September 22, 1998

EPA-SAB-EEAC-ADV-98-005

Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
401 M. Street, SW
Washington, DC 20460

Subject: An SAB Advisory on Economic Research Topics and Priorities

Dear Ms. Browner:

During its April 9, 1998 meeting, the Environmental Economics Advisory Committee (EEAC) of the Science Advisory Board (SAB) received a briefing by representatives from EPA's Office of Research and Development (ORD) and the Office of Policy (OP) on the Agency's efforts to prepare a plan to guide its economics research. No specific charge was provided to the EEAC prior to the meeting. Rather, the SAB was asked to consider how the EEAC might help to ensure that the best possible plan could be prepared to guide EPA's economics research.

The EEAC agreed to prepare an Advisory that would contain member comments on a list of topics being considered by EPA internally as candidates for Agency-sponsored economics research. The Committee again discussed this issue at its August 19, 1998 meeting. This Advisory, consisting of brief member commentaries on the 31 topic areas proposed by EPA, is the result of those discussions. In addition, the Committee's informal ranking reflecting the value it associates with each research topic is included as Appendix A.

This Advisory provides advice on an Agency work-in-progress and as such, provides information that the Agency might use for mid-course corrections to refine their ultimate research plan. When completed, this plan may once again be brought to the SAB for additional consideration. If another interaction is requested on this plan, a significant number of new participants will be added to the reviewing panel -- by normal and routine processes that result in annual changes in EEAC membership and/or inclusion of additional consultants -- to ensure independent assessment of the Agency's work.

A few remarks are necessary to ensure that the nature of the ranking information contained with this Advisory is clearly understood. First, the rankings did not result from a formal scientific survey procedure employing explicit criteria for the objective derivation of numeric values to indicate the importance of research in each topical category. Rather, the rank assigned to a specific topic is the simple average of rankings by individual Committee members reflecting their own opinions on whether topics should be given high, medium, or low priority for implementation. The final ranking provided in Appendix A reflect an aggregation of individual rankings for each topic derived by assigning numerical values of 3, 2, and 1 to rankings that EEAC members submitted for high, medium, and low priorities, respectively, for the 31 research areas. Members were asked to base rankings on their own informal benefit-cost assessment of the possible return from conducting research within that topic area. Further, the rankings reflect the individual opinions only of current members of the EEAC, and may reflect their current research interests.

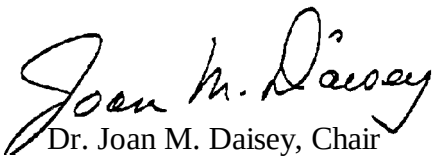
At the time the Committee members were ranking the research topics, some individuals were aware of rankings developed by EPA during its staff survey of economic research needs. However, members were asked to ignore those rankings in their decision making. No assessment of members' certainty about their rankings was conducted, nor did the Committee determine whether the individual ratings would be replicated if the exercise was conducted again. The Committee believes, however, that the average rankings across its members would likely be quite similar if the exercise was repeated.

It is also important that the process used to prepare the narratives on each research topic be clearly understood (these narratives are contained in Appendix B). First, the narratives were developed by a group of EEAC economists for use by EPA economists and staff who are involved with EPA's economics research program. The terminology used is of a specialized nature and it is familiar to professional economists and those involved in decision making activities associated with environmental public policy development.

Commentaries on each of the research topics were initially drafted by individual EEAC members, who, for the most part, chose topics upon which they wrote (although there were some cases where individuals were assigned topics not of their own choosing). Thus, the initial draft of each section generally reflected the author's own research interests and as such each narrative reflects some individuality. Even though the current composition of the EEAC broadly represents the range of research interests of environmental economists in general, the coverage is neither perfect nor complete. It is certainly possible that if each topic had been assigned to a different committee member, the commentaries would have turned out differently. However, language used in the narratives has been accepted by all members of the Committee.

In conclusion, the Committee finds that the list of topics for potential economics research being considered by the Agency is complete and reasonable but that some topics are of significantly greater importance than others. The Committee strongly supports the conduct of research on the economic implications of environmental actions. The SAB hopes that this Advisory is responsive to the Agency's needs at this time and that it helps EPA in guiding its economics research. The Committee is prepared to answer any questions that might arise in this regard.

