Valuing and Managing Ecosystems: Economic Research Sponsored by NSF/EPA

Proceedings of the first Workshop in the Environmental Policy and Economics Workshop Series

Washington, D.C.

October 29, 1998

Edited by Barbara Kanninen
for the Environmental Law Institute
1616 P St. NW, Washington, D.C. 20036

Prepared for the
Office of Research and Development and Office of Policy
U.S. Environmental Protection Agency
Washington, D.C.

Acknowledgements

This report was prepared by the Environmental Law Institute with the collaboration of Barbara Kanninen and with funding from the Office of Research and Development, U.S. Environmental Protection Agency. ELI wishes to thank Deborah Hanlon of EPA's Office of Research and Development, and project officer Alan Carlin together with Nicole Owens and Tracey Wolff of EPA's Office of Policy. ELI would also like to thank the researchers who provided the material for the report.

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Summary of Contents

Valuing and Managing Ecosystems: Economic Research Sponsored by NSF/EPA

The purpose of the Environmental Policy and Economics Workshop Series is to hold in-depth workshops on timely topics that will further the use of economics as a tool for environmental decision making. Both NSF/EPA grant recipients and researchers (from EPA, fellow Federal agencies, academia, and others) will be invited to attend and discuss their on-going research. Topics will be chosen based on relevance to current EPA issues and, more broadly, to issues of concern to the environmental economics community. These topics will include exploration of innovations in economic research methods as well as how research will further environmental policy making and future environmental economic studies. "Valuing and Managing Ecosystems: Economic Research Sponsored by NSF/EPA" was the first workshop of this series.

Opening Remarks

Brett Snyder, Environmental Protection Agency, Office of Policy, Director of Economy and Environment Division

Morning Session – Estimating the Value of Ecosystem Resources

Moderated by Charles Griffiths, Environmental Protection Agency, Office of Policy

PAPER ONE:

"Valuing Research Leads: Bioprospecting and the Conservation of Genetic Resources"
Gordon Rausser, University of California at Berkeley, Dean of College of Natural Resources and Arthur Small, Columbia University, Graduate School of Business and Columbia Earth Institute

Presented by Arthur Small

Professor Small looked at the value of genetic resources as inputs into the innovation process, particularly in the field of biotechnology. Such resources could be valued by deriving what research firms would be willing to pay to have access to them, or more specifically, to the information they provide. Currently, as with many public-access goods, genetic resources may be suffering from the well-known "tragedy of the commons" problem and, in some cases, may be becoming extinct, a process which would foreclose the possibility of future innovations based on them. A major theme throughout Professor Small's presentation and the later discussion was the question, should property rights and institutions be developed to prevent such losses and allow countries to extract the benefits their genetic resources could provide?

Advocates of bioprospecting have suggested that there are benefits associated with it—the transfer of wealth to gene-rich developing countries, the generation of incentives for biodiversity conservation, and the improvement of the efficiency of biotechnology research and development. The research question posed by Rausser and Small is whether or not significant enough rents would accrue to the resource to encourage the establishment of appropriate markets.

Professor Small discussed several key features that define genetic materials as research leads. Foremost, the first firm to discover their potential can capture the lion's share of the profits since only one copy is needed to reproduce genetic material. If, however, any particular genetic resource is lost, we cannot recreate it: the loss is irreversible. Further, the set of all research leads is highly heterogeneous, and any given lead is not certain to prove successful. These concepts have been central to the literature on biodiversity option value and the potential for bioprospecting. Recent work by Simpson, Sedjo, and Reid (1996)—hereafter SSR—found that the value of biodiversity at the margin is negligible because the last research lead is almost certain to be either infertile (to not contain the resource needed) or redundant (to contain only genetic material that has already been discovered).

To further the existing literature, Rausser and Small proposed an efficient search procedure that looks at the most promising (high probability of success) leads first. Small provided the analogy of conducting a search for a specific book in a library. Without a catalogue or other information on where to find the book among a large array of stacks, a glance at any particular book, at the margin, is worth almost nothing. On the other hand, some information about the general location of the book is valuable and would allow a more focused search with a higher probability of success.

