PROCEEDINGS

1998 DECISION-MAKING AND VALUATION FOR ENVIRONMENTAL POLICY WORKSHOP

2-3 April 1998
Washington, DC

Sponsored by the NSF/EPA Partnership for Environmental Research

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Introduction

On December 8, 1994, the National Science Foundation (NSF) and the Environmental Protection Agency (EPA) signed a Memorandum of Understanding establishing a partnership for the support and merit review of fundamental, extramural environmental research. Annual competitions funded through this partnership include: Technology for a Sustainable Environment, Environment Statistics, Water and Watersheds, and Decision-Making and Valuation for Environmental Policy.

The Decision-Making and Valuation for Environmental Policy competition was one of the competitions sponsored in Fiscal Year (FY) 1996 by the NSF/EPA Partnership for Environmental Research. Using panels of experts from outside the agencies, NSF and EPA staff reviewed 133 proposals and made 13 awards totaling $2.6M. Research was encouraged on the identification and measurement of values, with an emphasis on situations where prices or comparable standards of worth are deficient or absent, and on alternatives for involving groups and organizations in environmental decision-making. Research was solicited in four related areas:

- ***Costs of Environmental Programs:*** This area of research seeks to find and test integrated models and improved methods to estimate and validate aggregate and sectoral costs of environmental protection programs and policies.

- ***Ecosystem Valuation:*** Scientific advances in ecosystem research require a better understanding of the interconnections among social, economic, physical, and biological systems. Research in this area identifies valuable ecosystem functions and focuses on how comprehensive and critical ecosystem changes can be measured in terms of social welfare.

- ***Benefits of Environmental Programs and Policies:*** This area of research seeks to develop methods to improve estimations of values of environmental protection programs and reductions in mortality and morbidity risks resulting from pollution and other environmental hazards.

- ***Decision-Making for Environmental Policy:*** This area of research examines the behavioral and institutional factors that influence the development, implementation, and evaluation of environmental policies. Improved understanding of these influences can lead to improvements in policy design and acceptability.

The April 2-3, 1998, Workshop on Decision-Making and Valuation for Environmental Policy provides a forum for investigators funded by the FY 1995 and 1996 competitions to interact with one another and with EPA, NSF, and other federal officials interested in valuation research. For the proceedings volume, investigators were asked to contribute statements describing the objectives and significance of their work as well as preliminary findings from their first year of research.

The NSF/EPA Decision-Making and Valuation for Environmental Policy competition was executed again in 1997. The competition reviewed 69 proposals and made 15 awards. In FY 1998, an expanded Decision-Making and Valuation for Environmental Policy Program has received approximately 120 proposals. Decisions on these proposals are expected by July of 1998.

Any opinions, findings, conclusions, or recommendations expressed in this report are those of the investigators who participated in the research. For further information about this competition, please contact the Program Officers: Ms. Deborah Hanlon, EPA, Office of Research and Development, 202/564-6836, or Dr. Rachelle Hollander, NSF, 703/306-1743.

Further information on the competition, abstracts, and results of funded research and future solicitations may be found on the EPA National Center for Environmental Research and Quality Assurance Home Page at http://www.epa.gov.ncerqa.

Effective Environmental Policy in the Presence of Distorting Taxes

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Lawrence Goulder
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Traditional analysis of environmental problems is cast in a so-called "first best" setting absent distortions away from economic efficiency other than environmental externalities. This project is investigating the cost of environmental policies in a more realistic "second-best" setting in which the economy is distorted away from economic efficiency prior to the adoption of environmental policy. The economic cost of policy instruments is being investigated in the presence of preexisting distortionary taxes, and guidance for policymakers for the choice of instruments to reduce the cost of environmental policies is being developed.

Environmental policies offer benefits through environmental improvement and by imposing costs on firms that raise product prices to better reflect the social opportunity costs of resources used in production. However, set in a context with preexisting distortionary taxes, an offsetting detrimental effect is identified. The increase in product prices serves to lower the real wage of workers, which can be viewed as a "virtual tax" layered on top of preexisting taxes that amplifies the distortions of the tax system. Some environmental policies have a third effect stemming from their ability to raise revenues that in principle could be used to reduce preexisting taxes, offsetting the tax-interaction effect to an important but only partial degree.

This project focuses on the comparison of revenue-raising and nonrevenue-raising instruments and evaluates their economic cost in achieving a stated environmental goal. Analytical and numerical general equilibrium models are used to examine the costs of pollution reduction under a range of environmental policy instruments in a second-best setting with preexisting factor taxes and to provide guidance for the choice of policy instruments under various circumstances. The presence of distortionary taxes raises the costs of pollution abatement under each instrument that is examined (i.e., taxes, nonauctioned permits, performance standards, fuel [output] taxes and technology standards) relative to its costs in a first-best world. For plausible values of preexisting tax rates and other parameters, the cost increase for all policies is substantial (35 percent or more). This extra cost is an increasing function of the magnitude of preexisting tax rates.

Policies that raise revenues promise to significantly out-perform policies that fail to do so. For instance, nonauctioned permits can be several times more expensive than environmental taxes or auctioned permits. A detailed analysis of the SO_2 emission allowance trading program indicates that preexisting taxes raise the cost to the economy of this regulation by $907 million per year, adding an additional 70 percent to the compliance cost for the program. If the program were to raise revenue, this could reduce the cost by $533 million according to our model. Earlier work on instrument choice has emphasized the potential reduction in compliance cost achievable by converting fixed emissions quotas into tradeable emissions permits. This project's results indicate that the regulator's decision of whether to auction or grandfather emissions rights can have equally important cost impacts.

The cost differences among instruments depend importantly on the extent of pollution abatement under consideration. For small emission reductions, the investigators found that nonauctioned permits perform relatively worse. For instance, the costs of reducing carbon emissions by 10 percent are more than 300 percent higher using nonauctioned permits than under a tax. Strikingly, for all instruments, except the fuel tax, these costs converge to the same value as abatement levels approach 100 percent. Figure 1 indicates the net efficiency gain of taxes and nonauctioned permits in achieving climate change goals, when emissions are set at the so-called "Pigouvian level," calibrated to an efficient level in a first-best world absent preexisting taxes. The horizontal axis indicates a range of potential marginal damages from carbon that in turn determine the Pigouvian level of emission reductions (not shown), and the vertical axis indicates benefits less costs (net benefits). The top curve shows the efficient carbon tax if there are no preexisting taxes in the economy. The middle curve shows the efficient carbon tax given preexisting taxes. Though it is uniformly lower, both yield positive net levels for any level of marginal damages and an associated goal for emission reductions. The bottom curve indicates the net benefits if a nonauctioned permit (carbon quota) scheme is used to achieve the Pigouvian level of emission reductions. Over a large range of plausible marginal damage estimates, the net benefits of this type of policy are negative.