Sincerely,



Dr. Joan M. Daisey, Chair
Science Advisory Board

Dr. Robert N. Stavins, Chair
Environmental Economics Advisory Committee
Science Advisory Board

APPENDIX A

AGGREGATED RANKINGS FOR PROPOSED RESEARCH TOPICS

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Voting by members yielded average scores ranging from 1.1 to 2.8. Because of ties, these scores can be interpreted as implying fifteen levels of ranking, as follows, beginning with the highest priority:

1.	3B:	Trading Systems (Permits)	[2.8]
2.	1E:	Methods of Valuing Ecosystem Services	[2.7]
3.	1B:	Methods of Valuing Morbidity Risk Reduction	[2.6]
	1C:	Methods of Valuing Benefits for Vulnerable Populations	
4.	1A:	Methods of Valuing Mortality Risk Reduction	[2.5]

5.	3A:	Fees, Charges, Taxes, Subsidies, D-R Systems	[2.4]
	3C:	Liability Approaches	
6.	5A:	Methods of Incorporating Risk and Uncertainty	[2.3]
	5D:	Equity and Distributional Effects of Environmental Regulations	
	6A:	Effects of Regulation on Innovation and Technology Adoption	
7.	4E:	Economic Aspects of Land Use Regulations	[2.2]
8.	1F:	Methods of Valuing Non-Use Benefits	[2.1]
	4G:	Linkages Between International Standards, Trade, and Environmental Quality	
9.	2A:	Methods of Estimating Direct/Indirect Regulatory Costs	[2.0]
	6B:	Retrospective Cost-Benefit Analyses	
10.	1G:	Benefits Transfer Methods	[1.9]
	3D:	Information Approaches; Voluntary Programs for Industry	
	4F:	Linkages; Environmental Quality/Other Regulatory Policies	
11.	4B:	Population Growth, Economic Growth, and Environmental Quality	[1.8]
	4C:	Revision of National Income Accounts to Reflect Environment	
	5C:	Baseline Definitions and Adjustments that Affect Economic Values	
12.	5E:	Effect of Information on Private Economic Behavior	[1.7]
	6D:	Sustainability Indicators	
13.	1D:	Methods of Valuing Other Welfare Benefits	[1.6]
	1H:	Resolving Sensitivity of Some Benefit Estimation Methods	
	4D:	Regulatory Takings, Property Rights, and Compensation	
	6F:	Effect of Government-Provided Information on Innovation	
14.	2C:	Methods of Estimating Public Monitoring/Enforcement Costs	[1.4]
	4A:	Economic Aspects of Pollution Prevention Strategies	
15.	2B:	Methods of Estimating Private Monitoring/Enforcement Costs	[1.1]
	6C:	Economic Impacts on Business/Small Business	

APPENDIX B
MEMBER COMMENTS ON EPA ECONOMIC RESEARCH TOPICS

1. BENEFIT ESTIMATION

Topic 1.A Methods to Improve Estimation of Values for Reductions in Mortality Risks
[Priority Rank = 4 of 15]

We have a good sense of overall mortality risk values for accidental deaths to adults and some estimates for other outcomes such as cancer. We lack good estimates, however, that refine these values depending on the character of the risk and the population bearing it, for example, involuntary environmental cancer risk versus voluntary job accident risk. Adjustment of values for quantities of life extension (or life years saved) remain problematic and controversial, and EPA often makes no quantity adjustment. In its defense, there is no generally accepted rescaling to account for quantity. Saving the lives of children, as opposed to adults, is a key missing valuation component. Resolving these issues will require more than simple analogies based on job safety studies.

Topic 1.B Methods to Improve Estimation of Values for Reductions in Morbidity Risks
[Priority Rank = 3 of 15]

Morbidity risk valuation is even more complex than mortality risk valuation because of the substantial variation across individuals in morbidity outcomes. Similarly caused ailments may have quite different valuations (for example, chronic bronchitis and advanced emphysema). Contingent valuation studies or similar interview approaches can be useful. Attempts to use medical ratings of health outcome severity to rescale some reference health outcome value in a simple fashion are without economic foundation. Many of the same research issues that complicate mortality risk assessments come into play for morbidity risk as well.

