STATED PREFERENCE:
WHAT DO WE KNOW? WHERE DO WE GO?

PROCEEDINGS
SESSION THREE

APPLICATIONS OF STATED PREFERENCE METHODS TO ECOSYSTEM AND HEALTH ISSUES

A WORKSHOP SPONSORED BY THE US ENVIRONMENTAL PROTECTION AGENCY'S NATIONAL CENTER FOR ENVIRONMENTAL ECONOMICS AND NATIONAL CENTER FOR ENVIRONMENTAL RESEARCH

October 12-13, 2000
Doubletree Hotel, Park Terrace
Washington, DC

Edited by Sylvan Environmental Consultants for the
Environmental Law Institute
1616 P Street NW, Washington, D.C. 20036

ACKNOWLEDGEMENTS

Sections of this report, indicated as "summarizations," were prepared by Sylvan Environmental Consultants for the Environmental Law Institute with funding from the National Center for Environmental Economics. ELI wishes to thank Matthew Clark of EPA's Office of Research and Development and Kelly Brown, Julie Hewitt, Nicole Owens and project officer Alan Carlin of National Center for Environmental Economics.

DISCLAIMER

Session III Proceedings
Table of Contents

DO WETLANDS KILL TREES?: KNOWLEDGE AS AN INPUT IN ECOSYSTEM VALUATION

by
John Hoehn
Frank Lupi
Michael Kaplowitz

Michigan State University

Prepared for EPA National Center for Environmental Economics Workshop: *Stated Preference: What do we know? Where do we go?* Washington D.C., October 12, 2000. [ed. note: Draft]

Wetlands ecosystems are valued for a range of ecological services. These services are protected by national, state, and local regulation. The primary federal wetland protection statute is Section 404 of the Clean Water Act (33 U.S.C. §1344). Under this statute, the U.S. Army Corps of Engineers, in conjunction with the U.S. Environmental Protection Agency (EPA), administers a review and permitting process for the "discharge of fill material" in "waters of the United States." Since 1989, the guiding principle of federal wetland policy is the "no net loss" of wetlands criterion (Gaddie and Regens 2000). To implement this principle, the wetland permit process encourages potential dischargers to minimize and avoid wetland impacts wherever possible. Where wetlands are impaired or destroyed, wetland mitigation is required.

Mitigation refers to actions taken to recreate, restore, or protect wetlands of an equivalent type and function to those being impaired or destroyed (Denison and Schmid 1997). Since wetlands vary by type, ecological functions, and the services they yield to humans, the means for judging the equivalency of destroyed and mitigated wetlands is both problematic and central to successful implementation of the "no net loss" policy (National Research Council (U.S.). Committee on Characterization of Wetlands. 1995; Mitsch and Gosselink 1993). Substantial effort has been made to define and measure wetland equivalencies using engineering principles and biophysical characteristics (Bartoldus 1999). However, the economic equivalency of wetland services has received less attention. Absent an understanding of the economic tradeoffs, wetland mitigation may leave economically important services unprotected and under provided.

In this paper, we report initial research results regarding the development and application of a framework for measuring the relative economic values of wetland ecosystems. These initial results stem from the first eight months of a three-year, U.S.E.P.A. funded project. We begin by reviewing the ecological characteristics of wetland ecosystems and past efforts to value wetlands. We then derive a model that leads to three approaches to estimating wetland ecosystem values in stated choice experiments. The relative performance of these valuation approaches depends on the distribution and extent of ecological knowledge among respondents. Knowledge of a particular form is an essential input into accurate ecosystem valuation.

The second part of the paper examines the knowledge base that residents of central Michigan might use in valuing wetland ecosystems. Residents were contacted using random digit dialing and were asked to participate in a group discussion about natural resource issues. Each group involved 6 to 8 residents. Each group interview was conducted by a moderator using a prepared discussion guide.

Discussion participants demonstrated better than expected general knowledge of wetland ecosystems, but their detailed knowledge of wetland functions and services was uneven. Participants recognized habitat for plants and animals as a key wetland function. A smaller portion identified maintenance of water quality and water storage as important wetland functions. Misperceptions were also revealed. For example, several respondents thought that trees do not grow in wetlands and that wetlands kill trees despite the fact that wooded wetlands are common in Michigan. When asked to interpret and discuss photographs of wooded wetlands, these participants said that wetlands were killing the trees.

I. Wetlands Ecosystems and Valuation Research

Wetlands are transitional types of ecosystems that occupy a spectrum between land and water ecosystems. Their exact definition has been controversial (National Research Council (U.S.). Committee on Characterization of Wetlands. 1995). The operational definition used in Federal wetlands permitting regulations builds on two essential wetland characteristics: (i) the land is composed of soils that are water-saturated during part of the vegetation growing season and (ii) the land supports plants that are typical of saturated soils (Smith et al. 1995). Using this definition, wetlands may have covered about 12 percent of the area of the continental United States during colonial times. Since that time, human activity in the United States has converted approximately 45 percent of wetlands area to other uses (Heimlich, Carey, and Brazee 1989).

Wetlands ecosystems vary greatly in type, ecological function, and services to human beings. Wetland types include bottomland swamps, tidal marshes, cattail marshes, vernal ponds, fens, and bogs. Ecological functions of wetlands include water storage, maintenance of surface and groundwater flows, biochemical cycling, retention of water-suspended and dissolved materials, accumulation of peat, maintenance of characteristic biological energy flows, and maintenance of characteristic habitats.

Wetland types and functions provide services that affect human well-being. The water storage function, for instance, may result in service to human beings by retaining floodwaters. Maintenance of groundwater flows may contribute to stable sources of potable water. Wetland habitats may offer recreational opportunities, open space amenities in otherwise densely settled areas, and potential non-use services such as maintaining biodiversity.

The objective of wetland mitigation is to replace wetlands destroyed by permitted activities through the creation, restoration, or protection of equivalent wetlands. The ratio of mitigated wetland area to impaired wetland area is called the mitigation ratio. Mitigation ratios typically vary by wetland type. For instance, in Michigan, recent rules require compensatory mitigation of 1.5 acres for each acre lost when the wetland being lost is a common type. When the destroyed acreage is a rare wetland type, 5 acres of mitigation are required for each acre lost (MCL §324.30319). At the Federal level, the Army Corps of Engineers makes adjustments in the mitigation ratios to account for the type and duration of impacts, the rarity of the impacted wetlands, and the methods used in mitigation (U.S. Army Corps of Engineers-Charleston District 1996).

Wetland mitigation ratios are analogous to the in-kind prices of impaired wetlands. Such ratios represent an agency’s in-kind valuation of mitigation activities relative to the lost wetland type or function. A question then arises regarding the adequacy of such prices. For instance, a mitigation ratio that is satisfactory on engineering or biological grounds, may not be acceptable in terms of preventing the loss of economic services and values. For instance, a particular wetland may be ecologically common in a region or state, but rare in terms of its recreational services and open space amenities by virtue of its location in an urban area. Hence, using Michigan’s rules to make the point, the statutory mitigation ratio for replacement of a particular cattail marsh might be set at 1.5 to 1 on statewide ecological grounds, whereas the particular wetland's economic value to its urban area might warrant a rare wetland ratio of 5 to 1.

The economic literature suggests the importance of considering relative economic values in mitigation pricing. Many studies estimate the value of specific wetlands and thereby demonstrate the economic value of wetlands. However, most studies shed little light on the relative value of different wetlands types, functions, and wetland services (Heimlich et al. 1998). A handful of studies do document commercial and recreational values associated with some wetlands (Loomis et al. 2000; Costanza et al. 1998; Bergstrom and Stoll 1993). Other research suggests that wetlands may provide open space amenities (Mahan, Polasky, and Adams 2000; Opaluch 2000). Some recent studies imply that the economic services of wetlands, including recreation, water quality, and flood control services are well recognized by ordinary citizens (Azevedo, Herriges, and Kling 2000). Especially interestingly in terms of mitigation ratios, Mullarkey (1997) estimates that an acre of naturally occurring wetland is 6 times more valuable to respondents than an acre of mitigated wetland.

II. Key Economic Features of Wetland Ecosystems

Wetlands mitigation, to varying degrees in different cases, attempts to account for differences in wetland types, functions, and services. In the context of mitigation, economic values are useful to the extent that they allow for differences across wetland ecosystem types, functions, and services. In an economic sense, a wetland is not a generic, fungible economic commodity. Rather, a wetland is a Lancastrian, multi-attribute bundle that may vary in three major dimensions: type, function, and service. A research design for wetland ecosystem valuation would vary these attributes and assess how value changes with changes in ecosystem type, function, or service.

A second feature of wetland ecosystems that bears on the economics of wetland values is that wetland attributes occur in specific patterns and types. Ecosystems share a general pattern of species relationships. At the foundation of an ecosystem food web are plants that convert energy and nutrients into food. Plant consumers and predator relationships are build upon the vegetative foundation. The specific pattern of species relationship varies with the type and scale of an ecosystem (Miller 1999). That is, a fen does not support the same species and relationships as a bog. Nor does a small wetland of a particular type support the higher order predators that a larger wetland of the same might (Osborn 1996). Since the species mix and interrelationships may vary with type and scale, it is possible that the economic value of wetland types may differ from individually valued sets of wetland functions and services.

A third feature of wetland ecosystems that impacts the economics of wetland values is the uncertainty associated with incomplete knowledge. Knowledge of wetland ecosystems, their functions and services is incomplete on the scientific level (Miller 1999). That is, science may not be able to characterize a full list of relevant wetland attributes nor may science be able to help restore these attributes once there are impaired. In turn, ordinary citizens have incomplete and possibly inconsistent knowledge of the science of wetland ecosystems and functions. Given the evolving nature of science, a useful economic research design for ecosystem valuation might describe how wetland values change with specific changes in respondents' baseline knowledge of wetland types, functions, and services.

III. A Research Design for Wetland Ecosystem Valuation

The research design outlined below takes an initial step toward a rigorous framework for valuing wetland types and services in stated preference experiments. The goal is a research design that shows the relationship between the value of wetland types and the value of wetland services. As our research program advances, we plan to extend the framework to describe the derived demand for wetland functions. Additionally, we seek a wetland valuation design that makes explicit the role of respondents' knowledge in valuation.