The investigators are modeling the institutional setting of the U.S. electric utility industry to consider the regulation of multiple pollutants, other environmental policies special to the industry, and various forms of imperfect competition and market structure. Other important extensions have to do with the role of heterogeneity among firms and the relationship between environmental quality, economic productivity, and labor supply.

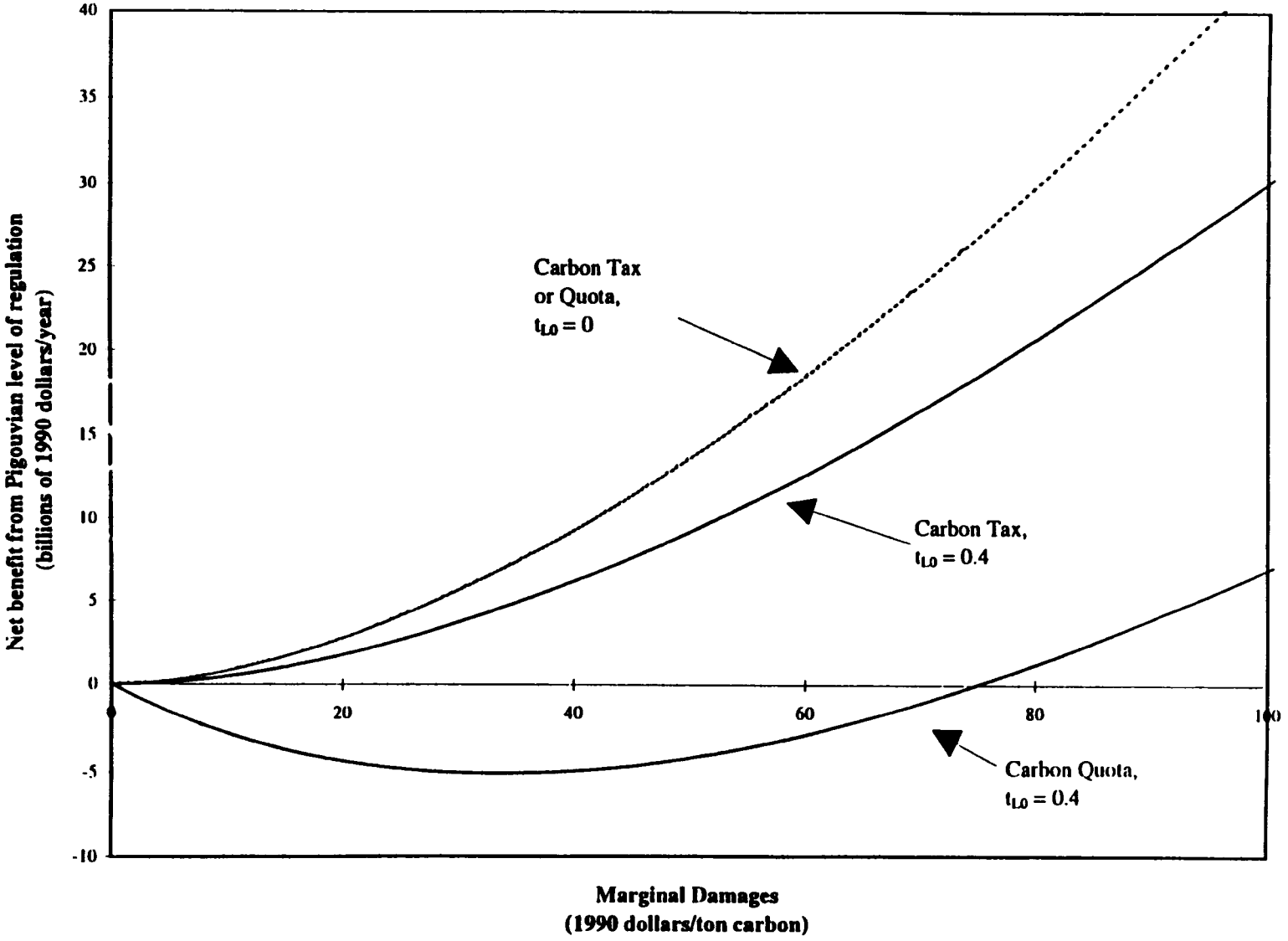

Figure 1. Net efficiency gain under the Pigouvian rule.

Policy Applications for the Patuxent Watershed Ecological-Economic Model

Jacqueline Geoghegan
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The spatial distribution of land-use/land cover change (LUCC) as a cause of other environmental change is well documented in the natural sciences. The spatial modeling of anthropocentric land-use change within the domain of the social sciences, especially economics, has been much more limited. Although it is true that two of the major LUCC categories: urbanization and tropical deforestation, have been extensively studied by economists, these are rarely spatially dissaggregated or spatially explicit. LUCC is a spatial process and must be modeled as such. To explain and predict LUCC, models must be developed to address where, when, and why LUCC happens.

This project extends work begun under an Environmental Protection Agency cooperative agreement in which a preliminary spatial econometric model of land-use change was developed for the Patuxent Watershed in Maryland that focuses on the large majority of land-use changes in the study region: open uses (forestry and agricultural) to residential uses. The first extension to the original spatially explicit hedonic model of residential land values is to include detailed information on the different types of open space around a residential land parcel, in addition to location and other attributes of the parcel. Two types of open space are included: publicly owned parks and privately owned forest land as well as agricultural land.

The investigators hypothesize that individuals will value these "permanent" open spaces differently than "developable" open spaces in their valuation of residential land. Preliminary results show that homeowners are willing to pay a premium to live near permanent open space. This estimated hedonic model is then used to create predicted spatial maps of value of undeveloped land if it was to be put in residential use, given the existing set of the natural, human, and regulatory landscape.