Topic 1.C Methods to Evaluate Economic Benefits of Projects Targeted at Children, Elderly, Other Vulnerable Population
[Priority Rank = 3 of 15]

In evaluating projects that target vulnerable populations, three analytical issues arise: (1) does the analysis adequately control for the dose of pollutant received and the population's increased susceptibility to that dose?; (2) does the valuation of the health endpoints acknowledge the impact of increased susceptibility on the individual's willingness-to-pay (WTP) to avoid the health effect?; and (3) should the welfare of vulnerable sub-populations receive greater weight in a benefit-cost analysis? The first issue is the subject of ongoing research by epidemiologists, toxicologists, and specialists in exposure measurement. The second topic is the province of economic research, and it raises some of the same issues as in areas 1.A and 1.B, above. Can we adequately control for the character of the population bearing the risk in measuring WTP to avoid adverse health effects? Finally, whether the welfare of some groups should be given more weight is a normative or policy question, not a subject for economic research.

Topic 1.D Methods to Improve Measurement of Increases in Other Welfare Benefits (For example, Visibility, Materials Damage, Agriculture, Recreation)
[Priority Rank = 13 of 15]

Standard economic theory leads directly to the valuation of changes in environmental quality when the consequences of those changes are exclusively reflected in changes in conditions of supply or demand for market goods, but when externalities, public goods, or quasi-public goods are involved, the analysis becomes less direct and more difficult. Visibility and recreation are two of the classic examples of non-market goods, changes in which must be evaluated indirectly (via travel cost or hedonic property value methods) or by using stated preference methods. Stated preference methods are controversial, but they are the only recourse for the valuation of goods which confer mainly "passive use" values. This reality will continue to drive a need for more research. Efforts must continue to bring stated preference methods more into line with economic theory (and vice-versa). Research in marketing and in cognitive psychology may continue to play a role.

Materials damage to market goods can be evaluated in the usual neoclassical framework, as can damage to agricultural resources such as land (soil quality, erosion, or any other attribute of properties traded in conventional markets). Materials damage to structures of cultural significance (such as acid precipitation damage to monuments or grave markers) is much more difficult to quantify. Stated preference methods of some type are likely to be necessary here as well, and significant progress has not yet been made on valuing many of these types of effects.

Topic 1.E Methods to Improve Valuation of Ecosystem Services
[Priority Rank = 2 of 15]

There is a growing awareness that ecosystems provide a wide range of valuable services to people, beyond the commodity flows and recreation services that have been the focus of most attention over the past 25 years or so. In recent years, the gross air and water pollution problems that have affected people directly have come under increasing control. It is now becoming more important to develop the capability to analyze how changes in the levels of environmental stressors (both increases, and policy-induced decreases) affect the levels of a variety of ecosystem service flows and the values they generate.

Topic 1.F Methods of Valuing Non-use Benefits
[Priority Rank = 8 of 15]

It is widely accepted that some form of contingent valuation is the only tool available for estimating nonuse values. EPA should continue to support the development of better stated preference methods. Still needed is research aimed at improving our understanding of how respondents to stated preference surveys construct values, especially for commodities that they are unfamiliar with thinking about in an economic context. The aim should be to use this understanding to improve the validity of contingent valuation methods more generally.

Topic 1.G Benefits Transfer Methods
[Priority Rank = 10 of 15]

It would be prohibitively expensive to require an original study of the economic benefits of environmental protection programs in every new instance where some value estimate might be required. Original research is necessary when there does not exist any prior estimated value for the environmental good in question. It is more efficient, however, if EPA can exploit systematic knowledge of the types of benefits that accrue in other similar situations. Environmental economists are generally in agreement that it is preferable to transfer *models* that predict economic benefits, rather than simple *point estimates* of benefits, since these models can be used to simulate benefits under conditions that differ from those under which their parameters were estimated.