To simplify the exposition, we outline a framework that addresses two wetland types. Wetland acreage of type 1 is represented by *A1*. Wetland acreage of type 2 is represented by *A2*. Each wetland type yields different sets of wetland services. Wetland type 1 yields services of a single kind that we represent with the symbol *S1*. Wetland type 2 yields services of the first kind, *S1*, as well as services of a second kind, *S2*. The total amounts of services available from acreages of type 1 and 2 are:

$$S1 = A1 + A2 \qquad (1)$$
$$S2 = K(A2)$$

where K(A2) is an increasing, concave function that maps the acreage of type 2 into a levels of services S2. Equation (1) might correspond to a situation where both wetlands provide open space amenities but only type 2 wetlands support habitat with significant biodiversity.

The next step in the valuation model is to link economic services with human well-being. Human well-being is represented by a utility function, U,

$$U = U(S1,S2,M), \qquad (2)$$

where the level of well-being depends on the levels of the two services and an economic measure of income, M. The link between wetland acreage and well-being comes from the combination of equations (1) and (2). Substituting equations (1) into (2) shows the relationship between economic well-being and wetland acreages,

$$U = U[A1 + A2, K(A2),M] \qquad (3)$$
$$= u[A1,A2,M]$$

where u() is utility function defined on wetland acreage rather than services. This latter utility function leaves the relationship between acreage and services implicit.

In economic terms, a no-net loss policy would leave economic well-being unchanged by compensating for a reduction in type 2 acreage with an increase in type 1 acreage and visa versa. For small changes in acreage, the amount of compensatory mitigation required to offset the loss of type 2 acreage is derived by taking the total differential of the second line of equation (3) with respect to *U*, *A1*, and *A2*. To keep well-being constant, *dU* is set equal to zero and the differentials rearranged. By this method, the following economic mitigation ratio is derived,

$$(4) \qquad P_{A2\ A1} = \quad u/ \quad A2 \ / \quad u/ \quad A1$$

$P_{A2\ A1}$ is the utility-theoretic mitigation price of a small reduction in type 2 acreage, measured in terms of a compensating increase in type 1 acreage. In terms of the utility function, this mitigation price is the ratio of the marginal utility of type 2 acreage, $U/ \quad A2$, and the marginal utility of type 1 acreage, $U/ \quad A1$.

Each of the marginal utilities in equation (4) is potentially measurable in stated choice experiments. In a choice experiment, respondents would be presented with alternative policy choices involving wetland acreage of type 1 and type 2. The choice data for acreage could then be used to statistically estimate the marginal utilities. Similar experiments could be conducted for choices involving wetland services such as open space and biodiversity. The problem then becomes how to link the estimated marginal utilities of services to the mitigation choices characterized in terms of acreage.

The link between the mitigation price of acreage, $P_{A2\ A1}$, and the mitigation price for services of type 1 and 2, $P_{S2\ S1}$, may be derived by taking the total differential of the first line of equation (3) with respect to *U*, *S1*, and *S2*. Setting *dU* equal to zero leads

$$(4) \qquad \begin{aligned} P_{A2\ A1} &= 1 + K' \quad u/ \quad S2 \ / \quad u/ \quad S1 \\ &= \ 1 + K' P_{S2\ S1} \\ & \quad 1 \end{aligned}$$

where *K'* is the marginal productivity of acreage of type 2 in producing services of kind 2, as understood and known by choice experiment respondents.

Several features of the mitigation price as stated in equation (4) are notable. First, we can expect the mitigation price of acreage to be greater than one when the in-kind price of services is positive.

Second, the mitigation price is a function of preferences as represented by the marginal utilities and by the perceived technical relationship between acreage and the second kind of service. This technical relationship is represented by K' in equation (4). The marginal utilities of acreage estimated in stated preference experiments are conditioned on respondents' knowledge of K'. If respondents' knowledge is inconsistent with wetland science, the mitigation prices may be inconsistent with wetland science as well.

Respondents' knowledge plays a central role in accurate estimation of the marginal utilities of acreage. If this knowledge is inconsistent with wetland science, there seem to be two ways to bring the mitigation prices in line with the science. First, it may be possible to bring respondents' knowledge in line with scientific knowledge using educational tools such as carefully worded text, photographs, and diagrams. Whether such informational devices can be effective is an open hypothesis that warrants appropriate tests.

A second way to bring mitigation prices in line with the science is to design stated preference experiments to elicit the mitigation price of services, $P_{S2\,S1}$. The wetland service preference information, $P_{S2\,S1}$, may be combined with a scientific estimate of K' to calculate a facsimile acreage mitigation price based on scientific information,

$$S_{A2\,A1} = 1 + k'\,P_{S2\,S1} \qquad (4)$$

where k' is the scientific measure of the marginal productivity of type 2 acreage in producing services of the type 2 kind.

The analysis of the economic model of ecosystem values leads to three alterative valuation approaches shown in Table 1. Each approach varies in its information requirements regarding individuals' preferences and the ecological relationship between acreage and services. One approach sets up the choice experiments in terms of acreage tradeoffs for different wetland types. Such an approach mixes preference with ecological knowledge in the structure of the mitigation prices. All else equal, it results in a valid estimate of mitigation prices if respondents' knowledge is adequately complete and consistent with science.

Table 1. Valuation Approaches

Choice Experiment Design		Limitations
1.	Tradeoffs in terms of acreage of different wetland types	Confounds preferences and ecological knowledge; Biased if respondents' knowledge is incomplete or inconsistent
2.	Tradeoffs in terms of final wetland services	Incomplete service list; miss value of whole
3	Tradeoffs by acreage type, but make systematic effort to provide scientific information	Perceptions may not be sensitive to scientific information

The second approach sets up the wetland ecosystem choice experiments in terms of tradeoffs in ecosystem services. Such an approach would compliment the preference information from respondents with information on ecological relationships from science. It would yield a mitigation price based on science that the researcher deems appropriate and acceptable. The science portion of the valuation may also be modified as scientific information changes. A drawback to this approach is that the list of relevant services identified by the research and specified in the model may be incomplete resulting in a partial valuation. In addition, such an approach may not capture the value associated with the pattern of ecological relationships represented by wetland types.

A third approach to wetland ecosystem valuation is based on wetland types. This approach modifies the first approach by attempting to bring respondents' knowledge in line with scientific knowledge. This approach would try to assess respondents' baseline knowledge and to develop information tools that would alter the baseline so that respondent's knowledge was consistent with scientific knowledge. Respondents would engage in choice experiments once they received a systematic exposure to the information treatment. A key issue for the success of this method is whether respondents are sufficiently sensitive to the new information. If not, the new information may have little effect and the choice experiment results would mirror those of the first approach.

The availability of three different approaches to valuing wetland ecosystems offers the opportunity for cross-corroboration and hypothesis testing. For instance, the second approach based on scientific information might be used to set reasonable upper bounds on the valuation estimates derived from the first approach. Further, the second approach might be used to set up hypotheses regarding the effects of information treatments on the mitigation price.

IV. Knowledge Base of Michigan Respondents

Qualitative research is helping us learn what it is that people value about wetland ecosystems. This step will be used to help the researchers determine the functions and services that should be the focus of the valuation effort. Furthermore, the qualitative research also gives insights into the general state of people's knowledge about wetland ecosystems, their functions, and types (Kaplowitz 2000). We have also been exploring ways of communicating to respondents about wetland functions, "what wetlands do."

To this point, the qualitative research has conducted three group discussions with participants recruited from the general population of adults in the Lansing, Michigan. Each discussion group involved 6 to 8 participants. Participants were initially contacted using random selected telephone numbers. Because of election year resistance to participate in political focus groups, participants were asked to participate in a group discussion of "natural resource issues in Michigan." They were not told that we would be discussing wetlands.

Basic outline of group interviews

Each group interview lasted for roughly two hours. Sessions were held in a facility on the campus of Michigan State University. All of the sessions were conducted by the same moderator who used the same discussion guide for each session. The moderator used non-directive prompts to encourage participants to participate and elaborate their responses. The discussion guide and the sessions had five basic sections, with the first three taking roughly 45 minutes and the last two sections taking roughly 45 minutes. The balance of the time was used for breaking the ice, taking a "snack" break, or completing university paperwork.

The five substantive sections of the discussion guide and sessions were:

1. Introduce participants, identify each participant's top three natural resource issues, and discuss.

2. General background questions about wetlands to explore what participants know about wetlands and to learn about their experiences with wetlands and the things that wetlands do.

3. Photographs of both wetland and non-wetland ecosystems projected on a screen to determine how people judge what is and is not a wetland, to see if

people can distinguish wetland and non-wetland plant communities, and to see if people know about different types of wetlands.

4. Verbal, written, and graphic presentation of different wetland functions including flood control, wildlife habitat, and sediment retention. The functions and definitions for this section were taken from scientific literature on wetlands.

5. Some questions about wetland mitigation and about replacement of impaired wetlands. In the later two focus groups, there were additional questions about replacing wetlands lost due to a highway project were used

Knowledge of wetland functions

Participants evidenced knowledge of wildlife habitat functions of wetlands. The participants also rated the wildlife habitat functions highly in terms of their relative importance vis-à-vis other wetland ecosystem functions. Almost all participants rated wildlife habitat as extremely important, the highest category, on their function ranking worksheets. This finding is consistent with other research on wetlands (Azevedo, Herriges, and Kling 2000; Swallow et al. 1998; Stevens, Benin, and Larson 1995).

Participants had mixed knowledge of some of the other functions of wetland ecosystems such as water quality, groundwater recharge and flood control. Often there were a few respondents in each focus group that were aware of and knowledgeable about one or more of these “non-habitat” functions. However, every group had a majority of participants who seemed much less aware of these types of functions and who did not seem very knowledgeable about them.

Interestingly, several of the scientifically recognized wetland functions prompted negative feedback from participants. Several individuals rejected the importance of functions such as pollution interception and waste treatment. These individuals expressed strong opinions that wetlands should not be used for these functions. In several instances, participants voiced their concern that environmental laws are supposed to provide for pollution cleanup and waste treatment; wetlands need not perform such functions. Note that these functions appear prominently in much of the literature describing wetland functions. After further discussions, most of these participants felt that it would be all right to create new wetlands for purposes such as waste treatment. This feedback seems to illustrate the potential difficulty of relying solely on scientific descriptions of wetland ecosystems, functions, and services.

What do photographs communicate?

As a part of the group sessions, photographs of various wetlands were shown to the participants. This exercise was intended to probe participants’ knowledge of wetland types, wetland vegetation, and general understanding of wetland ecosystems. The participants’ discussions of the images yielded some interesting insights about what photographs can communicate to people. For example, at one point we showed a photograph of a fen (a particular wetland type) that did not have visible water and had grasses and vegetation that was browning. In response to this image, some respondents noted that it did not look healthy and that it was not supposed to be that way. One participant said the photograph showed an area that "I would say [was] scorched by fire." In reality, the photograph contained a moderate amount of shadow that was mistaken as evidence of fire. This photograph clearly communicated something other than what had been intended, and the cue that caused the misperception, the shadows, is unlikely to be absent in future photographs of fens and other ecosystems.