The second stage of modeling and the second research innovation currently under way involve estimating a duration model of historical land-use conversion decisions. In this stage, historical decisions of land-use change are modeled as functions of the expected returns and expected costs at each point in time from the conversion of land-use from agricultural and forestry uses to residential development. These expectations will be a function of the value in original use, predicted value in residential use (derived above), and costs of conversion, which include regulatory costs.

Once the parameters of these two stages of the model are estimated, the model is used to generate the relative probabilities of conversion of different developable parcels in the landscape. A spatial pattern of relative development pressure is obtained as a function of characteristics of the parcels and their locations.

Because the explanatory variables used to predict the values in residential and alternative uses and the costs of conversion are all functions of ecological features, human infrastructure, and government policies, the effects of changes in any of these variables on land-use change can be simulated.

Valuation of Risks to Human Health: Insensitivity to Magnitude?

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The validity of contingent-valuation (CV) based estimates of willingness to pay (WTP) have been criticized on the basis that estimated WTP is not sufficiently sensitive to the magnitude of the good being valued. In contrast to other contexts, where the WTP for different quantities of a good often should be less than proportional to the quantity offered, conventional economic theory predicts that WTP for reductions in period-mortality risk should be proportional to the magnitude of the risk increment (except for a small income effect). This project's goals are to: (1) determine the extent to which inadequate sensitivity to magnitude is a barrier to eliciting valid estimates of WTP for reduction of risks to human health, and (2) develop and test (using split samples) alternative methods for communicating risks that may promote consistency between empirical and theoretical estimates of WTP.

A series of CV studies of WTP for reductions in health risk are being undertaken. These studies differ in the format (i.e., telephone vs. telephone/mail/telephone vs. in-person), the health risks presented (e.g., automobile accident, food-borne illness, blood transfusion), and the materials used to describe changes in health risks.

A series of verbal "probability analogies" were developed for use in telephone surveys. Focus groups and pilot tests were used to identify the most promising analogies, which were subsequently tested in a split-sample telephone survey. Visual risk communication devices (i.e., risk ladders, colored graph paper) are currently in development and will be tested using in-person and telephone/mail/telephone surveys. Risk-communication materials are evaluated by the extent to which they facilitate or impede obtaining estimated values that are consistent with theoretical predictions of the sensitivity of WTP to the magnitude of risk reduction.

This project's results reflect substantial variation between topics and details of the elicitation process. In telephone interviews, statistically significant differences were found consistently in WTP for automobile accident risk using an alternative elicitation format (in which the risk reduction required for a specified cost increment is elicited) instead of the conventional format. No difference was found in WTP to reduce the risk of food contamination, despite an order-of-magnitude difference in the risk. A comparison of WTP for qualitatively different risks of viral infection transmitted by blood transfusion indicates some sensitivity to risk magnitude. In all three risk contexts, use of the probability analogies to convey risk had a modest effect on improving the consistency of estimated and theoretical sensitivity to scope. Initial results suggest that verbal communication of small risk changes is challenging and casts some doubt on the validity of prior studies that elicited values for risk reduction using verbal descriptions.

Materials are being developed for a mixed telephone/mail/telephone format survey. This format will allow us to use visual aids for communicating risk magnitudes to respondents. In contrast to the limited means of communicating risks that are available in a telephone survey, these visual materials may lead to improved respondent understanding of the specific risk changes and greater consistency of estimated WTP with theoretical expectations.

Updating Prior Methods for Nonmarket Valuation: A Bayesian Approach To Combining Disparate Sources of Environmental Values

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This project uses a Bayesian framework to provide a systematic approach to integrating and interpreting data from disparate sources. For data integration and benefits transfer problems, the Bayesian paradigm provides a natural and internally consistent way of framing the problem and for developing methodological solutions. The framework is being applied to the combination of contingent valuation and travel cost data, the combination of travel cost and contingent behavior data, and to the transfer of travel cost or contingent valuation data from a set of studied sites to an unstudied policy site. This project's objectives are to: (1) develop and test Bayesian procedures for combining disparate sources of nonmarket valuations, (2) develop and test Bayesian procedures for benefits transfer, and (3) estimate the value of wetland restoration in the State of Iowa.

To explore the Bayesian methods in nonmarket valuation, the investigators proposed to undertake primary data collection via mail surveys. Specifically, 2,000 current fishing and hunting license holders in the State of Iowa are being randomly sampled as well as 4,000 Iowa residents drawn from the general population. A pretest of 600 Iowa residents was completed in the fall of 1997, and the full-blown study is being administered. The survey elicits several kinds of information from respondents. First, a series of questions is posed concerning the various visits that these individuals made during the past year to wetland areas across the state. For this task, the state is divided into 15 wetland regions. The number and location of the trips are elicited as well as information on the types of activities undertaken while at these sites (e.g., hunting, fishing, biking/hiking, nature viewing). After establishing their current usage pattern, the survey respondents are then asked a contingent behavior question. In particular, the respondent is asked whether he or she would have taken at least one visit to a specific location if the price of visiting that location was higher (this amount is the "bid"). Both the bid amount and the "location" are varied from survey to survey. The respondent is asked then how many trips he or she would have taken to each of the wetland areas, assuming that this new, higher cost of taking the trip was in effect. A protest question completes this portion of the survey.

The next major section of the survey collects information on a variety of issues related to current knowledge about wetlands and opinions about how these areas should be managed. This section is intended primarily to provide information for policy analysts in the state and for private and public agencies with interests in the amount of public awareness regarding wetland issues. The third component of the survey contains a detailed scenario concerning one of two major wetland areas in the state. One of the scenarios concerns the Prairie Pothole Joint Venture, a program that has restored wetlands in several states in the upper Midwest, including Iowa, as well as in portions of Canada. This restoration has been accomplished both by purchasing land outright from willing sellers and by developing a variety of easements where landowners retain the ownership of these lands, but agree to restore the land to its original prairie pothole wetland state. In this scenario, the Prairie Pothole Joint Venture is described, and a single-bounded contingent valuation question is asked concerning the respondent's willingness to pay for increased conversions of land via this program.