Rausser and Small developed a bioprospecting model with "informative priors," where the probabilities of successful discovery for each potential site are known. The model defines the search process as a sequential series of Bernoulli trials with known probabilities of success, costs per test site and benefits accruing to successful outcomes. Small first established that an optimal search program for a firm would be to test the most promising site first and continue with the next most promising site, etc., until continued testing is no longer profitable in expectation.

He then established, analytically, expressions for the total search value and the incremental value of each potential test site. The incremental value of a site can be decomposed into two components that he referred to as "information rent" and "scarcity rent." The first of these, information rent, represents the expected reduction in future search costs that is obtained by taking advantage of the promising lead offered by a particular site. The second component, scarcity rent, represents the contribution made by the marginal site when it is indistinguishable from any other site; in other words, if no information is available on it as a research lead. Small showed that as the number of available sites, or search opportunities, increases, the value of marginal opportunities goes toward zero and the value of each incremental promising lead becomes completely based on information rents.

Next, Small presented a numerical example that demonstrated the model's use as a valuation tool. The example considered 18 ecosystems as the potential search space and made assumptions about the key parameters in the model. The values derived vary for each ecosystem but go as high as $9,000 per hectare.

To summarize, Small pointed out that previous economic work on bioprospecting paid insufficient attention to the importance and availability of prior information and that with prior information, some genetic resources could command information rents large enough to create incentives for conservation. The existence of prior information plays an important role in the possible establishment of a bioprospecting market. Small suggested that host countries have the incentive to invest in information to improve their position in the “search queue” and that such investments could result in a commitment to a conservation strategy. Most importantly, it is vital to define property rights over genetic resources to create the appropriate conservation incentives.

Small briefly discussed other work he and Rausser are doing on the role of competition in the research and development industry and how it affects demand for research options. When there are many firms, each may hold options on only a small share of the set of all research leads. In this case, most redundancy costs are externalized. Further, if firms bid against one another for access rights, each has an incentive to keep leads away from competitors. Therefore, when firms compete in both input markets (for leads) and output markets (for discoveries), they will be willing to pay a premium for exclusive rights over research options.

References

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Rausser, Gordon C. and Arthur A. Small, “Bioprospecting with Patent Races,” Paper No. PW-98-07, PaineWebber Working Paper Series in Money, Economics and Finance, Columbia Business School, October, 1998.

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Rausser, Gordon C. and Arthur A. Small, "The Economic Value of Patents, Licenses, and Plant Variety Protection Certificates." Forthcoming in proceedings volume, *Building Partnerships for Commercializing University Research*, Tahoe City, California, May, 1996. Available as Giannini Foundation Working Paper No. 797, Dept. of Agricultural and Resource Economics, University of California at Berkeley, 1997.

PAPER TWO:

<u>"Decision-Making Under Uncertainty in the Conservation of Biological Diversity"</u>

Andrew Solow, Woods Hole Oceanographic Institute; Stephen Polasky, Oregon State University and the President's Council of Economic Advisors; Jeffrey Camm, University of Cincinnati; Raymond O'Connor, University of Maine; and Blair Csuti, University of Idaho

Presented by Stephen Polasky

Professor Polasky's research has the goal of developing a process for efficiently allocating scarce resources and setting conservation priorities. In his presentation, he discussed the decision-making framework he and his colleagues have developed and ways to assess the non-biological costs and probable biological effects of alternative conservation strategies through a reserve network selection scheme.

The conservation decision-making framework is basically a "cleverly disguised" model of utility maximization under a budget constraint. The objective is to maximize expected biological diversity conserved given the constraint of a limited budget. The model contains general functions for the measure of biological diversity, the probability that a particular outcome will occur under a particular conservation strategy, and the cost of implementing a particular strategy. By taking the budget as exogenous, the problem becomes one of cost-effectiveness analysis, or the efficient allocation of scarce resources.