Another example of the power of photographs to (mis)communicate was found when the blurry background in a photograph of a non-wetland meadow was "seen" by a respondent to be water. It is important to note that the focus group participants were viewing these images on a large projection screen at levels of resolution that are likely quite higher than what would be feasible in a typical survey application. The conclusion that can be drawn from these experiences is that photographs do communicate information, both intended and unintended, and that they must be pre-tested along with other potential survey elements. This will hold for web-based surveys as well as other mediums.

Wetland misperceptions: wetlands kill trees and trees don't grow there

As a part of the group interviews, participants were shown a variety of photographs that depicted different wetland types in different settings as well as photographs that did not show wetlands. Part of the group interview probed for whether or not each of the photographs depicted a wetland. In each of the groups, several respondents commented on the notion that trees do not grow in wetlands and that wetlands kill trees. In fact, some participants used their perceived presence of dead trees in the photographs to distinguish wetlands from non-wetlands. Therein lies the source of the paper title. The so-called "dead tree" comments occurred in all three of the sessions and they occurred in relation to different photographs of forested wetland areas. It is interesting to point out that in Michigan where the participants live over two-thirds of the wetlands are forested. Another factor that may have played a role in this perception was that one of the wetland photographs showed some prominent trees that had been attacked by Dutch Elm disease. However, two of the sessions raised comments about wetlands and dead trees in conjunction with photographs of forested wetlands shown before the image of the wetland with the diseased trees. Thus, the photograph with the dead elms did not cause the perception, though it may have amplified the perception for some individuals. One conclusion that emerges from these examples is that it seems vital to the design of an accurate valuation instrument that researchers be aware of respondents' perceptions (and mice-perceptions) about the good being valued. Establishing such information is a key step in the development of methods of communicating with respondents about the good to be valued and the context of the valuation.

Knowledge of mitigation

In all three of the group sessions, some questions were asked to about wetland mitigation and about the replacement of impaired wetlands. These questions were aimed at revealing peoples' understanding and acceptance of wetland mitigation. In the later two sessions, additional questions were asked in the context of a scenario in which the government would be replacing wetlands impaired by a highway project. This scenario was developed to force people to consider, to add realism, and reinforce the idea of trade-offs. The scenario was also used to learn more about one possible context for stated preference wetland valuation. The comments and discussion surrounding these portions of the group sessions revealed a general skepticism that wetland mitigation could adequately replace what might be lost due to a wetland impairment. This skepticism is related to the unique challenges posed by ecosystems as well as the role of knowledge as an input into ecosystem valuation.

Another finding from this section of the group interviews was that there was some confusion over the meaning of wetland mitigation, especially wetland replacement. Some individuals took the concept quite literally and inferred that it would mean transferring plants and animals from one site to the mitigation site. For example, one participant asked, "How are they going to transfer all those frogs?" Again, this serves as another example of how indispensable to survey design it is for researchers to have a grasp of respondents' baseline knowledge and understanding.

Perhaps the main finding from what was learned about peoples' knowledge of mitigation relates to the general skepticism about replacing all functions of a specific wetland. The following are examples of the kinds of comments we received in discussions on wetland mitigation:

> "I don't know if you can come out equal."
> "Really replacing or just duplicating parts you see?"
> "Like substituting oleo for butter."
> "Could they truly get back all that was lost?"

It appears that such skepticism consists of two elements. The first related to a disbelief that certain functions, or services, of wetlands could actually be replaced. The second related to a feeling by several individuals that wetland replacement would not adequately compensate for impairments because wetlands are complex. That is people acknowledge that even though many functions might be replaced, there is more to the wetland than the specific functions that get replaced. Both elements of peoples' skepticism raise issues that are fundamental to ecosystem valuation. The former element raises questions about whether we want to elicit people's beliefs in the underlying production relationship, K(.), at the same time we elicit economic choices and values. As illustrated above in the table, this can lead to a co-mingling of values and knowledge about how final services are derived from the "replacement" wetland ecosystem. The second element speaks to the notion that an ecosystem is more than a bundle of listed functions or services.

V. Conclusions

The valuation framework outlined above identifies three approaches to valuing wetland ecosystems and wetlands mitigation. The three approaches show that the economic value of wetlands is derived from the value of wetland services; wetlands are valued when they yield valuable services. This linkage between wetlands and wetland services has an important implication for stated choice experiments. If respondents' knowledge is inconsistent with wetland science, stated choice experiments may yield incomplete or inaccurate valuations.

Knowledge of the linkage between wetlands and wetland services plays a slightly different role in each of the three valuation approaches derived above. The first valuation approach takes respondents' knowledge as given. It elicits a valuation conditioned on respondents' baseline knowledge. The second approach elicits a valuation of wetland services and then uses scientific knowledge to compute a wetland valuation from the estimated value of services. The third approach attempts to bring respondents' knowledge in line with scientific knowledge using systematic information treatments. It elicits wetlands values conditioned on respondents' updated knowledge base.

The reported qualitative research was intended to explore the knowledge base of likely respondents in order to assess the feasibility of the three valuation approaches. Initial findings show that Michigan residents are more cognizant of wetlands than expected, but that their knowledge is uneven. Most respondents had some prior knowledge of wetlands functions such as provision of wildlife habitat, maintenance of groundwater flows, and floodwater retention. However, some functions identified by wetland science, such as retention of polluted run-off and waste treatment, were rejected as illegitimate by some respondents. A portion of these respondents thought that pollution retention would harm the ability of a wetland to support wildlife and other functions. Others thought that current environmental laws should lead to cleanup of pollution at the source, rather than letting pollution flow into a wetland.

The qualitative research also underscored the difficulties of using photographs to communicate wetland knowledge. The initial hypothesis was that photographs might be an effective means of communicating differences in wetlands types and functions. Photographs, however, seemed to be an inaccurate communication device. When shown a photograph of a fen, some respondents correctly interpreted dark areas as shadows, while others interpreted the same dark areas as evidence of impairment and, perhaps, fire. When shown photographs of wooded wetlands, some respondents concluded that the wetlands were killing the trees, even though healthy wooded wetlands are a common wetland type in Michigan.

The evidence thus far underscores the role of knowledge as an input in valuing wetland ecosystems. The empirical results show that respondents have some baseline knowledge of wetlands, but that this baseline knowledge may be incomplete or inaccurate in certain dimensions. In this context, each of the three valuations approaches may be useful in posing and testing hypotheses about wetlands values and the effect of knowledge. For instance, if respondents' baseline knowledge is incomplete, values estimated via the second approach may be larger than values estimated via the first approach. Thus, the three valuation approaches may offer the means of testing and corroborating wetland values.

References

Azevedo, Christopher, Joseph A. Herriges, and Catherine L. Kling. 2000. Iowa wetlands: Perceptions and values: Center for Agricultural and Rural Development.

Bartoldus, Candy C. 1999. *A comprehensive review of wetland assessment procedures: A guide for wetland practitioners*. St. Michaels, MD: Environmental Concern Inc.

Bergstrom, John C., and John R. Stoll. 1993. Value estimator models for wetlands-based recreational use values. *Land Economics* 69 (2):132-137.

Costanza, Robert, Ralph d'Arge, Rudolf de Groot, Stephen Farber, Monica Grasso, Bruce Hannon, Karin Limburg, Shahid Naeem, Robert V. O'Neill, Jose Paruelo, Robert G. Raskin, Paul Sutton, and Marjan van den Belt. 1998. The value of the world's ecosystem services and natural capital. *Ecological Economics* 25:3-15.

Denison, Mark S., and James A. Schmid. 1997. *Wetland mitigation: Mitigation banking and other strategies for development and compliance*. Rockville, MD: Government Institutes Inc.

Gaddie, Ronald K., and James L. Regens. 2000. *Regulating wetlands protection*. Edited by M. E. Kraft and H. Wilson, *Suny series in environmental politics and policy*. Albany: State University of New York Press.

Heimlich, R.E., M.B. Carey, and R.J. Brazee. 1989. Beyond swampbuster: A permanent wetland reserve. *Journal of Water Conservation* 44 (5):445-450.

Heimlich, Ralph E., Keith D. Wiebe, Roger Claassen, Dwight Gadsby, and Robert M. House. 1998. Wetlands and agriculture: Private interests and public benefits. Washington, D.C.: Resource Economics Divisions, Economic Research Service, U.S. Department of Agriculture.

Kaplowitz, Michael D. 2000. Identifying ecosystem services using multiple methods: Lessons from the mangrove wetlands of Yucatan, Mexico. Agriculture and Human Values 17 (2):169-179.

Loomis, John B., Paula Kent, Liz Strange, Kurt Fausch, and Alan Covich. 2000. Measuring the total economic value of restoring ecosystem services in an impaired river basin: Results from a contingent valuation survey,. *Ecological Economics* 33 (1):103-117.

Mahan, Brent L., Stephen Polasky, and Richard Adams. 2000. Valuing urban wetlands: A property price approach. *Land Economics* 76 (1):100-113.

Miller, G. Tyler. 1999. *Environmental science: Working with the earth*. Belmont, CA: Wadsworth Publishing Company.

Mitsch, William J., and James G. Gosselink. 1993. *Wetlands*. 2nd ed. New York: Van Nostrand Reinhold.

Mullarkey, Daniel J. 1997. Contingent valuation of wetlands: Testing sensitivity to scope. Dissertation, Agricultural and Applied Economics, University of Wisconsin - Madison, Madison, WI.

National Research Council (U.S.). Committee on Characterization of Wetlands. 1995. *Wetlands: Characteristics and boundaries*. Washington, D.C.: National Academy Press.

Opaluch, James. 2000. Strength of preference indicators. Paper read at EPA Environmental Policy and Economics Workshop Series, October 2000, at Washington, D.C.

Osborn, Ronald G.. 1996. Ecological criteria for evaluating wetlands. Fort Collins, CO: National Biological Service.

Smith, Daniel, Alan Ammann, Candy Bartoldus, and Mark Brinson. 1995. An approach for assessing wetland functions using hydrogeomorphic classification, reference wetlands and functional indices. Washington, D.C: U.S. Army Corps of Engineers.

Stevens, Thomas H., Samuel Benin, and Joseph S. Larson. 1995. Public attitudes and economic values for wetland preservation in new england. *Wetlands* 15:226-231.