The second scenario is based on the Iowa River Corridor Project, a second major wetlands restoration effort in the State of Iowa. The Iowa River Corridor is an area of saturated soils that experiences frequent flooding and encompasses approximately a 50-mile stretch along the Iowa River in central Iowa. As a consequence of the 1993 floods in the region, many landowners became interested in alternatives to traditional farming practices. As a result, the Natural Resource Conservation Service initiated the Iowa River Corridor Project, where landowners were given the option of enrolling their land in the Emergency Wetlands Reserve Program and would receive a one-time payment equal approximately to the value of their farm crops in exchange for a permanent easement on the land. The Natural Resource Conservation Service then restores the land to wetlands. In this version of the survey, the Iowa River Corridor Project is described to respondents. Respondents are asked about their willingness to pay for an additional 7,000 wetland acres in the region. Further, respondents are asked how many additional visits they would take to wetlands in the area.

The final section of the survey is common to both the Prairie Pothole and the Iowa River Corridor versions and gathers information concerning socioeconomic variables such as age, education levels, gender, and income. During the remainder of this project, efforts will turn towards the development and testing of Bayesian procedures for combining the various revealed and stated preferences obtained through the mail survey.

Optimal Experimental Design for Conjoint Analysis

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To assess the total value, including use and nonuse values, of nonmarket goods such as environmental amenities, researchers often apply survey techniques that allow them to explore public preferences for hypothetical goods or services. The standard survey technique for this purpose has been the contingent valuation (CV) method. Recently, conjoint analysis has been used in several environmental contexts. Conjoint analysis is a marketing technique that can be used to assess values for attributes of market or nonmarket goods based on survey respondents' willingness to trade-off different bundles of these attributes.

In a conjoint analysis survey, respondents are presented with a set of scenarios that differ in terms of a series of attributes and are asked to rank the alternative scenarios, or choose their most preferred. The scenarios in the choice set differ by the levels of the different attributes. A major cost consideration in conducting surveys for environmental valuation is the per unit cost of survey administration. At current costs, sample sizes are often limited to the smallest that researchers feel is necessary for a particular problem. By employing optimal survey design techniques, practitioners can increase the informational content of each observation, producing the equivalent effect of a larger sample size.

This project's goal is to determine optimal attribute levels and choice sets for conjoint analysis questions that, given a fixed number of observations, will provide the most information possible about parameter estimators of interest such as mean or median willingness to pay.

This project will extend the existing literature on the optimal design of conjoint analysis surveys in two ways: (1) it will consider attribute levels as well as choice sets as variables in the optimization problem, and (2) it will derive "optimal" designs as opposed to "efficient." The focus will be on deriving "D-optimal" designs, that is, designs that maximize the determinant of the information matrix.

Mortality Risk Valuation and Stated Preference Methods: An Exploratory Study

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Recent analyses of the benefits and costs of environmental regulations, such as EPA's *Retrospective Cost-Benefit Analysis of the 1970 Clean Air Act* and the *Regulatory Impact Analyses for Ozone and Particulates*, pivot around the estimates of the benefits from reducing mortality risks. Each of these studies relies on valuation literature that, being based primarily on hedonic labor market studies of accidental workplace deaths and on contingent valuation studies of reducing accidental death risks, is not necessarily applicable to the population and type of risk reduction appropriate to the case of pollution-induced mortality.

This project is designed to begin filling some of the gaps in the mortality risk valuation literature, focusing on the effect of current age and age of life extension on willingness to pay. The investigators have developed two unusually explicit contingent valuation instruments that are administered in-person and with visual aids—one presenting the "commodity" to be valued in terms of risk reductions, the other presenting the "commodity" in terms of life expectancy changes. These instruments have been developed using a "think aloud" protocol to help reveal how individuals process and interpret key concepts in valuing mortality risk reductions. These concepts include: small probabilities, tradeoffs, mortality risks, the hazard rate, the rate of time preference, conditional probabilities, and framing. Also, a protocol for identifying individuals who demonstrate a lack of understanding of some of these concepts is being tested.

The beginning section of the mortality risk survey is designed to educate and familiarize the subject with key concepts and the idea that he or she may already pay money to reduce death risks faced in daily life. The heart of the survey includes three sets of willingness-to-pay questions addressing a product or action that causes the following: (1) a reduction in their chance of dying of 5 in 1,000 over a 10-year period beginning now, (2) the same, but for a 1 in 1,000 risk reduction, and (3) a reduction in the chance of dying of 5 in 1,000 over a 10-year period beginning at age 70. The concluding section contains extensive debriefing material to test whether our scenarios and commodity descriptions were credible to the subject.

Policy, Norms, and Values in Forest Conservation: Protected Area Buffer Zone Management in Central America

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This project focuses on human forest conservation behaviors that contribute to patterns of forest cover that enhance the conservation benefits of parks and protected areas. The norms and values that may motivate forest conservation behavior in economically less developed countries are changing in important ways. Surprising findings from recent research indicate that people in poorer countries value the environment as much as their counterparts in wealthier parts of the world. Exposure to an expanding array of sometimes conflicting values can lead to social fragmentation, value conflicts between individuals, and uncertainty about socially appropriate environmental behaviors. This situation leads to the following theoretically derived empirical questions about subjectively held environmental values or value orientations: (1) What is the incidence of such value orientations in society? (2) What is the degree of heterogeneity among value orientations? and (3) What is the social and political content of environmental value orientations?

This project is evaluating the role of values in environmental behavior and focuses on the following objectives: (1) to determine the sources of environmental norms and values in economically less-developed settings, focusing on hypotheses posed in recent literature; (2) to specify relationships between environmental norms and values and forest conservation behaviors in protected area buffer zones; (3) to evaluate outcomes of self-reported forest conservation behaviors with objective measures of forest management and change; and (4) to develop policy recommendations on protected area buffer zone management based on research findings. Research is being conducted in the Central American countries of Costa Rica and Honduras. In Costa Rica, tropical research and ecotourism have drawn substantial attention to environmental issues. Costa Ricans are heavily exposed to a variety of environmental messages. In contrast, Honduras is one of the poorest countries in the Western Hemisphere. Although deforestation and environmental destruction are widespread, there is little infrastructure for the dissemination of environmental messages. Each country has a national park system, and both the management of parks and adjacent lands pose a variety of practical policy questions related to the values of rural people and their forest conservation behaviors. This project is using a quasi-experimental design on selected communities in each country with different exposures to forest conservation policies. This project's three main components are: (1) data collection involving semi-structured interviews, a survey of individuals and households, and followup semistructured interviews and focus groups; (2) land cover classification from satellite images; and (3) a policy-oriented workshop.