As potential conservation strategies Polasky mentions the conservation of habitat, the prevention of the spread of exotic species or outside predators introduced into an ecosystem, and the reduction of pollution. In principle, the decision-making framework is general and can consider any such strategy. In practice, however, analysis is limited to situations where both the biological and economic consequences of a strategy can be specified. Therefore, the research focuses on conserving habitat using a reserve network selection scheme.

Within the reserve network selection problem, the goal is species survival and the primary conservation strategy is the purchase and maintenance of parcels of land in their desired states in order to enhance survival – in other words, buying habitat for nature reserves. In this analysis, the biodiversity measure is "species richness." It is assumed that if a species is represented in at least one site selected as a nature reserve, it will survive. Species not represented in any site selected as a reserve will become extinct. For the initial analysis, it also is assumed that all potential reserve sites are equally costly to conserve.

The problem is to find an affordable set of reserves that represents the greatest number of species at least once (maximal coverage). Because of the great number of combinations that results when one selects even a modest number of sites out of a reasonably large number, the optimal solution is possibly unobtainable in finite time. Polasky looked at two approaches to obtaining a solution: 1) heuristic methods such as hotspot analysis (choosing locations that contain a large number of species) and the "greedy algorithm," (sequentially selecting sites that contain the most additional species to the set already selected); and 2) linear programming. Polasky provided an example that showed the failure of both heuristic methods for obtaining the optimal solution.

Polasky provided an empirical example of reserve network selection using the two heuristic methods and linear programming applied to the Oregon Terrestrial Vertebrate dataset. He found that the optimal solution conserves 90% of the species with only five sites and 95% of the species with ten sites. As one would expect, the optimal solution contains sites representing every distinct eco-region in the state.

Next, Polasky discussed the implications of considering the opportunity costs of the different land areas being considered as nature reserves. The opportunity costs for private land were derived based on assessed land values and for public land based on the estimated present value of resources located on the land. He noted that these approaches ignore the possibility that recreational or ecological service flows may increase with habitat conservation.

Using county-level endangered species data in the United States, Polasky and colleagues found that when choosing the minimum number of counties to cover the most endangered species regardless of cost, the most important areas are generally located in the western part of the United States, including Hawaii. Many of the counties in the solution are highly urban, for example, Los Angeles, San Francisco and Honolulu.

Combining the endangered species data with land value data, Polasky and colleagues solved for the minimum cost combination of counties to represent a given number of species. This solution includes lower-cost and less species rich areas in the Inner-Mountain west and Midwest. The solution costs, in general, one-third to one-half as much as the solution that minimizes sites. For a fixed budget of $100,000, the cost-minimizing solution could cover 750 species as opposed to the 590 that would be covered under the site-minimizing solution.

Professor Polasky reminded the audience of several assumptions that are slight stretches of reality. For example, on the ecology side, the analysis does not account for the different size habitats required of different species and, on the economics side, it does not account for the different land values that would occur within a county. To better conduct their analysis, they would need more detailed information about species distribution and range requirements and more detailed, parcel-level information about land values. Polasky also noted that there are currently a number of larger data uncertainties about the existence of species, particularly in the developing world.

Because it is uncertain as to whether or not a particular species is present or absent from a site, even when site conditions are conducive to their survival, Polasky discussed the use of a probabilistic approach to the reserve network problem. He showed, using synthetic data, that converting probabilistic information to a present/absent format can lead to incorrect recommendations. For example, a simple scheme that assigns all sites with probabilities greater than .5 to a "present" indicator for species existence and all sites with probabilities less than .5 to an “absent” indicator, might incorrectly favor a site with a few high probabilities when a site with a large number of lower probabilities, in fact, provides higher expected species richness.

Polasky also discussed several additional research directions. He is looking at the value of information: given a limited conservation budget, how much should be allocated to surveys versus land acquisition, and where specifically should survey teams be sent to gather information? He is also considering incorporating “threat/vulnerability” ratings on land parcels being considered as reserves. To improve the probabilistic information about species occurrence, he is considering the use of logit or probit analysis to predict the likelihood that species will occur at a particular site, based on observable sites. Finally, he would like to incorporate a multi-species population biology model that predicts how populations would be affected by land use.