Swallow, S., M. Spencer, C. Miller, P. Paton, R. Deegen, L. Whinstanley, and J. Shogren. 1998. Methods and applications for ecosystem valuation: A collage. In *Proceedings of the first workshop in the environmental policy and economics workshop series*, edited by B. Kanninen. Washington, D.C.: Office of Research and Development and Office of Policy, U.S. Environmental Protection Agency.

U.S. Army Corps of Engineers-Charleston District. 2000. *Compensatory mitigation*. 1996 [cited October 27 2000]. Available from http://www.sac.usace.army.mil/permits/sop96-01.pdf.

STRENGTH OF PREFERENCE INDICATORS AND DISCRETE CHOICE MODELS

Presented by James J. Opaluch, Environmental & Resource Economics,
University of Rhode Island
Co-authored with Steven Swallow and Thomas Weaver, Environmental & Resource Economics, University of Rhode Island

Summarization

Professor Opaluch presented a study of using strength of preference indicators along with discrete dichotomous choices to improve the accuracy of estimation of environmental values.

Because of limited funding, the study used data sets gathered for other projects.

Though theory assumes that preferences are ordinal, people are usually able to state the strength of their preferences. Many economists are skeptical of this information, doubting its consistency and equating its use with using cardinal utility scales and interpersonal comparisons of utility.

The study sought to determine whether strength of preference indicators contain useful information. In the context of practical policy analysis with real people, could these fuzzy strength of preference indicators improve measurements of preference?

The policy context was the siting of a new landfill in Rhode Island. The planners wanted public input for the siting process. Using focus groups, researchers had developed a survey to score potential sites.

The survey offered respondents pairs of choices. For example, in one pair, choice *A* sited the landfill in an area with high quality groundwater and normal wildlife habitat, occupying 100 acres of marsh, 300 acres of woods, and 100 acres of farmland, and costing each taxpayer $360 per year. Choice *B* was identical except the site included 400 acres of woods and no farmland. Researchers presented respondents with diagrams and descriptions of the choices and asked respondents to indicate their preference by pasting a large orange sticker labeled “Landfill” on one of the two diagrams. (The use of a sticker avoided confusion over whether respondents were marking the site they preferred as a landscape or the site they preferred to be used for the landfill.) Then, researchers asked respondents to indicate the strength of their preference on a five point scale, with one end of the scale labeled “Weakly prefer Site” and the other end labeled “Strongly prefer Site.”

In focus groups, the researchers found that the respondents needed significant background information about the need for landfills. Without that information, respondents were likely to tacitly reject all the options and not truly reveal the differences in preference that the survey tried to measure. The researchers presented this information in a professionally produced six-minute video, which proved much more effective than written or even live oral presentations.

The goal of the research was to see if the information in the answers to the strength of preference questions could be used with the discrete choice information to get better estimates of public preference than one could get with the discrete choice information alone.

The study had 12,000 observations in the full data set from the original survey. The researchers calculated the preference coefficients for a standard discrete choice model using just the discrete choice data (the full sample binary logit approach) and using the discrete choices with the strength of preference data (the full sample ordered logit approach). The researchers assumed that these two sets of results represented the true preferences of respondents.

Then the researchers took small random samples of those 12,000 observations and tested whether using the strength of preference data with the discrete choice data (the small sample ordered logit approach) could yield a better prediction of the true preference than using the discrete choice data alone (the small sample binary logit approach).

In using the strength of preference data, the researchers modeled the strength of preference indicators as quasi-cardinal measures. They took strength of preference statements to be comparable across respondents, but they did not assign equal magnitudes to the utility differences between alternatives.

For each choice pair, there were ten possible selections: five rankings (from strongly prefer to weakly prefer) for choice *A* and five similar rankings for choice *B*. Rather than assign cardinal values of rank to the selections, the researchers calculated ordered logit coefficients describing the probability that respondents would pick one choice over an adjacent choice. In effect, these coefficients represent cut-offs in utility between selections. The researchers found that the differences in coefficients between adjacent selections got larger towards the endpoints, perhaps because people psychologically tended to save the more extreme rankings for use on possible future choices. For any given pair of options, the increases in coefficients from weakly prefer to strongly prefer were roughly symmetrically.

The small random samples that the researchers took from the full sample ranged from 272 observations (a little more than 2%) to 2176 observations (nearly 20%). They took 100 random samples for each of eight sample sizes.

They estimated the preference coefficients for each sample using binary logit and ordered logit approaches, and calculated the difference from the “true” values calculated from the full sample. As a measure of how good the small sample estimate was, they calculated the mean of the squared difference between the estimated and “true” values.

When the “true” values were the ones calculated from the full sample using the ordered logit approach, the ordered logit approach on the small samples consistently beat the binary logit approach, by factors ranging roughly from three to four (comparing the sizes of the mean squared errors). The improved performance was greater on the smaller samples.

When the “true” values were the ones calculated from the full sample using the binary logit approach, the ordered approach still beat the binary approach for samples of fewer than 1360 observations. It converged to being roughly equal in accuracy on samples of 1360 or more observations.

Prof. Opaluch concluded that it can be worthwhile asking strength of preference questions, particularly when using small samples. Common language indicators do seem to contain real information. People seem to have some shared understanding about the meaning of these quasi-cardinal strength-of -preference rankings. He noted gains of from 100% to 400% in sampling efficiency, depending on sample size and what one considered to be the true values.

Discussion of Session IIIa Papers

by Daniel Hellerstein, USDA Economic Research Service

Strangely enough, or perhaps Julie and Nicole have access to my hard drive, I have recent experience with the subject matters of both these papers. Besides, as is typical of most ivory tower academics, the gist of these works is understanding concepts and tools, rather then analysis of a particular policy. I take this as a cue, that I allow my comments to range beyond those of a dedicated policy discussant.

Let's start with a big thought. Is there a "concept" that lurks in the background of both papers? Perhaps yes: let's call it "accounting for respondent uncertainty". For Swallow and Opaluch, it's accounting for respondents' strength of preferences; for Hoehn and Lupi it is accounting for how the respondent thinks about proposed alternatives.

Enough philosophy. Let's consider each paper.

Swallow, Opaluch, and Weaver Paper

The Swallow, Opaluch, and Weaver (SOW) paper is part of a continuing groundswell of work that uses ordered models, such as the ordered probit and ordered logit; these include works by:

Alberini, Boyle, Welsh: Maine fishing
Haefele and Loomis: Forest/pest management
Hellerstein et al: Grassland birds preferences for organic agriculture in Germany

Paralleling this work is an interest in allowing respondents to express uncertainty about their answers, as exemplified by papers by Champ and by Poe and Welsh.

So what's the deal? I think there are two somewhat competing notions that underlie both of the above:

a) Let people express uncertainty: the task of placing a dollar value on possibly obscure changes in environmental quality isn't easy; expecting people to be sure of their decisions is just not realistic. In such a world, forcing a yes/no decision is traumatic and is likely to lead to mistakes: perhaps people will yea say, perhaps people will back off from a hasty commitment to something that (most of the time) they do prefer.

b) Make 'em take it seriously: since it's too easy for respondents to act nicely in a hypothetical setting, strength of preference measures are useful as reality checks on people's intentions — they act as a proxy for making them pay up.

Dealing with the latter story is pretty clean cut — one chooses a cut-off that really means "yes I prefer A to B". For simple CV questions, this may mean treating anything less then a "DEFINITELY YES" as a "NO".

In the contingent-response world examined by SOW, this is complicated by the variety of attributes that may change. However, a null hypothesis that "only dollars matter" suggests that only a "strongly prefer" on a more expensive alternative would be treated as a choice of this (more expensive) alternative.

Yet the "make 'em take it seriously" notion seems inefficient, with real information arbitrarily collapsed. Moreover, it's too conservative — it doubts that a probably yes is anything but a polite no. Is that what you mean by a probably yes? Herein lies the appeal of the ordered estimators (such as the ordered probit and ordered logit) — they offer a systematic means of dealing with real uncertainty.

Actually, in the contingent-response world, it can be argued that (for example) a strongly prefer versus a weakly prefer measures the magnitude of a preference, rather then respondent uncertainty. That is, a respondent knows what she likes better, but wants to be able to qualify her statement (by saying, "I only like it a little bit better" versus "I like it a lot better").

Perhaps, but the same interpretation can be given to a "definitely yes" versus a "probably yes" response to a dichotomous choice question. That is, in either the dichotomous choice or the contingent response framework, either of these two notions may be operative.

I like the idea of ordered models, but (as pointed out by SOW) much of the profession is skeptical; a skepticism based on the subjectivity inherent in these rankings. For example, holding tastes constant (including the random component of taste that the ordered models seek to control), a "decisive" individual may say "DEFINITELY YES" (or "STRONGLY PREFER"), whereas a more cautious fellow may say "UNSURE" (or "SLIGHTLY PREFER"). Lacking a way of classifying individuals into such categories, the concern is that the ordered estimator will be ill defined and subject to bias.

SOW deal with this problem explicitly. First, in their appendix they show that "thresholds" that are randomly distributed around a (threshold specific) mean can yield a familiar ordered probit model. I'm a bit concerned that this framework will yield greater uncertainty about the underlying error variance (hence a larger confidence interval for WTP), but I suspect that this is both unavoidable and of minor significance.

More importantly, they use split sample designs to see what does a better job — the test being what estimator yields the best answers, where the "truth" is the WTP derived from a larger sample. This truth also depends on what estimator is used for the large sample.

One would expect that if the "truth" is a simple world where strength of preferences are merely a conversational ploy by respondents, then a simple model (the standard logit) would be best. Conversely, if strength of preferences is really related to underlying utility, then the ordered model should be a winner.

Somewhat surprisingly, the ordered model (ordered logit in their case) comes out as a winner — it does a better job in both worlds! This suggests that adding extra information doesn't hurt, and can help. These results do give some breathing room to practitioners wishing to use ordered models.

Unfortunately, from a policy perspective this does not let us off the hook of choosing between the "let people express uncertainty" versus the "make them take the task seriously" interpretation of strength of preference. Basically, several of us (myself, and Alberini) have found that WTP numbers computed from ordered models are similar to WTP numbers that arise from using "unsure" as a cut-off in binary choice models. Use of these UNSURE models inflates WTP values (often by a factor of 2 or 3) in comparison to using DEFINITELY YES. Although SOW use a somewhat different framework (how much they "prefer" rather then how "certain" they are), the concern still holds.