Semistructured interviews have been conducted in both countries to identify study sites and to begin distinguishing locally held conceptual models about forest conservation. Initial interviews suggest that some conceptual orientations are only loosely related to empirical facts. The investigators will continue to identify common models guiding forest conservation behavior and to assess their behavioral consequences. Work with satellite images of Honduras and Costa Rica to determine the location and extent of deforestation also have begun. The Geographic Information System analysis will be integrated into our site selection and analysis of socioeconomic data.

Aggregative and Deliberative Contexts for Valuation

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Policy decisions concerning environmental resources typically engage a decisionmaker (e.g., the Environmental Protection Agency (EPA), Forest Service, or other federal agency) and a group of client "stakeholders,"(i.e., parties whom those decisions affect). Social science research often seeks to improve methods on which decisionmakers may rely to gather and aggregate data concerning the preferences of these concerned individuals. For example, contingent valuation (CV) methods seek to capture the "non-use" values of members of society to improve cost-benefit calculations undertaken by the EPA and other agencies. In this framework, social science research may improve agency decisions by making them more sensitive to the preexisting preferences of members of the client society.

For many reasons, a new framework for environmental decisionmaking has emerged that reverses the direction of the flow of scientific information. On this model, stakeholder and other citizen groups representing diverse views and interests become responsible for making the decisions—or solving the problems—associated with the management of a particular forest, wetland, watershed, or, indeed, any environmental asset. For example, the Forest Service may convene representatives of environmental, industry, and community groups, along with other interested citizens, to serve as a council with power as "trustees" to make local forest management decisions for which that group is then accountable. In this framework, those most affected by a decision—or their representatives—resolve controversies on the basis of information and advice that may be provided by the federal agency and by other, perhaps competing sources.

This project seeks to understand the role that social science research, particularly that associated with CV methods, may play in the framework in which representative stakeholder groups or councils become responsible for many decisions concerning the management of environmental assets, such as forests, watersheds, and wetlands. This project hypothesizes that social science research into group processes can be useful in this context by serving not so much as a diagnostic but rather as a constructive function. Rather than seeking to plumb ever more reliably the preexisting preferences of citizens, researchers would examine how group processes can help civic environmental associations work through evidence and argument to solve particular environmental problems. The emphasis would change, then, from aggregating over preferences to deliberating over solutions. The goal would not be to maximize the satisfaction of preexisting preferences but to develop democratic institutions to resolve local and regional environmental controversies.

Recent literature in political theory can be joined with that of social science in determining what counts as a suitably diverse, representative, and deliberative body to which agencies may democratically "devolve" certain management decisions. Problems for further research include identifying guidelines for convening stakeholder groups and for identifying the conditions most favorable to negotiation, deliberation, and consensus building. Two papers representative of the output of this project—one a theoretical essay concerning the move from aggregative to deliberative methods, the other an analytic case study—will be available to workshop participants.

Distinguishing Values From Valuation in a Policy-Relevant Manner

Theresa Satterfield
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This project is rooted in current efforts to identify environment-centered values not amenable to economic frameworks. We argue that some some values are expressed discursively, embedded in the contextually, emotively, and morally rich stories and narratives through which we define ourselves and our actions in relation to natural systems. This project's goal is to develop tools that contribute both theoretically and empirically to construct narrative values. Narrative processes offer new opportunities to express and elicit core values that reflect the visceral and varied ways in which stakeholders are invested in certain natural systems.

A series of narrative-based tasks for interview and paper-and-pencil contexts have been conducted. These include the use of nature photography to evoke value information in a storied form; the use of environmental-conflict narratives to initiate a series of values reflection tasks; and the use of story-completion tasks to elicit value-based justifications for proposed actions. Insight from a series of interviews with professional nature writers also has been drawn.

Some of the values elicited as part of this project are similar to those emphasized in other social and economic evaluations. Other values elicited as part of this project have a distinctly noneconomic cast, as realized by the ability of narrative to summon such things as embodied values (expressed as sensory experiences that emphasize affect, express interdependencies between the human and biotic community, and juxtapose objective and subjective valuations of natural phenomena); recovery values (expressions that place the historical-temporal evolution of biotic life at the center of judgments about natural resource uses); embedded values (the recognition that some values defy verbal characterization; they are buried in imagistic descriptions but are otherwise unnamed and unnameable); and creativity values (valuations of nature as the source of human thought and ingenuity). Finally, the investigators have found that narrative forms are especially proficient for motivating values reflection because stories tend to focus on concrete, vivid detail told through the eyes of a character with whom the reader can identify.

Succeeding research efforts will clarify the strengths and weaknesses of narrative frames by comparing them to logical-justificatory frames and to tools used by economic and decision analysts (e.g., multiattribute utility theory, contingent valuation, and cost-benefit analyses). A staged design—the comparative framing exercise shown in Figure 1—will be tested in both focus group and multiple-subject contexts.

The application of technical approaches to valuation (e.g., CVM, CBA, etc.) is often frustrated by the fact that so many lay stakeholders, especially those in smaller resource communities, do not think about values in a manner amenable to the technical approaches currently in use or are critical of valuation approaches for embracing overly narrow conceptions of value. There is a tension between policy initiatives aimed at incorporating public values and the discursive frame in which those values are expressed by lay persons. We, as policy researchers, hope to begin closing that gap or ameliorating that tension by developing narrative tools for the expression, elicitation, and incorporation of values.