Papers and Manuscripts by Solow and Polasky

Ando, Amy, Jeffry Camm, Stephen Polasky, Andrew Solow "Species Distributions, Land Values, and Efficient Conservation,” *Science*, Vol. 279, March 27, 1998.

Polasky, Stephen and Andrew R. Solow, “Conserving Biological Diversity with Scarce Resources,” Forthcoming in *Landscape Ecological Analysis: Issues and Applications,* Klopatek and Gardner, editors, Springer-Verlag.

Panelist Discussion and Audience Q&A

David Simpson, Resources for the Future, Energy and Natural Resources Division

Dr. Simpson offered three points of disagreement with the research presented by Small. First, he wanted to make clear, as the primary author of a paper which Rausser and Small mentioned prominently in their research (SSR), that he does not fully disagree with the work of Rausser and Small. Second, he criticized one part of the mathematical analysis in the paper, “Bioprospecting with Patent Races.” Third, he suggested that there are important policy implications from the research that they should try to think about jointly with the goal of reaching a consensus.

Addressing his second point first, Dr. Simpson refuted the conclusion of Rausser and Small, as he interpreted it, that the surplus value available in the search for a single, new pharmaceutical product is linear in the number of potential leads available. He stated his disagreement with this conclusion in both heuristic and technical terms. Heuristically, testing opportunities or sites should not increase the total benefits available from a product (as they would have to if the surplus is linear); if all opportunities are valuable, there must be some possibility of redundancy, or the repetition of a discovery. Mathematically, Simpson noted that his earlier paper could be regarded as a special case of the Rausser and Small analysis by letting all sites be judged equally promising as research leads, and therefore, Rausser and Small’s result on surplus value should also be obtained in the earlier paper – but it is not.

To address his first point, Dr. Simpson suggested that it is impossible to fully disagree with the Rausser and Small research because the research essentially reflected a tautology: that "things that are known to be valuable are valuable." In fact, Simpson argued that, by showing that promising leads are more valuable than unpromising leads, Rausser and Small validated the SSR results by implying that as valuable sites are discovered, unpromising sites are even less valuable.

In his final point, Dr. Simpson argued the need to provide responsible advice to developing countries. He said that all countries seem to believe they have resources of great value for bioprospecting, but in truth, they would be better off devoting their time and resources toward more important investments in other areas. He mentioned his visits to many developing countries where the numbers that have been suggested in the literature as the values of promising land parcels have been inappropriately treated as truth, a problem that he suggested academics must not treat lightly since it may lead to misdirected policies to promote bioprospecting in the hopes of significant payoffs.

Dr. Simpson briefly described his current research in the area, which entails the inclusion of a time dimension to the bioprospecting search. His results are qualitatively similar to the SSR paper in that site testing is not done too quickly so as to avoid the possibility of redundancy.

<u>John Tschirhart, Department of Economics and Finance, University of Wyoming</u>

Professor Tschirhart began his discussion by commenting that he felt that some of the most important work economists are doing today is work on ecosystems, principally because of the fact that ecosystems have been and are currently disappearing. He liked both research projects and said that their work was important and would be useful for his own research.

Tshirhart found the Rausser and Small work to be a "neat model" and nice extension of the work of SSR. He had one quibble with their use of the term "scarcity rent" which has a standard use and meaning in the economics literature already. Instead, he suggested using a term such as "expected cost savings" to represent that component of the resource valuation.

He also praised the work of Polasky and Solow as a noble attempt at defining value for biodiversity and allocating resources accordingly, noting in particular that when biology alone (without economics) is used to define value and allocate resources, sub-optimal outcomes can result. He also noted that their work represents only a partial equilibrium analysis and that a more complete approach would take account of feedbacks within the ecosystem, and between the ecosystem and the rest of the economy. By accounting for these interactions, we might discover that seemingly non-valuable species (e.g. microorganisms) are critical to the prosperity of the system.