I don't know the answer to this one. I suspect it's tied into the public goods nature of environmental goods. On one hand, there is evidence (such as Champ's work and the experience of market research) that only the most definitive people will actually pony up the money when offered the hypothetical good. On the other, for public goods (such as the existence values often the subject of stated preference work), the concern for free riding is likely to cause people to hesitate on actually paying a stated amount, even if this amount is the personal value of the proposed level of the environmental good. In this world, ordered models may be doing a good job of capturing these concerns.

Hoehn and Lupi Paper

Rather then worry about how certain people are about their responses, Hoehn and Lupi (HL) are most concerned about how certain people are about the proposed alternatives.

But first, allow me to digress and consider the problem of the value of wetlands. Recently, we undertook a literature review to determine wetland values by wetland type and region of the country. We examined several broad studies, including:

Heimlich: 33 studies
Woodward and Wui: 35 studies (meta analysis, and graphical analysis)
Brouwer et al: 30 studies (meta analysis)
Bardecki: review of 277 papers

The general conclusion from these four reviews is that the prospects for benefits transfer are not strong. Some cautious statements can be made about what functions are valuable (such as flood protection versus maintenance of biodiversity), and there seems to be some indication that valuation methodology is not highly significant. However, the general finding is that the range of values is extreme, with a coefficient of variation well above 1.0.

Despite these general findings, we attempted to come up with some number for the varying functions provided by different types of wetlands in different parts of the nation.

The table will give some sense of the paucity of information: with filled-in squares representing cells for which some study has some kind of value.

Thumbnail Sketch: Availability of wetland benefit measures
(Shaded squares = study of value available)

Key

Regions	
I	N. Crescent
II	E. Uplands
III	S. Seaboard
IV	Heartland
V	Miss. Portal
VI	Prairie Gateway
VII	N. Great Plains
VIII	Basin & Range
IX	Fruitful Rim

Services	
A	Wildlife habitat
B	Recreation
C	Flood protection
D	Storm buffers
E	Water quality
F	Com. fish/shell
G	Timber etc.
H	Aesthetic/OS
J	Non-use

Wetland types	
Est	Esturine
PF	Palustrine forested
PE	Palustrine emergent
PS	Palustrine shrub

I	Est	PF	PE	PS
A		■	■	■
B	■	■		
C		■		■
D				
E		■	■	■
F	■			
G				
H		■		■
J		■	■	■

II	Est	PF	PE	PS
A				
B		■		
C				
D				
E				
F				
G				
H				
J		■		

III	Est	PF	PE	PS
A				
B				
C				
D				
E				
F	■			
G				
H				
J		■		

IV	Est	PF	PE	PS
A				
B		■	■	■
C				
D				
E				
F				
G				
H				
J				

V	Est	PF	PE	PS
A				
B	■			
C	■			
D	■			
E	■			
F	■			
G				
H				
J				

VI	Est	PF	PE	PS
A				
B				
C				
D				
E				
F				
G				
H				
J				

VII	Est	PF	PE	PS
A			■	
B		■	■	■
C				
D				
E				
F				
G				
H				
J				

VIII	Est	PF	PE	PS
A				
B				
C				
D				
E				
F				
G				
H				
J				

IX	Est	PF	PE	PS
A		■	■	■
B	■			
C		■		
D				
E	■	■	■	■
F	■			
G				
H				
J				

The point of this digression is that the we don't have a very good inventory of values of wetland service flows and hence welcome contributions that may broaden our knowledge base, especially if this contribution allows us to readily do benefit transfer.

So what do HL bring to this problem? Right now, they don't have a lot of tested hypotheses, but the notion they are exploring is of great interest: that how people think about environmental values may differ from what us inside-the-beltway analysts would find convenient. And they do this for both "wrong" and "right" reasons.

The wrong reason is that they don't believe the science -- they refuse to accept our policy scenarios as possible.

The right reason is that their real concerns are not being addressed -- that what we ask them to value is not what they really care about, or not all that they care about.

The wrong reason is actually sort of interesting. One could argue that people value what they perceive, not necessarily what is really out there (the sizzle is more important than the steak). Perhaps, but let's assume that the long run isn't that long, so that the populace will thank us (eventually) for using the correct facts when they are known. That still leaves the second problem -- what do people really care about? And that's a much tougher nut to crack.

I digress and relate our experience with our survey that valued grassland birds. We were interested in the value of more birds and tried our best to conjure a scenario where only grassland bird numbers changed. Despite our efforts, our screener questions revealed that of the respondents who would be willing to pay at least $1, over half did it because "of the overall effects that supporting bird populations would have on the environment", whereas about 20% did it "just for the birds".

Are these people wrong? Or are they properly skeptical, seeing through our tricks to the truth that one can't change birds without effecting a lot of other things?

As a policy matter, this has some profound effects. Let's call it the dilemma of hedonics -- that even if we had a vector of prices for environmental goods and services, it wouldn't allow us to do good benefits transfer.

For example, let's consider the non-market value of conservation programs. If there was a finite set of environmental goods and services that people care about, then all we need to do is find unit values of these goods and services. Then, come the next ambitious conservation program ginned up by the farmers, enviros, or whatever; we'd be able to do a simple vector product to yield the program's value (assuming the science was there to tell us the size of the change in environmental goods and services).

HL suggest that it won't be that simple -- that the "sum is greater then the parts", hence adding up the (appropriately weighted) parts isn't enough. Interestingly, this is in contrast to John's earlier work, wherein $WTP(A) + WTP(B) > WTP(A+B)$!

So what do we do? Perhaps there are arcane, yet important, parts that need to be included in the bundle of more obvious goods and services. Yet, being “arcane”, these won’t be easy to measure or to communicate to respondents — Alternatively, a collection of indices (say, species diversity indices) may capture much of what people care about and also be sufficiently related to physical changes to allow benefits transfer. Or, perhaps a collection of wetland “types” can be identified — sort of a multinomial approach to valuation, as opposed to an hedonic approach (an interesting possibility, but one that may sacrifice our ability to measure the value of small changes).

Let me end on a last philosophical point — that the information given to, and by, respondents can matter — that the way we interpret this information can have real impacts on measured values of the size, and scope, of the benefits due to environmental improvements.

EVALUATING CONTINGENT VALUATION OF ENVIRONMENTAL HEALTH RISKS: THE PROPORTIONALITY TEST[1]

James K. Hammitt
Center for Risk Analysis
Harvard School of Public Health

718 Huntington Ave., Boston, MA 02115
James_Hammitt@Harvard.edu

February 2000

[1] Published in the *Association of Environmental and Resource Economists Newsletter* 20(1): 14-19, May 2000.

The rate at which people are willing to substitute money for mortality risk can be estimated using revealed- or stated-preference methods. Revealed-preference methods are generally considered more credible since it is reasonably assumed that people's choices about real risks are more thoughtful and better informed than their responses to survey questions about hypothetical risks. However, revealed-preference estimates of the value of mortality risk can only be obtained in settings where the alternatives that an individual passes up can be identified and the differences in risk, cost, and other important dimensions can be estimated. Unobserved differences between individual risks and actuarial risk estimates can produce misleading results.

Most revealed-preference estimates of the monetary value of mortality risk have been obtained by comparing workers' pay and on-the-job fatality risk (Viscusi, 1993). After controlling for education and other factors that influence employment opportunities, these studies find that workers in high-risk jobs receive higher wages than those in safer jobs. For example, workers facing an annual occupational-fatality risk of 3 in 10,000 may receive $500 more in annual wages than workers with otherwise similar jobs in which the risk is only 2 in 10,000.

The rate of compensation for risk is commonly expressed as a "value per statistical life" (VSL). In this example, the VSL is $5 million (= $\$500 \div 1/10{,}000$). Since workers who prefer the safer, lower-risk job are willing to give up $500 per year for the risk reduction, 10,000 such workers would together be willing to give up $5 million per year to prevent one expected death among them.

Are the estimates of VSL obtained from occupational-risk studies appropriate for evaluating the benefits of environmental and public-health regulations? A number of factors suggest they may not be.

First, the target populations may include different types of people. Wage-risk studies by necessity reflect the preferences of workers in high-risk jobs, who are generally healthy, male, and young adults. In contrast, environmental and public-health regulations may primarily benefit children or the elderly, or people who are unusually susceptible to pollution due to chronic lung disease, HIV-impaired immune systems, or other factors.

Second, wage-risk studies are based on the preferences of people who accept high-risk jobs, who implicitly reveal a greater willingness to accept risk for money than otherwise similar people who do not accept these jobs.

Third, the types of mortality risks differ. Wage-risk studies are largely based on fatal-accident risks. The mortality benefits of environmental regulations more often come in the form of lower risk of cancer or other fatal disease, which people may value differently.

If the results of wage-risk studies are of limited application to environmental risks, contingent valuation (CV) may be a valuable alternative. CV is an extremely flexible method. One can ask almost any sort of question about a hypothetical choice between alternative situations varying in risk and monetary consequences and experience suggests that most survey respondents will answer. Moreover, the questions can be targeted to the population most likely to benefit from a specific environmental regulation—the elderly, those with chronic disease, or others with relevant characteristics.

Evaluating Contingent Valuation

Does contingent valuation yield valid estimates of WTP to reduce mortality risk? The fact that respondents will answer survey questions does not in itself imply that those answers are either thoughtful or informed. Other criteria are required to evaluate CV results.

One criterion is the extent to which the values estimated from CV studies agree with estimates from revealed-preference approaches. Some comparisons have been made which show rough consistency between CV and revealed-preference estimates. Yet the value of those comparisons is limited by the fact that revealed-preference estimates can only be obtained for goods with which consumers have experience. These comparisons do not provide direct evidence about the validity of CV estimates in cases where CV is most needed—for novel or unfamiliar goods.

A second criterion is the consistency between CV estimates and theoretical predictions about which factors should, and should not, affect willingness to pay (WTP). For mortality-risk reduction and many other goods one would expect that WTP for a benefit would be larger for people with higher incomes, all else being equal. By contrast, WTP should not depend on logically inessential aspects of the question such as whether the risk reduction is described as a change in probability (from 0.0003 to 0.0002), frequency (from 3 in 10,000 to 2 in 10,000), or odds (from 1 in 3,333 to 1 in 5,000).

Proportionality of WTP to the Risk Reduction

One theoretical prediction that has received much attention is "sensitivity to scope," that is, the extent to which estimated WTP depends on the size of the risk reduction or other good. CV has been criticized on the grounds that estimates of WTP are inadequately sensitive to differences between the items that are valued.

In some applications to environmental quality, respondents may indicate virtually the same WTP for protection of substantially different wilderness areas or numbers of wildlife (Diamond and Hausman, 1994). When respondents indicate they are willing to pay the same amount for improvements of widely differing magnitude, it raises a concern that they are simply expressing general support for environmental protection rather than valuing the specified improvement.