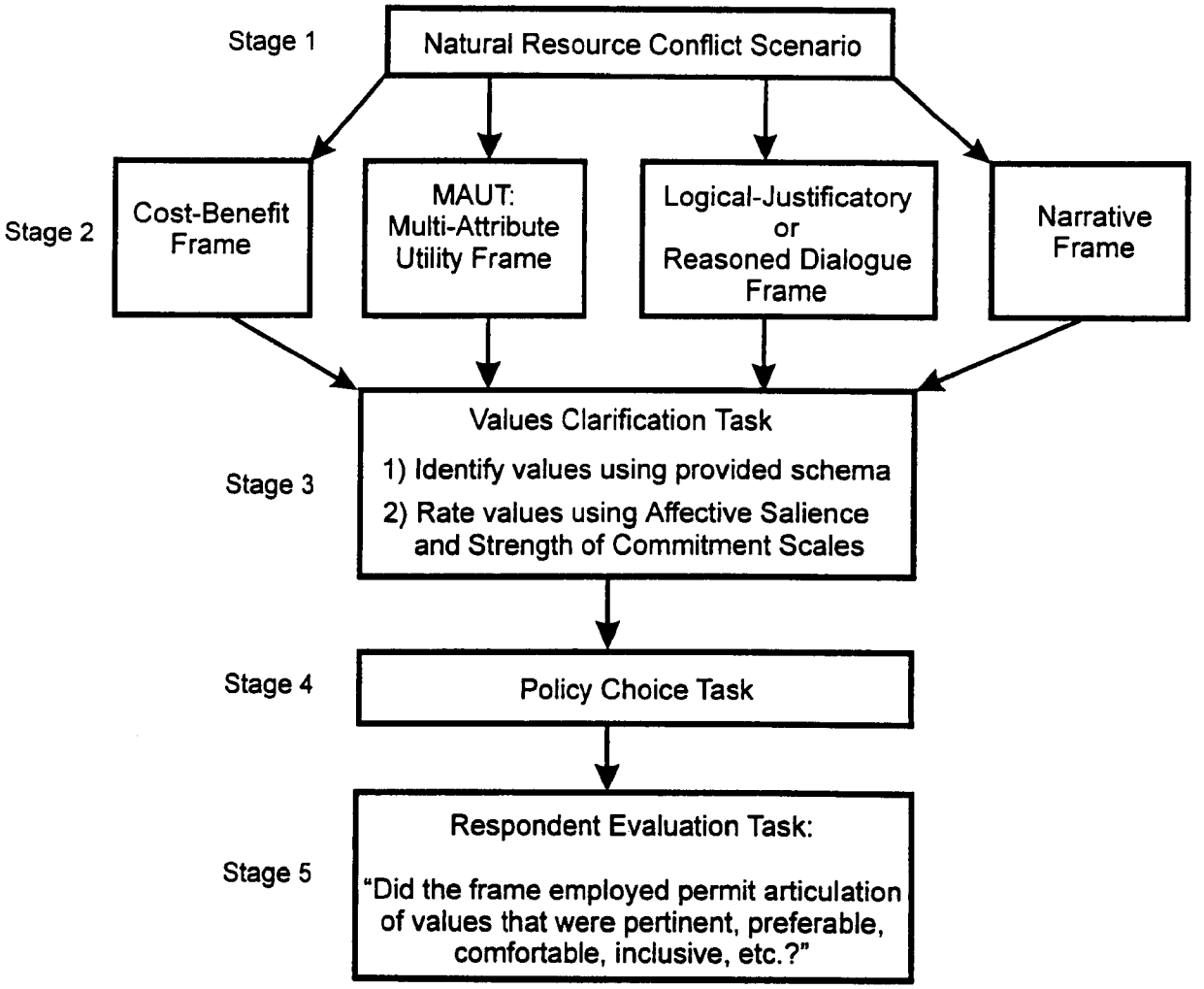

Figure 1. Proposed comparative framing exercise.

Decision-Making Under Uncertainty in the Conservation of Biological Diversity

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This project's goal is to develop and evaluate methods for setting species conservation priorities when information is incomplete. This project is organized around the general problem of selecting a subset of potential sites for the establishment of biological reserves. The research will focus on three specific issues: (1) estimating the probability that a species is present within a particular site; (2) based on these probabilities, identifying the subset of potential reserve sites with maximal expected species coverage; and (3) exploring the extent to which species number serves as a reasonable proxy for more refined measures of biological diversity.

Alternative approaches will be evaluated in a sequence of experiments using a modified version of the North American Breeding Bird Survey data set. This project is expected to result in a set of practical methods that can be used to guide conservation decisionmaking.

Stated Preference Valuation Using Real Money for Real Forested Wetlands

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Peter Paton and Robert Deegen
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This project is developing a model of public preferences for forested wetland attributes in Rhode Island by integrating methods from environmental economics with guidance from conservation biology. The project's objectives are to: (1) identify critical ecosystem attributes of forested wetlands, considering both the impact on residents' quality of life and factors identified as important by conservation biologists; (2) develop a model of public preferences for alternative attributes of forested wetlands, using Rhode Island as a case study; and (3) estimate money-measures of economic value for forested wetland attributes by conducting a survey of the public and comparing survey responses based on hypothetical dollar costs to responses based on questions that require respondents to contribute real money.

The survey method will ask respondents to review descriptions of two or more parcels of land with wetland attributes and to choose a parcel, if any, for which the respondent would be willing to pay a specified price to guarantee some level of protection of ecological services. Some of these parcel descriptions will pertain to land that belongs to private landowners who have agreed to cooperate with the research.

Prior to the actual wetland survey, a review of conservation biological guidance has been completed for the selection of lands for priority preservation, as practiced by private and public organizations in New England. Preliminary surveys are being developed to serve as extensive pretests of the format and presentation of choice questions involving either real or hypothetical monetary payments for wetland conservation. These preliminary surveys involve the use of a closely related good, the provision of water-quality monitoring services on freshwater bodies in Rhode Island.