As the inventory of already-completed studies grows, it may become feasible to discern how the features of an affected environmental resource interact with the characteristics of the affected population to yield typical economic benefits. EPA could simply allow the inventories of existing studies concerning significant environmental

problems to develop in an *ad hoc* fashion. However, EPA could identify gaps in these inventories that prevent relevant sets of existing studies from spanning the range of conditions under which benefits transfer exercises are likely to be necessary. Filling these gaps would hasten the development of models that would allow for broader types of benefits transfer exercises.

Topic 1.H Model Uncertainty; Resolving the Sensitivity of Some Benefit Estimation Methods to Model Specification [Priority Rank = 13 of 15]

Many revealed and stated preference models can generate quite different welfare estimates, depending upon their model specifications. Due to the highly non-nested nature of these models, standard goodness-of-fit tests are often inappropriate, and other methods for assessing the validity of the models must be considered. There is a continuing need for research aimed at learning how widespread this problem is, and, where it occurs, developing appropriate model selection criteria. Furthermore, EPA can play a role by supporting the documentation and archiving of empirical data, including not only data from the studies EPA funds, but also from other studies. Only if data are adequately preserved can the processes of replication and verification by external analysts examine the robustness of benefit estimates or reveal sensitivity to researchers' specification choices.

2. COST ESTIMATION

Topic 2.A Methods to Improve Estimation of the Direct and Indirect Costs of Environmental Regulations to Regulated Parties [Priority Rank = 9 of 15]

In most Regulatory Impact Analyses, direct compliance costs are estimated using an engineering cost approach. It is of interest to know how such calculations compare with econometric estimates of abatement costs, which (in theory) should capture the full range of adjustments that firms make to environmental regulations. Case studies could be conducted for major generators of pollution to compare the two approaches. This, of course, requires data on the inputs and outputs of firms, input and output prices, and the levels of effluents emitted. A reasonable task for EPA is to assure that such data are available. With the demise of the Pollutant Abatement Costs and Expenditures (PACE) survey, it would be appropriate to consider joining forces with other agencies to assure that data collected from firms are appropriate for estimating the costs of environmental regulations. In cases where regulations are likely to have significant general equilibrium effects, it is necessary that the indirect costs of regulations be estimated as well.

Topic 2.B Methods to Improve Estimation of Monitoring Costs Incurred by the Regulated Parties [Priority Rank = 15 of 15]

Surveys to collect data on compliance costs should include questions about expenditures to monitor effluents. Accurate estimation of monitoring costs might not be accorded a high priority on the grounds that these costs are small relative to abatement costs. But the marginal cost of collecting these data should also be small.

Topic 2.C Methods to Improve Estimation of Monitoring and Enforcement Costs Incurred by the Regulating Agency [Priority Rank = 14 of 15]

If information does not currently exist on the monitoring and enforcement actions of state EPAs, it would be useful to conduct a survey to collect this information, including expenditures on monitoring and enforcement costs. This should be a relatively inexpensive survey to conduct. There are research questions that need to control for regulatory resources before judging regulatory outcomes. Few environmental regulatory agencies retain any more than just current data on their budgets, number of personnel, etc., and there is no centralized depository for these data. Panel data (combining cross-sectional and time series data) on these variables would make it easier to judge whether regulatory outcomes are partly explained by differing monitoring and enforcement resources.

3. ECONOMIC INCENTIVES

Topic 3.A Fees, Charges and Taxes; Subsidies; Deposit Refund Systems [Priority Rank = 5 of 15]

The bulk of the work on price-based economic incentives that EPA needs to carry out is in the realm of implementation. For the most part, research questions are associated with measuring the effectiveness of existing programs that use this type of incentive. This would include unit pricing for trash disposal, fees for hazardous waste generation and disposal and tax-based subsidies. Research could effectively investigate existing programs, not only in the U.S., but also overseas. There remains a need to investigate the efficiency properties of less direct economic incentives, such as fees based only on observation of ambient quality, and fees on inputs or outputs related to effluent production.