For environmental quality, while it is reasonable to expect that WTP should be larger for a greater improvement there seems to be no clear answer to the question of how much larger is enough. For small reductions in mortality risk, however, there are good reasons to assert that WTP should be nearly proportional to the reduction in risk. Indeed, near proportionality between WTP and change in mortality risk appears to be a necessary (but not sufficient) condition for CV-based estimates to be considered valid measures of VSL. If estimated WTP is not proportional to the magnitude of the risk reduction, the estimated VSL will be strongly sensitive to the arbitrary choice of how large a risk reduction is presented in the CV instrument.

The individual's VSL describes the rate at which he would pay for infinitesimal reductions in risk. It is not constant but depends on income and baseline risk. As the individual buys successive increments his VSL will fall as both his remaining income and his risk decline. But under standard models of decision making, both effects should be small.

The standard model of WTP for reductions in current mortality risk is based on the assumption that individuals seek to maximize their expected state-dependent utility of income

$$U(p, w) = (1 - p)\, u_a(w) + p\, u_d(w) \tag{1}$$

where p is the probability of dying in the current period and $u_a(w)$ and $u_d(w)$ are the utility of income w conditional on surviving and not surviving the period, respectively (Drèze, 1962; Jones-Lee, 1974; Weinstein et al., 1980). Holding expected utility constant yields

$$VSL = \frac{dw}{dp} = \frac{u_a(w) - u_d(w)}{(1-p)u_a'(w) + pu_d'(w)}. \tag{2}$$

The numerator is the difference in utility between surviving and dying and the denominator is the expected marginal utility of income. Under the conventional and reasonable assumptions that $u_a(w) > u_d(w)$ and $u_a'(w) > u_d'(w) \geq 0$, VSL increases in risk. Risk aversion in both states ($u_a''(w) < 0$, $u_d''(w) \leq 0$) is sufficient for VSL to increase with wealth.

The effect of risk on VSL—the "dead-anyway effect" (Pratt and Zeckhauser, 1996)—reflects the difference in the marginal utility of income depending on whether or not the individual survives the period. The effect is largest when the marginal utilities are as different as possible, that is, for $u_d'(w) = 0$. In this case, decreasing the mortality risk p by Δp decreases VSL by the proportional change in survival probability $(1 - p)/(1 - p + \Delta p)$. For the usual case where the baseline risk p is a few percent or less, the proportional decrease in VSL is approximately equal to $1 - \Delta p$.

While theory implies the dead-anyway effect is small, it places no obvious constraints on the income effect. Thus, we must turn to empirical estimates. These suggest the income elasticity of VSL is no greater than one.

The primary sources of information on VSL -- studies of compensating wage differentials--typically do not provide information about the income elasticity because income (or wage) is the dependent variable and cannot also be used as an explanatory variable. One approach to estimating the income elasticity is to conduct a meta-analysis of compensating-wage-differential studies where the populations differ in income, risk, and other factors. Liu et al. (1997) used this approach to evaluate the relationship between estimated VSL, average income, and fatality risk for the 17 compensating-wage-differential studies listed in Viscusi's (1993) review article for which these variables were available. They estimated an income elasticity of 0.5.

Income elasticity can be estimated from revealed-preference studies for goods other than employment and from CV studies. For example, Blomquist (1979) estimated an elasticity with respect to the present value of future earnings of 0.3 in his study of seat-belt use. CV studies do not always find a statistically significant relationship with income or report sufficient information to calculate an elasticity. Jones-Lee et al. (1985) estimated a value of 0.3 in a study of transportation risk. Evans and Viscusi (1990) estimated an income elasticity of 1.0 for nonfatal injury risk.

The available evidence suggests that the income elasticity of VSL is no greater than one, and may be substantially smaller. If so, the effect of changing income on the proportionality of WTP to risk reduction is small whenever WTP is a small share of income.

How large a departure from proportionality is consistent with the standard model? Consider an individual with annual income of $40,000 (the approximate average for US households) facing a 28 in 10,000 chance of dying in the next year (the approximate average for US residents aged 25-54). Assume the individual's VSL is $5 million (a standard estimate). How much more would he pay to reduce his risk by 2 in 10,000 than by 1 in 10,000?

For this individual, WTP_1 to reduce mortality risk this year from 28/10,000 to 27/10,000 is equal to the risk increment $\Delta p_1 = 1/10{,}000$ times some VSL intermediate to its initial value VSL_0 (= $5 million) and its value VSL_1 at the final position where his risk is 27/10,000 and his income is ($40,000 - WTP_1). Since WTP_1 is less than $\Delta p_1 \bullet VSL_0$ = $500, his final income will be greater than $39,500. If his income elasticity is no greater than one, the income effect alone yields $VSL_1 > 39{,}500/40{,}000 \bullet VSL_0$ = $4.9375 million. The dead-anyway effect decreases this value by a factor no smaller than 0.9999, to $4.9374 million. Thus WTP_1 is between $500 and $493.74.

Similarly, the individual's WTP_2 to reduce his risk from 28/10,000 to 26/10,000 is equal to $\Delta p_2 = 2/10{,}000$ times some VSL between VSL_0 and its value VSL_2 once he has paid for the larger risk reduction. In this case, his final income will be greater than $39,000, the dead-anyway effect reduces VSL by a factor of no less than 0.9998, and so $VSL_2 > 39{,}000/40{,}000 \bullet 0.9998 \bullet VSL_0$ = $4.874 million. WTP_2 is between $1,000 and $974.80. Dividing the lower bound on WTP_2 by the upper bound on WTP_1 implies that the individual will pay at least 1.95 times as much to reduce his risk by 2/10,000 as he will pay to reduce it by 1/10,000.

The near-proportionality of WTP to change in mortality risk depends on several factors. First, the effect of reduced income cannot be too large, which implies that it is unreasonable to expect near-linearity if the payments are a substantial fraction of income (or if the income elasticity of VSL is much larger than current estimates suggest).

The dead-anyway effect is always small unless the risk change is a substantial fraction of the individual's total survival probability. Note that the effect depends on the individual's total mortality risk rather than the level of risk from any specific cause. Whether the risk reduction to be valued involves a small or large fractional change in a particular risk (for example, road accidents) is irrelevant, except perhaps if the marginal utility of income if one dies depends strongly on the cause of death.

Near-proportionality does not depend on the assumption that the individual maximizes his expected utility. Most alternative theories of decision making under uncertainty are locally linear in the probabilities (Machina, 1987) which is all that is required. Under rank-dependent expected utility, for example, the individual would evaluate his position using

$$V(p, w) = [1 - \pi(p)]\, u_a(w) + \pi(p)\, u_d(w) \qquad (3)$$

where $\pi(p)$ is a smooth, monotonically increasing function with $\pi(0) = 0$ and $\pi(1) = 1$ (Quiggin, 1993). Holding V constant yields

$$VSL = \frac{dw}{dp} = \frac{p'(p)\left[u_a(w) - u_d(w)\right]}{\left[1 - p(p)\right]u_a'(w) + p(p)\,u_d'(w)}. \qquad (4)$$

Compared with the standard expected-utility result shown in equation (2), the numerator is multiplied by $\pi'(p)$ and the expected marginal utility in the denominator is calculated using the transformed probabilities. This formula will yield qualitatively similar results to the standard model so long as $\pi'(p)$ does not change sharply between the initial and final risks.

In contrast, near proportionality need not hold under theories of decision making such as prospect theory (Kahneman and Tversky, 1979) that allow for thresholds in the way people evaluate probabilities. For example, if an individual perceives an annual mortality risk of 27/10,000 as equivalent to zero but a risk of 28/10,000 as different from zero, then he would pay something to reduce his risk from 28/10,000 to 27/10,000 but nothing for the further reduction to 26/10,000. Thus, his WTP for the larger and smaller risk reductions would be equal.

Although such a result is possible, probability thresholds seem to be an *ad hoc* and context-specific rationalization. Depending on how the question is framed, the existence of probability thresholds could also yield a much greater than proportional relationship between WTP and risk change. If an individual views a reduction of 1/10,000 as negligible but a reduction of 2/10,000 as meaningful, WTP for the smaller reduction might be zero while WTP for the larger one would be positive.

Another possible reason for non-proportionality in CV studies is that respondents may not report their values for the numerical risk change specified in the question. As suggested by Viscusi (1985, 1989), they may instead combine the stated risk reduction with their own prior estimates of how effective the hypothetical program might be to form a revised, posterior estimate of the risk reduction. Even if the respondents' reported values are proportional to their posterior risk estimates, they may not be proportional to the risk reductions specified in the survey. In this case, it is impossible to estimate the respondents' marginal rate of substitution for money and risk unless the posterior risks they value can be ascertained.

The argument for near proportionality of WTP to change in risk does not require that the individual be willing to pay the same amount to reduce different risks, since it concerns WTP to reduce the same type of fatality risk by different amounts. An individual might be willing to pay different amounts to reduce his risk of dying in a traffic accident and from cancer by 1 in 10,000. Nevertheless, he should be willing to pay nearly twice those amounts to reduce each risk by 2 in 10,000.

The State of the Field

Hammitt and Graham (1999) reviewed the results of every CV study we could find that was published since 1980 and estimated WTP for reductions in numerically specified health risks. We sought to determine whether estimates of WTP were proportional to the risk reduction.

Of the 25 studies we identified, only 14 provided information on how estimated WTP varied with the magnitude of risk reduction. Eight studies involved fatality risks. Of these, WTP was statistically significantly related to the magnitude of risk reduction in six cases and not significantly related in two. In every case, WTP varied much less than proportionately to the risk reduction. Some of these studies asked the same respondents to value larger and smaller risk reductions and found that many reported they would pay the same amount for both reductions.

For example, Jones-Lee et al. (1985) elicited British respondents' WTP to reduce fatality risk on a foreign bus trip by 4/100,000 and 7/100,000 (from an initial level of 8/100,000). Mean WTP are £137 and £155, respectively. Because estimated WTP is not proportionate to the risk reduction, dividing WTP by the risk change yields different estimates of VSL—£3.4 million and £2.2 million, respectively. Moreover, median WTP for the two risk reductions are equal (£50) and 42% of the respondents indicated the same WTP for both risk reductions. (Eight percent indicated greater WTP for the smaller risk reduction.)

Six of the 14 studies evaluated nonfatal risks and revealed a similar lack of sensitivity to the magnitude of benefit. WTP was significantly related to the risk change in five studies but was always much less than proportional to the magnitude of the change.