Conservation biological guidelines used by state environmental management officials and nonprofit conservation groups focus on criteria that include (but are not limited to) the role of a wetland in expanding existing conservation reserves or in completing a connecting corridor between reserves; the relative rarity of the wetland type; the size of the parcel (e.g., >10 ha.); the surrounding land-use matrix and potential impacts from external land uses; and species diversity. Focus group discussions reveal, anecdotally, that many Rhode Island residents consider similar factors, albeit in laymen's terms, when attempting to identify whether a parcel deserves a high priority for conservation funding. Residents also consider the potential for public access to newly protected parcels, and they may give greater weight to the diversity of species that may be more visible (e.g., birds, mammals). These findings support the working assumption that respondents will have some preexisting experience with evaluating wetlands along criteria that parallel factors considered by conservation biologists. One preliminary survey involving water quality monitoring is complete (Spencer, Swallow, and Miller, *Agricultural and Resource Economics Review*, forthcoming April 1998). This experiment produced no statistically significant difference between the estimated value of water quality monitoring services based on real or hypothetical dollar payments. However, the hypothetical-dollar estimate did exceed the real-dollar estimate by a factor of four; statistical insignificance of the difference could be attributed to the wide standard error on hypothetical estimates (see Table 1). In this experiment, the hypothetical survey presented choice questions in a format that paralleled the real money survey by including a hypothetical version of the details necessary in the real-money survey. Investigators are designing the next pretest to examine whether this additional detail generated an unanticipated hypothetical bias that may account for the high standard errors in the hypothetical survey.

The last pretest survey is under way for spring of 1998. Various mechanisms will be evaluated to discourage free-riding in the real-money survey, including the use of "provision points" (or "funding targets" and "money-back guarantees." The pretest is focused on using the discrete choice format because our focus group results suggest that this format focuses respondents' attention on tradeoffs among choice attributes. The surveys will be conducted in a field format. These plans also allow for comparisons with hypothetical formats that parallel the real formats to varying degrees. Based on these comparisons, the survey concerning forested wetland attributes will be conducted using the hypothetical survey format that matches the real-money willingness-to-pay figures most closely.

Table 1. Willingness-to-pay estimates for the average respondent, based on Spencer, Swallow, and Miller *(Agricultural and Resource Economics Review, forthcoming April 1998).*

	Hypothetical WTP	Real-Money WTP
Pond A	\$42.69 (\$38.24)	\$9.15* (\$1.79)
Pond B	\$63.23 (\$58.67)	\$13.55* (\$2.42)
Difference (WTP_B-WTP_A)	\$20.54 (\$21.78)	\$4.40† (\$1.76)

Note: Parentheses denote standard errors.

* Significant at $P< 0.001$ for a one-tailed test of H_0: $WTP_k = 0$ versus H_A: $WTP_k > 0$.

† Significant at $P< 0.01$ for a one-tailed test of H_0: $WTP_B = WTP_A$ versus H_A: $WTP_B > WTP_A$.

The Transition to "Green" Technology: Implications of Irreversibility and Nonconvexity

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In the ongoing debate over how to mitigate long-term pollution threats (e.g., climate change, accumulative water pollutants) and promote long-term sustainable economic development, all sides agree on the importance of developing and disseminating new environmentally friendly technologies. There is a significant debate over how this is best done, with many economists advocating the use of broad environmental performance standards and economic incentives for environmental protection that will induce technical change, while others advocate a more proactive government role in inducing the use of green technologies.

For the most part, the conceptual part of this debate has been engaged using fairly simple analytical frameworks that do not encompass a number of important stylized facts, such as: (1) the process of environmental degradation is dynamic, as is the switchover to new technology; (2) there are uncertainties and irreversibilities surrounding both the accumulation of ecological damages and the costs of new technologies; and (3) both environmental degradation and technical change may exhibit nonconvexities (i.e., threshold effects, multiple ecological equilibria, and lumpy technology transition costs) that complicate the identification of a socially efficient path and the realization of such a path in practice through appropriate policy. In particular, a policy of simply "getting prices right" with respect to environmental damages may not succeed in inducing a socially efficient investment path with nonconvexities and irreversibilities.

This project's objective is to expand understanding of these issues by extending existing dynamic models of production, investment, and pollution accumulation. Of particular interest is the extent to which efficient outcomes are realizable or can be approximated in practice given a limited number of relatively "clumsy" policy tools, which are available in practice (e.g., it is impossible to implement complex dynamically optimal pollution tax paths). The investigator will consider the properties of socially efficient outcomes under conditions of irreversibility and nonconvexity, and the extent to which pollution internalization policies (e.g., emissions permits systems) need to be dovetailed with other policies (e.g., information campaigns, demonstration programs, and subsidies for initial investments in new technology) to overcome sunk cost barriers to the adoption of socially efficient new products and processes, particularly if there are multiple potential socially efficient outcomes.

In addressing uncertainty and irreversibility, this project will use recent theoretical advances in valuing "technology options" to address how the value of waiting versus investing is affected by nonconvexities. This project will contribute to the ongoing debate about what portfolio of policies is best suited to support socially efficient technology transitions in addressing problems such as climate change, accumulative pollutants like methyl bromide and other ozone depletors, and the protection of water bodies from accumulative pollutants, among other cases.

Valuing Reductions in Environmental Sources of Infertility Risk Using the Efficient Household Framework

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In recent years, there has been growing concern about potential threats from endocrine-disrupting chemicals in the environment. These chemicals have the potential to impact human health in various ways, among them increased risks of infertility. This project will develop and evaluate a methodology for applying stated preference techniques to assess the value associated with reducing infertility risks. Previous research in nonmarket valuation of health and environmental risks has focused on individual decisions; however, infertility risks clearly present a context where the household (i.e., the couple) is the relevant decisionmaking unit. This project develops a conceptual framework for linking collective (household) decisions to the preferences of the individual members. It provides a method for demonstrating how measures of economic welfare based on households' observed or stated decisions relate to the preferences of its individual members.

The investigators are developing a model of household decisions in which children are treated as a nonrival good within the household, and the household decision is whether to reduce the risks of infertility. In contrast to the more traditional "unitary" models that treat household decisions as if they were made by one individual (i.e., a benevolent preference formulation), this project's formulation is equivalent to assuming that the household maximizes a weighted sum of the members' preferences and that the members are not altruistic. This formulation, or "collective" model, is equivalent to each member maximizing his or her preference function subject to a budget constraint where a sharing function describing the income available to each member exists.

Observed choices for private and nonrival goods within the household reflect both individual preferences and the income-sharing rule. Information on household consumption, individual choices (from the stated preference survey), and *a priori* assumptions allow us to distinguish key dimensions of each individual's preferences along with the income-sharing rule. For the problem of infertility risk, this process, along with our pilot survey results, implies that reliance on a unitary model may lead to misleading conclusions about household willingness to pay for programs to reduce infertility risks.