Topic 3.B Trading Systems (Permits)
[Priority Rank = 1 of 15]

The attention given to developing tradeable permit systems for various environmental problems continues to increase. Much research has already been dedicated to examining the feasibility of these systems for new applications, but too much of this work has contrasted *perfectly-functioning* tradeable permit systems (i.e. cost-effective systems that perfectly equate marginal abatement among sources) with conventional policy approaches. More attention needs to be devoted to assessing reasonably constrained prospective programs, taking account of such impinging factors as transaction costs, market concentration, and the pre-existing regulatory environment (including interactions with existing, distortionary taxes). Even more valuable, at this point, would be better retrospective analyses of existing or past tradeable permit systems, including the Emissions Trading Program, the leaded gasoline phasedown, the SO_2 allowance trading program, Regional Clean Air Incentives Market (RECLAIM), and others. With the exception of the SO_2 program, empirical assessments have been limited by data availability, particularly with regard to trading volume and prices. Were such data made available and the scholarly research community made aware of its availability, research would be initiated, even without EPA funding.

Topic 3.C Liability Approaches
[Priority Rank = 5 of 15]

The existing liability system has proven to have high transactions costs, to deal poorly with assessment of scientific information, and to yield inconsistent results across jurisdictions and cases. Research is needed to investigate whether institutional remedies for these defects can be found in specific applications, such as CERCLA and toxic torts. Research is also needed to learn how significant the deterrent effect of the liability system has been, and to evaluate the extent to which possible insolvency affects this deterrent effect.

Topic 3.D Information Approaches; Voluntary Programs for Industry
[Priority Rank = 10 of 15]

There is some evidence that such approaches have been cost-effective. However, absent proper experimental design in the programs' construction, evaluations have been hampered and subject to possibly severe selection bias. Proper evaluation processes and data collection should be built into the design of voluntary and informational programs. Research is also needed to clarify which information disclosure requirements are effective in bringing about change, which incentives (and implicit threats) are effective in motivating

voluntary actions, and which issues are most (and least) amenable to informational approaches.

4. ECONOMIC POLICY

Topic 4.A Economic Aspects of Pollution Prevention Strategies [Priority Rank = 14 of 15]

Although industrialists increasingly espouse "ecoefficiency" — reducing pollution profitably by eliminating resource waste — economists debate whether such win-win opportunities are significant. The key issue is whether market, regulatory, and informational barriers act as obstacles to implementing win-win possibilities to reduce pollution and save money. Useful research would involve EPA in partnerships to investigate important industrial sub-sectors to try to identify such obstacles. There would need to be a commitment on government's side to try to eliminate obstacles that are found, if possible, and on industry's side to undertake the pollution prevention investments, if possible.

Topic 4.B The Relationship Between Population Growth, Economic Growth, and Environmental Quality [Priority Rank = 11 of 15]

The linkages between population growth, economic growth, and environmental quality have received only limited attention by EPA. To deal with this broad issue, is it useful to consider the macroeconomy as an open subsystem of the larger biophysical ecosystem, dependent on the larger system for inputs of low-entropy resources and absorption of high-entropy waste? If such a viewpoint is adopted, then is it not reasonable to ask how large a burden of extraction and insertion the economy can impose on the larger system, and at what point marginal costs of ecological disruption outweigh the marginal benefits of expansion of the economy? In other words, is there not an optimal physical scale of the economic subsystem relative to the containing ecosystem? In microeconomics, the Marginal Benefits = Marginal Costs (MB = MC) rule of optimization is sometimes aptly called the "when to stop" rule. An analogous rule is lacking in macroeconomics, even at the conceptual level. EPA could sponsor fundamental theoretical and empirical research on developing a macroeconomic analog to the microeconomic logic or show why the "when to stop" rule has no relevant analog in macroeconomics.

There are other issues regarding how the environment and ecosystem affect the macroeconomy. An understanding of the relationship among environmental quality,

economic growth, and population growth is an important component in analysis of the global macroeconomy. At the national level, the role of scarce environmental resources and valuable ecosystem services in the macroeconomy is also poorly understood. There are other important issues involving the interaction between population growth, economic growth, and natural resource degradation in developing countries. Poverty and population growth may lead to deforestation, with concomitant problems of soil erosion, desertificaiton, and the release of greenhouse gases. Research in this area is needed to better quantify these relationships and to understand how various policies could influence the rate of environmental degradation.