One reason that CV studies usually yield estimates of WTP that are inadequately sensitive to the risk reduction may be the difficulty of accurately communicating small risk changes to survey respondents. Except for the studies by Loomis and duVair (1993) and Hammitt and Graham (1999), there has been little formal testing of the effect of risk-communication methods in CV.

In recent work, Corso et al. (1999) found evidence that difficulties in communicating small changes in risk may be a major contributor to the generally inadequate sensitivity of CV-estimated WTP to the magnitude of risk reduction. These authors elicited WTP to reduce respondents' annual automobile-accident fatality risk by 5/100,000 and 10/100,000 from randomly chosen subsamples of respondents. Respondents were further randomized to one of three groups presented with a visual risk-communication aid (a chart with 25,000 dots, logarithmic or linear risk ladder) or to a control group that received no visual aid.

Table 1 presents regression models estimated separately for each of the four groups. The models assume WTP is lognormally distributed and include only an intercept and a dummy variable “Large risk reduction” which is equal to one if the respondent was offered the larger risk reduction and zero otherwise.

As shown in the table, sensitivity to scope varied markedly with the visual aid used. In the control group, median WTP for the larger risk reduction is 1.10 times larger than for the smaller reduction. The estimates are not significantly different (the coefficient on the dummy variable “Large risk reduction” is not significantly different from zero) and so the hypothesis that WTP is insensitive to risk reduction cannot be rejected. As a result, the estimates of VSL obtained by dividing estimated WTP by the risk reduction differ by a factor approaching two. In contrast, for the group presented with the dots, median WTP is nearly proportionate to the risk reduction (the coefficient on the dummy variable is not significantly different from log(2) = 0.693) and the hypothesis that WTP is proportionate to the risk reduction cannot be rejected. For this group, the estimated VSL is virtually the same for the subsamples valuing the smaller and larger risk changes. Results for the two groups presented with risk ladders fall between these extreme cases.

Table 1: WTP as a Function of Risk Reduction
(Models estimated separately by subsample)

	No aid	Linear	Logarithmic	Dots
Intercept	5.448	5.630	5.333	5.067
	(0.141)	(0.145)	(0.145)	(0.141)
Large risk reduction[a]	0.097	0.318	0.503	0.658
	(0.198)	(0.202)	(0.198)	(0.209)
Sample size	277	288	264	275
Reject insensitivity?	no	no	yes**	yes***
Reject proportionality?	yes***	yes*	no	no
Median WTP (small,	$232	$279	$207	$159
large)	$256	$383	$342	$306
Ratio of WTP	1.10	1.37	1.65	1.93
Median VSL (small,	$4.6	$5.6	$4.1	$3.2
large) (millions)	$2.6	$3.8	$3.4	$3.1

Notes: Standard errors in parentheses.
[a] Dummy variable equal to one if respondent offered larger risk reduction.
*, **, *** = significant at 10%, 5%, 1%.

Conclusion

Contingent valuation is an extremely flexible method for eliciting preferences about health risks. There are few alternatives for obtaining empirical estimates of the value of reducing mortality risk to a specified population. For CV to fill this need, investigators need to develop methods for conducting CV studies that yield demonstrably valid results. An important criterion for evaluating validity is consistency with other information, including the predictions of reasonable theories of decision making and valuation of health risk. In particular, VSL estimates from studies that do not demonstrate the near-proportionality between estimated WTP and risk reduction implied by theory must be viewed with some skepticism.

Acknowledgments

This essay is an expanded version of "Valuing Lifesaving: Is Contingent Valuation Useful?" *Risk in Perspective* 8(3), Harvard Center for Risk Analysis, March 2000. Magnus Johannesson, John Loomis, and Jason Shogren provided helpful comments and the US EPA provided financial support. The views expressed may not represent Agency views or policy.

References

Blomquist, G., "Value of Life Saving: Implications of Consumption Activity," *Journal of Political Economy* 87: 540-558, 1979.

Corso, P.S., J.K. Hammitt, and J.D. Graham, "Evaluating the Effect of Visual Aids on Willingness to Pay for Reductions in Mortality Risk," Harvard Center for Risk Analysis, October 1999.

Diamond, P.A., and J.A. Hausman, "Contingent Valuation: Is Some Number Better than No Number?" *Journal of Economic Perspectives* 8(4): 45-64, 1994.

Drèze, J., L'Utilitè Sociale d'une Vie Humaine, *Revue Française de Recherche Opèrationelle* 6: 93-118, 1962.

Evans, W.N., and W.K. Viscusi, "Estimation of State-Dependent Utility Functions Using Survey Data," *Review of Economics and Statistics* 73: 94-104, 1990.

Hammitt, J.K., and J.D. Graham, "Willingness to Pay for Health Protection: Inadequate Sensitivity to Probability?" *Journal of Risk and Uncertainty* 18: 33-62, 1999.

Jones-Lee, M., "The Value of Changes in the Probability of Death or Injury," *Journal of Political Economy* 82: 835-849, 1974.

Jones-Lee, M., M. Hammerton, and P. Philips. "The Value of Safety: Results of a National Survey," *The Economic Journal* 95: 49-72, 1985.

Kahneman, D., and A. Tversky, "Prospect Theory: An Analysis of Decision Under Risk," *Econometrica* 47: 263-291, 1979.

Liu, J.-T., J.K. Hammitt, and J.-L. Liu, "Estimated Hedonic Wage Function and Value of Life in a Developing Country," *Economics Letters* 57: 353-358, 1997.

Loomis, J.B., and P. duVair, "Evaluating the Effect of Alternative Risk Communication Devices on Willingness to Pay: Results from a Dichotomous Choice Contingent Valuation Experiment," *Land Economics* 69: 287-298, 1993.

Machina, M.J., "Choice under Uncertainty: Problems Solved and Unsolved," *Journal of Economic Perspectives* 1: 121-154, 1987.

Pratt, J.W., and R.J. Zeckhauser, "Willingness to Pay and the Distribution of Risk and Wealth," *Journal of Political Economy*, 104: 747-763, 1996.

Quiggin, J., *Generalized Expected Utility Theory: The Rank-Dependent Model*, Kluwer Academic Publishers, Dordrecht, 1993.

Viscusi, W.K., "A Bayesian Perspective on Biases in Risk Perception," *Economic Letters* 17: 59-62, 1985.

Viscusi, W.K., "Prospective Reference Theory: Toward an Explanation of the Paradoxes," *Journal of Risk and Uncertainty* 2: 235-263, 1989.

Viscusi, W.K., "The Value of Risks to Life and Health," *Journal of Economic Literature* 31: 1912-1946, 1993.

Weinstein, M.C., D.S. Shepard, and J.S. Pliskin, "The Economic Value of Changing Mortality Probabilities: A Decision-Theoretic Approach," *Quarterly Journal of Economics* 94: 373-396, 1980.

AGE, HEALTH, AND THE WILLINGNESS TO PAY FOR MORTALITY RISK REDUCTIONS: A CONTINGENT VALUATION SURVEY OF ONTARIO RESIDENTS

Presented by Maureen Cropper, World Bank and University of Maryland
Co-authored with Alan Krupnick, Resources for the Future, Anna Alberini, University of Maryland, Nathalie Simon, EPA, Bernie O'Brien, McMaster University, Ron Goeree, McMaster University, Martin Heintzelman, Resources for the Future

Summarization

Dr. Cropper presented the results of one of several surveys she and her colleagues have done looking at the impact of age and health status on people's willingness to pay (WTP) to reduce the risk of dying. The reason they are interested in these two questions, she said, is because most of the benefits from air pollution control programs and other health and safety programs that save lives are in proportion to the existing distribution of death. So it matters for policy decisions what happens to people's willingness to pay for risk reductions as they get older. People with certain pre-existing health conditions, like chronic heart and lung diseases, benefit most from regulations like those reducing air pollution, so it is also important to know how willingness to pay varies with health status.

The researchers conducted a contingent valuation survey looking for the dollar amount people were willing to pay for an abstract product to reduce the risk of death over the next ten years. They were also interested in what people would pay for a product that would reduce their risk of dying beginning at age 70. Cropper said she would not focus on those results because of time but said they are also important for policy.

The survey took place in Hamilton, Ontario, Canada, with people between the ages of 40 and 75. The researchers asked people if they had particular chronic illnesses, focusing on heart and lung diseases, and to fill in Standard Form-36 (SF-36). (SF-36 is a quality-of-life survey of 36 questions used routinely by the medical community to measure physical, mental, and emotional health.) The survey was administered at a centralized facility by computer so that people could go through it at their own pace. To insure they did the survey completely, a researcher read each screen to them.

To represent the chances of surviving versus the chances of dying, researchers used a visual aid that worked well with focus groups. This was a grid made up of 1,000 squares, some blank, some filled in, illustrating the baseline risk of dying over the next 10 years and changes in the risk of dying if one bought the product. In focus groups they found that people had a hard time understanding their risk of dying over a short time period. It became a more real concept in the context of the relatively long period of ten years.

They asked people to value reductions in their risk of dying over this ten-year period for either a 1 in 10,000 or 5 in 10,000 annual risk reduction. To do this they asked them what they would pay for an abstract product that would reduce their own personal risk. They used external and internal scope tests and were concerned whether WTP for different size risk changes would increase on average in proportion to the risk change.

The study was set up in two groups or waves. In the first wave, people got a 5 in 1,000 risk change first, in the second wave they got a 1 in 1,000 change first. The researchers compared these answers in an external scope test. Each individual was presented with both sizes of current risk reduction and a future risk reduction of 5 in 1,000 starting at age 70. So, Cropper explained, they were able to do internal scope tests, as well.

She went on to detail the structure of the survey. They started by asking people about their health, if they had conditions such as chronic bronchitis, asthma, high blood pressure, etc. They next talked about chance and communicated information on the risk of death with visual aids and explained the idea of baseline probabilities. They allowed people to do various exercises, adding and erasing squares on a thousand-square grid to visually demonstrate the benefits of using the product and the risks of death. They then tested their comprehension.

Next, they told the respondents what the risk of death was for people of their race and gender over the next ten years. They discussed what people were currently doing to reduce their own risk, such actions as prostrate cancer screening, controlling cholesterol, etc., and told them what were the quantitative reductions in risk for these interventions.

They then posed the WTP questions, asking people if they would buy the product, which would not be covered by health insurance but was shown to be safe and effective. They used a bid structure with payments (in 1999 Canadian dollars) made annually over ten years from which people would receive annual risk reductions. They asked one follow-up question. If people told them "no" twice, that they were not willing to pay the offered amounts of $100 and $50, they asked if there was any amount they would pay. They recorded those amounts and used them later in their estimation of a WTP function.