To support the development of the conceptual model and to evaluate the use of a stated preference technique for valuing reductions in infertility, the investigators conducted two focus groups with childless couples and, based in part on these groups, designed and implemented a small-scale (200 respondents) pilot survey, which was administered in a computer-assisted format using mall intercept recruiting. Designed for nonsingle but currently childless individuals between the ages of 20 and 35 years, the survey describes how the typical risks of infertility increase with the age of the female partner. It then offers respondents, for a specified price that varies randomly across interviews, a hypothetical medication to reduce their future infertility risks, as shown in Figure 1.

Initial results suggest that female respondents, in particular, provide answers that support the internal validity of the instrument—the probability of accepting the medication appears to increase with the risk reduction, their individual income, and their perceived risk of experiencing infertility, and to decrease with the size of the payment. Differential effects of their own and their partner's income on the stated choice also contradict the income-pooling hypothesis that underlies the more traditional unitary models of household decisions. This suggests that a more appropriate model is one that explicitly accounts for the separate role of individual preferences within household decisions.

The investigators' plan is to use the results of this initial survey to revise the instrument and collect additional survey data in a second pilot survey. In the future, our sample will be restricted to female respondents. Also, we will incorporate questions that better address the timing dimension of the decision to purchase the medication.

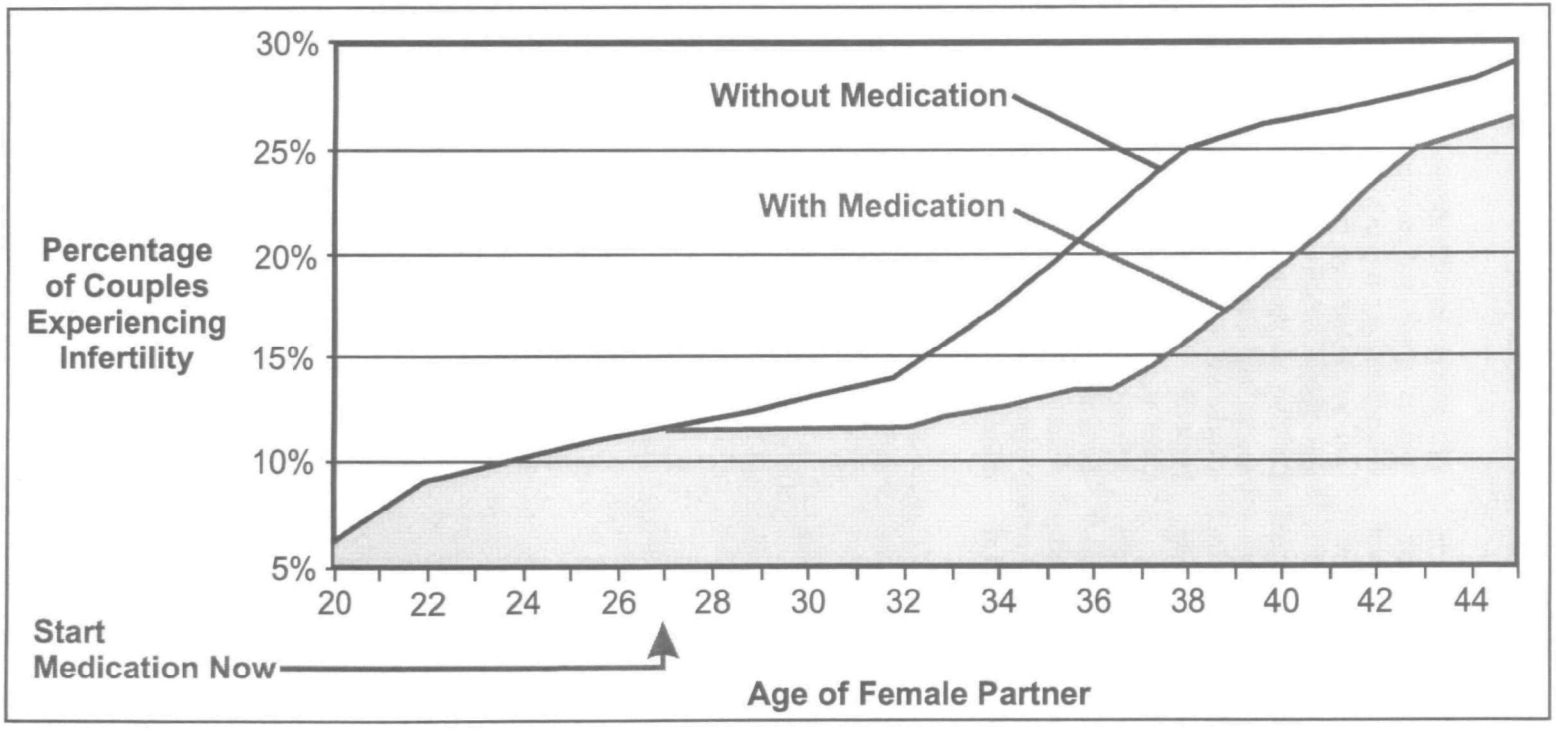

Figure 1. Survey's graphical depiction of an infertility risk reduction scenario.

Factors Influencing Participation of Local Government Officials in Environmental Policymaking and Implementation

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This project will explore the factors influencing the nature of the participation (whether or not they participated and how they participated) of local government officials in environmental policymaking initiatives sponsored by the Environmental Protection Agency. Participation by local government officials is not given the same attention in the literature as that of citizens, technical experts, or stakeholders. Yet, local governments are often a keystone to successfully implementing and enforcing environmental policies.

This project will examine three applications from the National Estuary Program: New Hampshire Estuaries, Casco Bay in Maine, and Massachusetts Bays. Maine and Massachusetts cases were selected because they achieved very different levels of participation of local government officials, and they used similar yet not identical procedural structures. New Hampshire was selected because it is in a much earlier phase of operation, yet it draws on the lessons learned in the Maine and Massachusetts cases. The factors influencing the decision of local government officials to participate in national and regional policymaking and implementation efforts will be examined through a direct interview protocol and responses to hypothetical policy scenarios. Once it is better understood how local government officials interpret the messages they receive from decisionmaking bodies, it will be possible to generate prescriptive advice for how to approach and involve this body of people in policymaking and implementation efforts.