by the literature actually occur and the situations in which this effect may or may not be true or significant. EPA will attempt to address these questions in the future.

**COMMENT MM&I 13**

Another important area for future study that is excluded from the EERS is the implication of MM&I designs for the perception of equity or fairness, and ultimately political feasibility of environmental policies. Economic research is often oriented toward measures of efficiency, but it also offers the tools to identify the distributional effects of policy. Of special interest and potential contribution is the identification of the distributional effects associated with different types of policy design for a given environmental goal. This research could measure the effects of policies on market value of firms and the distribution of damage from existing environmental burdens (and, implicitly, the distribution of benefits from improvements).

**Response to Comment MM&I 13:** Please see the response to Comments MM&I 4 and 5. Distributional considerations arose with some regularity in discussions with EPA staff and management. It is generally agreed that this is an important area for research, and future MM&I solicitations will give more emphasis to distributional issues. Some EPA offices whose focus is on localized environmental issues, such as the solid waste and hazardous waste programs, listed distributional issues as important topics but not as their top priorities.

**COMMENT MM&I 14**

Furthermore, ORD should consider an investigation into so-called "risk-risk" trade-offs affecting the various types of costs and burdens imposed on households as a result of environmental controls. Potential cost sav-

ings of \$40 billion from greater use of incentive-based regulation, as has been suggested, may be one of the most effective programs for improving public health and the environment, according to the risk literature, and this is a topic that deserves formal study.

**Response:** This point is well taken and will be considered in implementation planning for MM&I and other research.

#### **COMMENT MM&I 15**

The implications of technological innovation in the design of environmental policy were identified by the Committee as a crosscutting theme in environmental economics research. This topic also deserves special attention in the study of MM&I. Important questions remain about the design of MM&I policies to promote efficient innovation and technological diffusion. Although there has been important recent work in this area, evolving methodologies make this area fruitful for additional empirical and theoretical study.

**Response:** Please see the response to Comments MM&I 1-3. This effect of alternative policy instruments on innovation will be addressed in future solicitations.

#### **COMMENT MM&I 16**

Developing methods to estimate the cost savings associated with MM&I would be valuable for evaluating the benefits of these programs. Estimating these savings is actually very difficult to do. The process requires modeling of costs under both the market approach and a "traditional" policy with the same environmental goal. Although a number of prospective studies of the benefits of market mechanisms compared to traditional approaches exist, there have been few retrospective studies of the benefits of MM&I.

**Response:** EPA agrees that this is a desirable and useful area of inquiry and will continue some studies in this area (see EPA 2001). In its MM&I solicitations, EPA has customarily asked for estimates of potential cost savings as part of a larger research scope. To date, only a few research projects have addressed this issue, Ellerman and Montero (2003) being a notable exception. Although data might be hard to obtain, this might be an appropriate area for internal EPA research.

### **2.5.2 Research Feasibility**

Given the implementation strategy laid out in the EERS, to what extent is this research scientifically feasible at a high level of quality? How successful is this research likely to be in answering policy-relevant questions for EPA within the next 8-10 years?

Environmental economic researchers have examined many of these issues at some level, although further work needs to be conducted. It is very likely that high-quality and highly policy-relevant work can be conducted in the next 8-10 years.

## **2.6 BENEFITS OF ENVIRONMENTAL INFORMATION DISCLOSURE (BEID)**

### **2.6.1 Characterization of Research Gaps and Priorities and Research Feasibility**

Is the characterization of each of the major research gaps in the literature adequate? Will these priorities and implementation approaches effectively address the areas of greatest scientific uncertainty?

Given the implementation strategy laid out in the EERS: To what extent is this research scientifically feasible at a high level of quality? How successful is this research likely to be in answering policy-relevant questions for EPA within the next 8-10 years?

Several statutes under which EPA operates, including the Emergency Planning and Community Right-to-Know Act of 1986 and the Safe Drinking Water Act amendments of 1996, require that information about environmental performance be disclosed to affected communities and/or the general public. EPA states that there is no generally accepted method to estimate the benefits of such information disclosure, although selected anecdotal evidence suggests that information disclosure programs affect the behavior of entities that are required to provide the information.

#### **COMMENT BEID 1**

EPA is correct that there is no generally accepted method, but it is not clear that one should search for a "general method." The fact remains, however, that research to date has not estimated the benefits (or the costs) of environmental information disclosure programs. For the most part, the major analytical challenge is not associated with monetizing impacts, but with identifying behavioral responses to information disclosure requirements.

Clearly, there is increasing interest in the United States (and other countries) in the potential role that can be played by information disclosure programs, as substitutes or complements for conventional command-and-control or market-based environmental policy instruments. Much of this interest can be attributed to the success that has been claimed for the Toxics Release Inventory (TRI) program, which requires large manufacturing facilities to report publicly their annual releases of certain chemicals. Since the inception of the TRI program in 1986, reported releases of more than 300 regulated chemicals have fallen by more than 45 percent.