They included bid amounts that were large enough so people could have a valued statistical life, or VST, of $7.5 million Canadian, which is comparable to the United States VST of $6 million used by EPA. They then asked a series of debriefing questions: did people believe the baseline risk, or believe in the product's effectiveness, etc. The answers were used as co-variants in looking at factors explaining the differences in the WTP responses. Finally, they gave SF-36 to determine physical and mental limitations.

One concern, Dr. Cropper said, was the low response rate, but she added, they were comforted by the fact that, in regard to health and income, the people in the survey looked like the people of Ontario. They were not, however, as old a group as they would have liked, the average age was 54 and only 9 percent were over 60.

A higher percentage of people were willing to pay the stated amounts for the larger risk change of 5 in 1,000. There were a lot of people in both waves that said they would pay nothing for the product. Unfortunately, they did not debrief them as to why. In their current surveys, she said, they have included questions to find out why they are getting such large numbers of zeroes.

The big question, she thinks, is do people pass the proportional scope test? Is WTP on average for the 5 in 10,000 annual risk reduction 5 times as large as that for the 1 in 10,000 reduction? If it is, the mean VSL should be the same for the two size risk changes. Regardless of the model used for the data, she said, showing the results from the double-bounded, Turnbull, and spike models, they did not arrive at proportionality.

She then showed some of the results of the co-variants for age and health status. Putting the age variables from wave one into the WTP equation, with dummy variables for the age categories, they ended up with statistically significant results. When they imposed quadratic and linear functions, the results were statistically insignificant.

Next, she showed the results of the re-estimation of the spike model, which they viewed as their best model because it incorporated all the responses. Displaying a table showing the mean WTP and the standard error for the various age groups, she pointed out the statistically significant difference between the $418 mean WTP for the over-70 group and the values for the other groups. Between the peak value for the age group between 51 and 70 and the value for the group over 70 there was a one-third decline. Dr. Cropper cautioned that this was a tentative result.

What was more surprising, she said, was the lack of significance of the effects of chronic health conditions and the SF-36 scores on WTP. To illustrate her point, she used a table of coefficients indicating what happened when they put the chronic-condition variable dummies, one at a time, into a regression that included income, education, age, debriefing variables, and also some of the summary scores from SF-36. The resulting figures showed the maximum impacts of each of the disease categories on WTP. Pointing to the p-values, she said that the only thing that came in as possibly significant was the cancer variable. People with cancer were willing to pay $270 more than people without cancer. Her co-authors would interpret this as more significant then she would, Dr. Cropper said. She cautioned that the results were from only 26 people and that they had obviously dealt well enough with cancer to be able to come in to do a survey at a centralized facility. To say that people with cancer are willing to pay more to increase their life expectancy based on these results she thinks is premature.

What was statistically significant, she noted, was the higher willingness to pay of the respondents with higher mental health. When they looked at the SF-36 data, they found that the p-values relating to people's mental states were significant. People with fewer signs of depression were willing to pay more for risk reduction. Mental status, not physical status, seems to matter in WTP, she concluded.

Dr. Cropper cautioned that she didn't want to claim too much for the survey. One problem was the low response rate. Another weakness was the failure of WTP for the 1 in 10,000 risk reduction to vary with age and health in the wave two results. She also thought that the failure of the proportionality test was a problem.

Her tentative conclusions are that there is some evidence of willingness to pay for a reduction of the risk of death going down after age 70 and that physical health status itself does not seem to have a significant effect on the willingness to pay.

She and her colleagues are currently doing a similar study based on data collected from 1,350 respondents in the US via Web-TV and plan to do another centralized facility survey in Prince George's County, Maryland.

Discussion of Session IIIb Papers
by Steve Crutchfield, USDA Economic Research Service

This participant's remarks are not available.

Question and Answer Period for Session III

Kelly Brown, U. S. Environmental Protection Agency, asked James Opaluch to clarify that the survey he described was actually done and that it was the source of the previously collected data in his study.

Opaluch confirmed that it was an actual survey and that they randomly selected from the sample.

Richard Carson, University of California, San Diego, remarked that in a typical choice experiment you might have ten choice sets and 100 respondents, giving you 1000 choices. This seems enough to give you good results from the binary estimator. The range over which the ordinal estimators do a better job than the binary estimators seems limited to fairly small sample sizes.

Opaluch agreed their study suggests that when analyzing 200 to 1000 choices, the ordinal estimators do a better job but after that the two do about the same.

Carson noted that the proportionality test in the Hammitt study falls out of the textbook formulation of risk. But there are other models, and the evidence from actual markets is either absent or inconsistent with the proportionality test. He suggested that it is nice but not essential to have proportionality, whereas a violation of the general scope test (people not willing to pay more for larger risk reductions) would be disturbing.

James Hammitt replied that one could construct models where proportionality is not expected. But he was troubled by some of the implications that people might try to draw out of non-proportionality, such as arguing that it is better to break up reductions in risks into small packets rather than to consider them all at once.

Daniel Mullarkey, Economic Research Service, USDA, noted that in wetlands work he had found similar results to those of Frank Lupi and John Hoehn. People may know a lot about some wetlands functions but little about others. There is scientific uncertainty and lack of information in the area, which breeds potential for respondents to reject the scenario that you offer. He asked the panel how to screen for scenario rejection.

John Hoehn said one way is to develop tests based on the different approaches to valuation, comparing the results, looking for consistency.

Mullarkey asked about more direct screening. That is, what if you ask a respondent if the scenario was believable and the respondent said no?

Hoehn said we should try to have a general idea in advance about what wetlands services people really value. For example if people value habitat services, we should try to describe those services to people in a really salient way. We also need to better understand what it is about habitat that people value.

V. Kerry Smith, North Carolina State University, posed three questions. First, in Maureen Cropper's study, did they ask respondents about recent changes in activity limitations? Other research suggests that changes in health or activity signal changes in quality of life perception.

Second, were the people who were unwilling to pay for reduced risk the same people who had difficulty understanding probabilities?

Third, for John Hoehn, there are data from the American Association of State Highway Transportation Officials on prices paid for wetland banking in highway projects. It would be interesting to compare those to what Hoehn found.

John Hoehn agreed.

Maureen Cropper said they asked about current health status over the last four weeks. It is an interesting question whether people become accustomed to physical limitations and if so how long it takes.

Cropper also noted that unwillingness to pay does not correlate to inability to understand the probability questions in the survey. We asked some of these people open-ended questions about their response. Typically they told us that they considered the risk change too small or that they could not afford to pay.

F. Reed Johnson, Triangle Economic Research, asked how should economists deal with ill-informed preference? Does aggressively informing respondents bias results? Can people be rationally ignorant? If a person lacks knowledge of a resource, can a change in the resource affect the person's welfare? Should we be measuring how much people are willing to pay to become informed?

Also, he noted that existence values can be negative as well as positive. In February when the wetlands behind his house are a source of chorusing frogs, his wife is pleased. Two months later when the mosquitoes come, she is not.

John Hoehn acknowledged that wetlands can have negative existence values, noting a situation in Michigan where wetlands may be converting mercury into bioactive forms.

He said that a change in a resource can often matter to an uninformed person.

Does it matter that people are uninformed? As information changes, values may change. We may not want to base policy on values that are highly unstable. So it is important to examine the basis of people's values and their sensitivity to new information. Researchers need to examine and understand the conditionality of values. Some of the unexplained results that we have talked about during this conference may reflect scenario rejection based upon the respondent's knowledge. If we apply these results without understanding them, we risk bias.

James Hammitt remarked that Dr. Johnson's questions were profound and intriguing. Should government function as a referendum or should it provide leadership or act as well-informed people would wish it to act? Hammitt said that if a study were tricked by framing effects, he would not want government to change its policy on that account.

Mike Christie, University of Wales, Aberystwyth, wondered about the possibilities and drawbacks of using web-based surveys. They offer large samples and easy data entry, but how do you control sample size and how can you aggregate the data?

John Hoehn said he was concentrating on developing a questionnaire format that takes advantage of the web. He was not focused yet on the sampling problems.

Maureen Cropper said they were using a commercial service to locate a random sample of households. Subscribers to the service get free web television in return for taking surveys. The service allows them to target by age groups. The researchers can compare the demographic characteristics of their sample against the general population. This is better than putting the survey out on the web and letting people self-select.

Jim Opaluch returned to the "tree falling in the forest" issue of whether a person can benefit from a resource the person does not know about. The answer depends on use versus non-use values. If there is a health effect, through an improvement water quality, there are values even if people don't know what is happening. We can educate people about the connection between water quality and health and measure those values.

But suppose there is a species that exists but everybody thinks it is extinct. Are we really getting value from the species? It is a difficult question.

Daniel Mullarkey noted that lack of knowledge of a good today may change and create value for the good in the future. Don't zero people out just because they don't know now.

Daniel Hellerstein observed that it is dangerous to assume ignorance is bliss, or to assume that if nobody knows, nobody will ever care.

Kerry Smith said that if you expose someone to a latent hazard such as asbestos and the risk is not discovered for ten years, it still has a value even though you cannot change the risky behavior.

Jim Opaluch replied that in that case – a health case – there clearly is a value. But with existence values the question is more difficult. The definition of existence value is the value of knowing that something exists. But is there value if it exists whether you know it or not?

Glenn Harrison, University of South Carolina, thought Opaluch might be confusing the standing issue with valuation.

Richard Carson returned to Johnson's questions of rational ignorance and the value of information. The typical person has little opportunity to influence policy. It is dangerous to draw conclusions from people's not investing in information when their ability to act on the information is limited.

Regarding Opaluch's endangered species example, value in an economic sense is only defined by offering choices. The willingness to spend money to save the species is the only sign to the economist that the species is valuable. Consider new consumer goods – cell phones, for example. Once upon a time people didn't know they existed. If you take the strict willingness to pay view, they only acquired value when people got to make choices about them. The degree of knowledge is not relevant to thinking about value in that sort of context.

Carol Mansfield, Research Triangle Institute, observed that existence value of wetlands stems from a sense that the wetlands are functioning, not from knowledge of how exactly they function. You can get utility from ecosystem function without knowing whether specific animals or plants exist.

Patrick Welle, Bemidji State University, saw a methodological issue here about contingent valuation, dichotomous choice, and conjoint analysis. We have to be careful about how we separate out some of these attributes in choice experiments. People might not be able to imagine the choice presented and would reject the scenario.