As an example of the importance of seemingly obscure ecosystem interactions, he discussed three hypothetical types of orchids, called x, y and z, where x is considered to be more valuable than y and y is more valuable than z, which has no value. Suppose there is a bee species that pollinates all three types of orchids, but orchid z is allowed to become extinct. Without z, the bee might not have enough orchids to pollinate and would also disappear. So although orchid z is thought to have no direct value, its role in the ecosystem might be crucial.

Tschirhart's own research has the goal of jointly modeling the ecosystem and economy as a computable general equilibrium (CGE) model. The ecosystem side of the model is similar to a traditional economic model except that organisms have the objective of maximizing stored energy as their form of currency. By assuming organisms are "price takers" in their economy, Tschirhart and his colleagues find that a long run equilibrium is obtained when all organisms have zero stored energy. Demand and supply conditions then dictate the changes in population levels of the various species that will move toward this equilibrium. Tschirhart noted that the research presented by Small and Polasky would be a useful input to this research effort.

Kathleen Bell, Environmental Protection Agency, Office of Policy

Dr. Bell focused her discussion on the linkages between the research presented and the needs and interests of EPA. She suggested taking a step back from the specifics of the research presented and looking for the policy questions inherent in them as well as what we have learned about the gaps in our knowledge and understanding of ecosystem valuation. In particular, she noted that there is little scientific and behavioral understanding of ecosystems, despite the fact that informed policy decisions would require this information. She commented that her personal research has focused on land use conversions and values and suggested that we need a better understanding of the spatial patterns, scale and timing of land use decisions.

As policy issues, she felt that we need a better understanding of how human behavior and land use changes, both major stressors on the ecosystem, are affected by policies and how these stressors affect biodiversity. She noted that many types of policies, not just those that specifically address conservation, affect these stressors. In other words, she believes it is important for us to be able to bring issues of human and land use stresses on biodiversity into a variety of policy discussions.

Dr. Bell noted that both research projects address roles played by market incentives on ecosystem problems. The projects also emphasize the consideration of both economic and ecological institutions, interactions and approaches for measuring biodiversity. She commented that unconventional models such as these have arisen out of our need to jointly address ecological and economic concerns.

On a practical note, Dr. Bell discussed the need for better record keeping and data management, noting that papers by both presenters identified gaps in the data they needed to properly conduct their research. She hopes EPA will play a role in filling these gaps.

Speaker Responses

Professor Small responded to some of Simpson's technical comments and suggested that the two of them may be misunderstanding each others' assumptions. He suggested that they get together to discuss the details of each of their models further. Small further argued that the conclusions of SSR are, in fact, quite different from those of Rausser and Small. The former, he argued, claim that bioprospecting has no potential as a source of biodiversity conservation finance, while the latter claim that it may have significant potential under certain conditions. Small acknowledged that further research would be needed to ascertain where these conditions hold. (Replying later to Simpson's written comments, Small strengthened his assertion that there is not a mathematical error in "Bioprospecting with Patent Races.")

Audience Q&A

The question and answer session began as a discussion of whether and how developing countries should benefit from bioprospecting. Small asserted, as he did in his presentation, that the establishment of property rights and institutions to sell access to genetic resources on an exclusive basis would increase the benefits for developing countries, compared to those they could realize from selling on a non-exclusive basis. Simpson disagreed however, saying that developing countries are being misled by the values being suggested and that it is irresponsible of us to be encouraging countries to devote their scarce resources to bioprospecting. (Strategies undertaken in developing countries have included both attempts to contract for access to resources and attempts to vertically integrate into pharmaceutical research and production).

This led to the question of whether and how we can prevent values generated by academic research, intended as illustrations of a technique, from being misinterpreted and misused by policy-makers. There was also a question of whether or not non-governmental organizations can be relied upon for technical assistance or whether they have their own agendas that are not necessarily in the best interests of the developing countries.