**Response:** Noted.

#### **COMMENT BEID 2**

What is needed is analysis of the efficacy of such information disclosure programs by examining the ways in which these programs can, in theory, affect environmental quality and by investigating empirically the ways in which the programs have actually affected pollutant releases.

**Response:** Noted.

#### **COMMENT BEID 3**

In terms of theory, there are several pathways through which information disclosure might lead to pollution reduction, including: green consumerism, green investing, community pressure, impacts on labor, the threat of future regulation, and organizational limitations of the firm. Better theoretical modeling of firms' production and pollution decisions would incorporate these pathways. Such theoretical frameworks could then be used as the basis for empirical (econometric) analyses of the effects of TRI on facility decision-making. Such research could produce greater understanding of how facilities respond to information disclosure programs such as the TRI. This is a necessary first step to estimating the benefits of such information disclosure programs.

**Response:** This observation will be incorporated into a future RFA addressing BEID.

**COMMENT BEID 4**

As EPA notes, there are a variety of other important research questions, including cost-effectiveness comparisons of information disclosure programs with command-and-control and/or market-based environmental policy instruments. In general, EPA's Office of Research and Development has begun funding such research efforts under its category of "Corporate Environmental Behavior: Examining the Effectiveness of Government Interventions and Voluntary Initiatives," part of the STAR program.

**Response:** EPA believes this comment is accurate but that a more concerted effort might be needed to sort the effects of information disclosure on stakeholders and regulators.

**COMMENT BEID 5**

It is important to distinguish between information disclosure as a complement and as a substitute for other forms of regulation. EPA suggests in places that information disclosure might be a substitute for regulation (as in the third bullet point on page 20). Although disclosure requirements might induce pollution reductions, theory suggests that only in a limiting case would these reductions match those under efficiency-maximizing regulation. In the context of the TRI, firms would need to assume that, at the margin, the public-relations cost of pollutant emissions (that is, the negative impact on product demand) were equal to marginal environmental damages. This would only be the case if customers fully internalized the costs of pollution in their purchasing decisions. It seems more likely that information-disclosure requirements will lead only to partial reductions in pollution, relative to the efficient level of reduction.

**Response:** Noted. EPA will try to incorporate this observation into a future RFA addressing BEID.

**COMMENT BEID 6**

This suggests that information-disclosure requirements may indeed be a substitute for regulation that is less stringent than the efficient amount, but that they are unlikely on their own to yield large enough reductions to correspond to the efficient level of pollution-abatement. This also suggests the need for research that examines how information-disclosure rules and other regulatory approaches will operate jointly. Even when the two instruments—information disclosure and other regulation—are used together, there are potential cost savings from the information-disclosure component, for example, by facilitating monitoring and enforcement activities.

These considerations imply several additional research questions (See comments BEID 7 - BEID 9).

**COMMENT BEID 7**

First, how large is the reduction in pollution induced by information-disclosure requirements, relative to the efficiency-maximizing reduction? (Perhaps, we should note that the desired reductions from EPA policies are not typically the "efficiency" maximizing" level, but more likely that set by law or other determinate. The "efficient" level of reduction is not the best benchmark for comparison.

**COMMENT BEID 8**

Correspondingly, what fraction of the damage from pollution is internalized in the purchasing decisions of consumers, once they are aware of respective pollution? Interesting, but it is an academic question and not so policy relevant, given the comment above.

**COMMENT BEID 9**

What are the cost savings from combining information-disclosure requirements with direct regulation, compared with costs under direct regulation alone?

**Response to Comments BEID 6-9:** These are relevant and important questions for EPA to research. EPA will try to incorporate these observations into a future RFA addressing BEID.

**Miscellaneous Comments****COMMENT MISC 1**

The topic of information disclosure relates closely to another potential area of economic research for EPA that is likely to become more important over time, with increasing concerns about the effectiveness of terrorism risk policies on plant safety and security. In particular, EPA might support econometric analysis of the effectiveness of current and proposed terrorism risk regulations on plant safety and security, drawing on publicly available data, as well as the Risk Management Plan database housed at EPA's Chemical Emergency Preparedness and Prevention Office, and data collected by local emergency preparedness agencies under the Emergency Planning and Community-Right-to-Know Act.