Topic 4.C Methods to Revise National Income Accounting Procedures to Better Reflect Environmental Aspects of Changes in Productivity, Assets, and Welfare (Green Accounting) [Priority Rank = 11 of 15]

Conventional national income accounts are not intended to provide measures of welfare, but policy makers around the world, and the general public as well, tend to focus on changes in gross domestic product as the central measure of national economic health. Is Hicksian income the theoretical concept that the net national income account should try to approximate? If not, what is? Is a part of what we currently measure in Net National Product (NNP) is really consumption of natural capital? If so, should not that capital consumption be subtracted from gross income, as is consumption of manmade capital? Are not "defensive expenditures" more in the nature of intermediate costs of other products than final goods, and if so should they not be excluded from net national income? What is the evidence that, in the U.S. today, further growth in aggregate NNP really increases welfare? To what extent might mismeasures of NNP and a loose connection between NNP and welfare bias policy decisions, especially those related to the environment? Although considerable research has been done over the past decade to identify improvements in national income accounts that would reflect depreciation of natural capital, more work needs to be done. This is an area where EPA could reasonably partner with other agencies, such as the Departments of Commerce and Labor, if it has not already done so.

Topic 4.D Regulatory Takings, Property Rights, and Compensation [Priority Rank = 13 of 15]

This issue requires input from both law and economics. The weighting of the sovereignty of land ownership versus the externalities associated with certain land uses is at the heart of this issue. Society's ability to address certain types of resource losses will hinge on resolution of takings issues. Research might reasonably involve both conceptual,

interdisciplinary work and case studies of the ultimate impact on property values of apparent "takings."

Topic 4.E Economic Aspects of Land Use Regulations [Priority Rank = 7 of 15]

The term "land use regulation" generally refers to state and local government regulations that affect the taxation of different types of land use and the regulation of the location and configuration of development. Since land use and land use patterns are the principal drivers of non-point source pollution, the effect of these regulations on land use conversion decisions has implications for the environment. Land use regulations also affect the siting of industry and thus have implications for the spatial distribution of point sources. Research on plant siting has a longer history than the more recent work on changes in land use patterns (specifically conversion of forest and farmland into residential and commercial use.) In the last several years, state and local governments have become especially interested in using a variety of land use management tools to try to "direct" growth in patterns that mitigate rapidly rising expenditures on public goods. However, because they affect land use patterns, these tools can have significant ecological effects. Although EPA does not typically have regulatory authority in land use management, EPA-sponsored research in this area that explores how land use conversion decisions are affected by land-use regulations would be useful. This would assist local governments, which are in no position to do this research themselves, and could identify the ecological and public finance consequences of these land-use regulations.

Topic 4.F Economic Aspects of Linkages Between Environmental Quality and Other Regulatory Policies (urban planning, transportation, energy, agriculture, etc.) [Priority Rank = 10 of 15]

The previous section concerned those regulations that directly affect conversion among different land uses and thus alter the spatial patterns of land uses. In addition, there are many other regulatory policies that either indirectly affect land use conversion or that alter the "practices" associated with any given land use. An example of the former is the building of a major road or the reduction of the gas tax, either one of which would increase the value of a more remote location for residential construction. An example of the latter might be agriculture or urban best management practices. The importance to EPA once again hinges largely on the importance of non-point sources of pollution. The impact of EPA research on decision-makers' responses to these policies depends to some extent on how many of these policies can be influenced by EPA. There are many researchers working on the agriculture-environment interface; the problem here is not

lack of research interest, but confidentiality of data. Environmental economists have been working on air quality issues surrounding the Intermodal Surface Transfer Efficiency Act (ISTEA), but the land use implications have not been sufficiently studied. There may be many counterproductive, inconsistent policies promulgated by different agencies. An assessment of the most seriously conflicting policies, together with developing a means to address them (jointly with other agencies) could have considerable payoff.