The discussion then turned to the question of whether and to what extent markets can be the solution to ecosystem management problems. Small argued that we should be looking for opportunities where markets can play a role in capturing the economic value of ecosystem services. Governments could then focus their limited resources on ecosystems for which markets cannot serve as a source of conservation finance. Several audience members and speakers argued that markets cannot take account of the full value of ecosystems, partly because of our own ignorance of their true worth, and partly because markets cannot be established to account for the existence, aesthetic and other nonuse values we place on biological resources. In other words, markets cannot capture the public good nature of the ecosystem problem.

It was further asserted that the idea of relying on the market for bioprospecting to solve even part of the problem may be flawed because pharmaceutical companies have not shown a great deal of enthusiasm for the use of bioprospecting; their bioprospecting programs are small and some are being cancelled. From a biological perspective, it was suggested that the approach to bioprospecting presented here implies that one discovery, or endpoint, is sufficient to solve large problems and ignores the complex nature of such problems as developing a cure for cancer.

The speakers generally agreed that markets should be allowed to work when they can be established, and that in the case of public goods, they often cannot be established. Simpson and Small clarified that their current debate focused only on whether or not returns would be large enough to warrant the establishment of markets for bioprospecting, not ecosystems in general.

Afternoon Session – Improving Stated Preference Valuation of Ecosystems

Moderated by Nicole Owens, Environmental Protection Agency, Office of Policy

PAPER ONE:
"Developing Conjoint Stated Preference Methods for Valuation of Environmental Resources Within Their Ecological Context"
James Opaluch and Stephen Swallow, Department of Environmental and Natural Resources, University of Rhode Island

Presented by James Opaluch

Professor Opaluch discussed the use of conjoint analysis as a method for valuing ecological resources and presented two valuation studies that used conjoint analysis. In the first, he showed that using preference scales with conjoint analysis can be two to three times more statistically efficient than a standard, binary choice approach. In the second, he demonstrated how the potential phenomenon of symbolic bias can be investigated and measured.

Professor Opaluch began his presentation by discussing the fundamentals of conjoint analysis and its potential advantages. With conjoint analysis, survey or experimental respondents are asked to make choices from a set of alternative commodities that are defined by a series of attributes. Although one approach is to ask respondents to choose their most preferred alternative, the approach Professor Opaluch prefers is to use preference scales, where respondents rate the different alternatives on a scale, for example, from one to five, because it increases the information obtained. He pointed out that a simple version of a conjoint analysis can be strategically equivalent to contingent valuation, specifically when the choice offered is a fixed scenario versus the status quo situation.

Conjoint analysis has several advantages over contingent valuation. The task asked of respondents is more balanced; they are given choices that differ only by the levels of the attributes, so the choices generally represent environment-to-environment trade-offs rather than environment-to-money. Because choices are not clearly defined as pro or anti-environmental, it is more likely that symbolic effects will be avoided. The approach is also more likely to avoid ethically charged questions. Professor Opaluch pointed out that because of budgetary constraints, the investigations were conducted using existing survey data. No new surveys were conducted under the current grant.

To investigate the use of strength of preference indicators, Professor Opaluch used a Rhode Island landfill siting survey where survey respondents were presented with two potential sites for the landfill. The sites differed in terms of acres of marsh, woods, and farmland as well as groundwater quality and importance as a wildlife habitat. Each site also had a cost associated with it, representing the cost that each Rhode Island household would have to bear to convert the site to a landfill. Respondents were asked to make two types of choices: a discrete choice between the two alternatives and an ordinal strength of preference rating for both sites on a scale from one to five.

Professor Opaluch emphasized that the use of pictorial graphics in the survey to show the differences between the sites was quite successful. He learned that people found the graphics easier to understand than verbal descriptions alone and that they found them visually interesting. He also noted, however, that it became important to be precise about the details included in the pictures to avoid unintended misunderstandings. For example, in focus groups, participants sometimes counted trees or looked at the density of trees in the picture to make their own assessments of the quality of forestland.

With a total of 12,000 observations, Opaluch was able to design a bootstrapping method for comparing the discrete and strength of preference responses without making assumptions about the true underlying model. Instead, he assumed the full (large) sample gave the true model and then drew a series of small samples, ranging from 2.5 to 20% of the total number of observations. Parameters were estimated using a binary logit for the discrete choice data and an ordered logit for the strength of preference data.