As noted above, several regulations, beginning in the late 1980s, were designed to reduce the risk of large-scale chemical accidents. The Emergency Planning and Community-Right-to-Know Act of 1986 established disclosure requirements for plants using and storing hazardous chemicals onsite. Section 112(r) of the Clean Air Act Amendments of 1990 requires detailed risk management planning and reporting for all large chemical plants. The International Standard Organization (ISO) developed a set of management practices designed to improve environmental performance, but also likely to reduce risk from chemical use. And in the aftermath of September 11, 2001, the American Chemistry Council, a trade organization representing the largest chemical manufacturing firms, established management practices for enhancing the security of chemical plants.

Although most of these programs and policies were not specifically designed to reduce risk from terrorism, studies of the effectiveness of these approaches will provide valuable information regarding the viability of alternative types of policies to reduce the environmental component of terrorism risk. Until now, little empirical research has been conducted to evaluate the relative effectiveness of these regulations on plant and community safety.

**Response:** EPA agrees that these are interesting questions; however, EPA first needs to ascertain whether others (e.g., Department of Homeland Security [DHS]) have completed or commissioned studies on these topics. Because these issues did not arise as EPA priorities in interviews, and DHS economics research is in its initial stages, this has not yet been done. We also should investigate the balancing of the public's right to know and terrorism risks posed by disclosing environmental information.

**3. ANSWER TO CHARGE QUESTION 3****3.1 Missing Issues**

Can the SAB identify by consensus any environmental economics issues of overriding importance to EPA that the EERS has missed, and that EPA should address provided that more resources be made available for environmental economics research?

Within each of the five subject areas discussed in section 2 of this report, the Committee has identified topics not originally mentioned in the Research Strategy. For example, under market methods and incentives we have suggested that the Agency broaden its purview to consider renewable portfolio standards and incentives other than permit trading. In the case of valuation of environmental benefits, we have stressed the importance of valuing nonmarginal as well as marginal changes in risk of death and threats to ecosystems.

**Response:** EPA has considered and responded to these suggestions as appropriate above.

#### **COMMENT MISC 2**

The EEAC, however, believes that that the five subject areas on which the Agency has focused in the EERS are the most important areas of environmental economics research in terms of their importance to the Agency and in terms of gaps in the literature.

**Response:** Noted.

#### **COMMENT MISC 3**

There is, however, an additional area of research, namely, the distributional consequences of regulation, to which the Agency might give more attention. We know that it is difficult to attribute the full general equilibrium costs and benefits of any given policy to specific groups of individuals; however, as long as people have only one vote each, and cannot exercise a number of votes in proportion to their perceived individual net benefits from environmental regulations, an awareness of distributional consequences will be important to the political feasibility of environmental regulations. Even a very attractive potential Pareto improvement will not fly if the distributional consequences do not meet with society's approval. The political economy of regulation will be an enduring dimension of successful environmental management. We urge the Agency to give more weight to the distributional consequences of regulation in its strategy for benefit valuation and, to the extent possible, in the measurement of the costs of environmental regulation.

**Response:** In response to this suggestion, EPA intends to incorporate requests for research on the distributional consequences of different interventions into each solicitation in each area of research—valuation, CEB, and MM&Is. Through this approach, EPA will solicit research on the equity aspects of stated and revealed preference methods of value elicitation, the equity aspects of different measures of cost-effectiveness (e.g., WTP vs. QALYs), the suitability of each in a free-market economy, and the distribution of costs and cost savings associated with different interventions. As the SAB notes, this is a potentially fruitful area of research to inform policymaking.

## **4. ANSWER TO CHARGE QUESTION 4**

### **4.1 Communication of the Research Strategy**

What is the best way for EPA to communicate the results of the research strategy and plans for achieving its long-term research goals to the wider research community and other potential users?

#### **COMMENT MISC 3**

One way in which EPA could foster dialogue with members of the research community is to hold workshops in conjunction with the American Economics Association and American Agricultural Economics Association

annual meetings. These sessions would give the Agency an opportunity both to communicate its long-range research goals and to hear from researchers how these goals might best be met. This would inform the Agency's formulation of Requests for Proposals.

**Response:** In response to this suggestion, EPA will submit a proposal for a session addressing EPA's research needs for the 2005 American Agricultural Economics Association annual meeting.

#### **COMMENT MISC 4**

Currently, EPA's requests for proposals are announced 90-120 days in advance, and may be found on EPA's Web Site under "Funding Opportunities-Environmental Research Grant Announcements [<http://es.epa.gov/ncer/rfa/>]. The EEAC suggests that these notices also be sent to the Chairs of Departments of Economics and Agricultural Economics, and that announcements be placed in the newsletters of the Association of Environmental and Resource Economists and American Agricultural Economics Association.

**Response:** Noted. EPA will take this suggestion into consideration as feasible, given the timing of solicitations and the publication schedule for association newsletters (those mentioned as well as others). Following development of the Multi-Year (implementation) Plan, it might be more feasible to provide advance notice in these newsletters.

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