Topic 4.G The Linkages Between International Standards and Trade and Effects on Environmental Quality
[Priority Rank = 8 of 15]

This remains a poorly understood area of economics. Although there has been some research, both empirical and theoretical, the complex relationships among environmental regulations, international trade, and environmental quality are not fully understood. If environmental regulations can affect trade, then we may expect to see pressures to relax environmental regulations, as the world becomes more economically integrated. Furthermore, as environmental problems evolve that are more international in scope and as the world economy becomes more integrated, this is bound to be a significant area for EPA investigation.

5. OTHER ISSUES AFFECTING OR RELATED TO ECONOMIC ANALYSES

Topic 5.A Methods of Incorporating Risk and Uncertainty into Economic Analyses and Risk Assessments
[Priority Rank = 6 of 15]

The problems of dealing with risk and uncertainty in economic analysis are significant for EPA, whether the sources of the uncertainty are economic or from the underlying natural science. Clearly risk and uncertainty will be dominant themes in the environmental problems that EPA will be facing in coming decades. Although we have some basic understanding of how to incorporate risk into analysis, at least theoretically, our knowledge is incomplete at the level of implementation. This is particularly the case for making regulatory decisions that involve intertemporal issues with long time horizons, such as climate change and species preservation.

Topic 5.C Baseline Definition and Adjustments That Affect Economic Values [Priority Rank = 11 of 15]

This topic refers to the difficulties involved in linking human preferences to scientific environmental indicators. Economic theory provides little or no guidance as to what environmental measures enter individual preference functions. Researchers often arbitrarily choose quantitative environmental measures for use in empirical studies depending largely on data availability and/or simple intuition of the analyst. The degree to which these arbitrary decisions may bias resulting benefit measures has received little attention, yet benefit estimates might be quite sensitive to these choices. This is fundamentally a measurement error problem. Reducing these measurement errors may provide large returns in the form of more accurate benefit estimates from research. Such work would likely require interdisciplinary teams where environmental economists would work with wildlife biologists, ecologists, or other physical scientists to develop an understanding of these linkages.

Topic 5.D. Equity Issues and Distributional Effects of Environmental Regulations [Priority Rank = 6 of 15]

In recent years, increasing attention has been paid to environmental justice or, more generally, to which households and individuals bear costs and which receive benefits. Unfortunately, much of the discussion of the incidence of costs and benefits has been anecdotal and impressionistic. The reasons for not being more systematic typically include lack of data, lack of time, or both. EPA could foster research aimed at developing standard, disaggregated (household-level?) data sets and methods of analysis that would enable investigators to obtain useful approximations (if not necessarily exact information) on the incidence of costs and benefits associated with environmental protection. If it were likely to succeed, this project might merit high priority, but since the likelihood of success may not be very great, EPA ought not spend very much to develop a system for incidence analysis. Nevertheless, EPA might develop one or more small contracts for, in effect, preparation of a detailed proposal for the development of such a system.

Topic 5.E Effect of Information on Private Economic Behavior [Priority Rank = 12 of 15]

The area of greatest payoff may be studying which socio-demographic groups benefit from what type of information, and what form of information provision from what types of sources is effective for these various groups (television advertisements, school education programs, web pages, hot lines, etc.). Given the concerns associated with risks

such as radon, lead poisoning, asbestos, and climate change, such research seems appropriate.

6. OTHER ECONOMIC ISSUES FOR RESEARCH

Topic 6.A Effect of Regulation on Innovation and Technology Adoption [Priority Rank = 6 of 15]

There are two major economic dimensions along which various types of environmental policy instruments are thought to differ: static cost-effectiveness; and dynamic incentives for the adoption of environmentally superior technologies. This second category might be summarized as "dynamic cost-effectiveness," that is, the present discounted value of the future stream of abatement costs, affected by the rate and direction of technological change. There are substantial literatures that examine in theoretical terms the cost effectiveness and the dynamic efficiency properties of alternative environmental policy instruments, but there have been exceptionally few *empirical* analyses of the relative dynamic efficiency attributes of alternative policy instruments.

In order to achieve widespread benefits from a new technology, three steps are required: *invention* -- the development of a new technical idea; *innovation* -- the incorporation of a new idea into a commercial product or process and the first marketplace implementation thereof; and *diffusion* -- the typically gradual process by which improved products or processes become widely used. All types of environmental policy instruments have the potential for inducing or forcing some amount of technological change, but empirical (most likely, econometric) analyses are required of the effects of alternative environmental policy instruments on the invention, innovation, and diffusion of new technologies, and of the effects that these induced changes have on pollution abatement costs.

Topic 6.B Retrospective Cost-Benefit Analyses (Includes Comparative *ex ante* and *ex post* Evaluations of Costs) [Priority Rank = 9 of 15]

Section 812 of the 1990 Clean Air Act Amendments reflected an argument accepted by many observers: there is much to be learned through the careful evaluation of the actual effects of ongoing programs. Instead, most analytical energy is devoted to prediction of the effects of proposed programs. Conventional wisdom (and experience with the 812 studies) has also made clear the difficulty of having an agency candidly evaluate its own programs and activities. The 812 experience reinforced the importance of asking useful questions: knowing the overall costs and benefits of clean air programs

does not help make any real decisions, for instance. Regular performance of retrospective analysis will be of value, but we believe it should be performed outside EPA, preferably by entities that do not depend on EPA for the bulk of their revenues. We would also suggest that the selection of retrospective analysis proposals for funding should be done by a committee on which EPA employees play at most a minority role.

Studies comparing *ex ante* and *ex post* evaluations of costs could provide valuable information, but only if undertaken primarily to improve *ex ante* cost estimation methods. Simple comparisons do not seem to be of much potential use in this regard. Finding that past *ex ante* estimates have overstated *ex post* costs by some percent on average, for instance, invites a simple adjustment to future *ex ante* estimates. This sort of adjustment will be resisted on the grounds that the *ex ante* situation being considered differs from the average of the past situations studied and that different methods of cost estimation have been employed. More useful would be a study that explained past errors as a plausible function of observables. We think it unlikely, however, that useful and persuasive results will be obtained, in part because we lack the tools necessary to forecast technical progress with any accuracy.

Topic 6.C Economic Impacts on Business/Small Business [Priority Rank = 15 of 15]

General equilibrium effects aside, it is not conceptually difficult to evaluate effects of particular programs on particular sectors. Apart from a general shortage of data, analysis of impacts on small business poses no novel general issues. There is a widespread perception that costs imposed on small firms are borne by less wealthy people than are costs imposed on large firms. It would be interesting to know how true this is, but this is a difficult issue to study (in part because it is hard to identify the owners of small firms) and not of central importance to EPA.

Topic 6.D Sustainability Indicators [Priority Rank = 12 of 15]

The word “sustainability” came to have political value and meaning for policy makers before many economists had given direct attention to the concept. But research has begun to examine what sustainability might mean from an economic perspective. Numerous questions remain. Does Hicksian income already embody the idea of sustainability and therefore provide the best conceptual basis for elaborating and measuring sustainability? Is there a better basis? If we start with the concept of Hicksian income, then would not the relevant operational indicators be measures of total capital, consisting of manmade and natural capital? What is the best way to measure natural

capital? Must both categories be maintained intact, or only the sum of the two? This depends on whether manmade and natural capital are fundamentally substitutes or complements. Even before this issue is resolved, would partial physical indicators of natural capital levels and changes be useful? What set of partial physical indicators best reflects overall changes in the state of natural capital?

Topic 6.F Effect of Government-Provided Information on Innovation [Priority Rank = 13 of 15]

In section 6A, above, we considered research on the effects of alternative types of environmental regulation on the rates of technology innovation and diffusion. Government-provided information is one such type of policy instrument. In the recent past, a number of studies have examined the effects of specific government information programs on the rate and direction of technological change, particularly but not exclusively in the context of government energy-efficiency labeling programs. More work should be carried out.

APPENDIX C
ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CV	Contingent Valuation
ISTEA	Intermodal Surface Transportation Efficiency Act
MB	Marginal Benefits
MC	Marginal Costs
NNP	Net National Product
PACE	Pollutant Abatement Costs and Expenditures survey
RECLAIM	Regional Clean Air Incentives Market

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