The two approaches were compared using mean squared errors. Opaluch found that, although mean squared errors declined as sample size increased for either model, the efficiency ratio between mean squared errors of the binary logit model over the ordered logit model remained approximately constant, ranging from 2.5 to 3. He concluded that the strength of preference approach, estimated using ordered logit, is therefore about 2.5 to 3 times more efficient, or informative, than the standard discrete choice approach.

Next, Professor Opaluch discussed a case study of land preservation in Peconic Estuary, a section of East Long Island, New York, which he used to investigate the potential problem of survey respondents incorporating symbolic preferences into their responses. Symbolic effects are defined by Mitchell and Carson (1989) as "when respondents react to an amenity's general symbolic meaning instead of to the *specific levels of provision described.*"

In the study, a three-way choice was presented where respondents could choose one of two possible resource protection programs or no new action. The attributes in the choices included amount of farmland, wetland, eelgrass, shellfish and undeveloped land. Opaluch stated that the choice between a program and no new action is essentially equivalent to a contingent valuation question, and that there might be symbolic effects associated with the choice to take action, or choose one of the two programs to protect the environment.

Opaluch described three models that were estimated using the conjoint data. The first model was a multinomial logit that included a constant term to represent the otherwise unexplainable preference for taking action versus no action. It also included a constant term to express any unexplained preference for program A over program B. He noted that one problem with this model is that the constants can be interpreted in multiple ways, especially as indicators of mis-specified functional form. The results from the first model obtained an "action constant," the constant term in the choice to take action or not, that was large and statistically significant, and a constant for program A over B that was small but significant.

The second model was a non-parametric model that included dummy variables for the attribute levels and an action/no action constant. The non-parametric approach is a flexible approach that imposes no functional form on the data. It also allows a scope test in this example, in that the constant term for a larger program should be greater than that for a smaller program. The models passed the scope test for four out of the five attributes, failing only for the wetland attribute. The action/no action constant was statistically significant, again indicating the presence of symbolic effects in the action/no action choice.

Model three was a two-level nested logit model that considered the choice between programs A and B to be a function of the program attributes and the action/no action choice to be a function only of a constant term and the inclusive value derived from the choice between programs. Again, symbolic effects, as represented by the constant in the action/no action choice, were found to be significant.

Dollar values for the attributes stemming from these three models were compared. In all cases, the multinomial logit model estimated the greatest dollar value for the attributes. Statistically, the equivalence of the values stemming from the multinomial logit model versus the non-parametric model was rejected and the equivalence between the values from the second and third models could not be rejected.

Opaluch summarized his findings, concluding that one can specify models to identify and extract symbolic values. In the case provided, 30-45% of attribute values were found to represent symbolic values. Through focus groups he found other sources of symbolic bias—for example, that some people saw program price as an indicator of program quality and that others tended to ignore price and base their choices only on the attribute levels offered in the programs. He also concluded that conjoint analysis faces many of the same challenges (e.g. the existence of biases) as contingent valuation for obtaining monetary values but found that relative values – those expressed in terms of other attributes, rather than money – were more stable and reliable than monetary values. He argued that relative values are sufficient for many purposes, for example natural resource damage assessment and situations where a decision-maker faces a fixed budget.

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Papers and Manuscripts by Opaluch and Swallow

Mazola, Marisa J., James J. Opaluch and Thomas A. Grigalunas, "Identifying symbolic Effects in Contingent Choice Surveys: A Case Study of The Peconic Estuary System," currently under journal review, 1998.

Swallow, Stephen K., James J. Opaluch and Thomas F. Weaver, "Strength of Preference Indicators and an Ordered-Response Model for Ordinarily Dichotomous, Discrete-Choice Data," Draft Manuscript, 1997.

Q&A following Opaluch presentation

A short question and answer period followed Professor Opaluch's presentation. The questions tended to focus on technical details of the survey design and language of the hypothetical scenarios posed within the survey. For example, one audience member was concerned about the uncertainty inherent in the scenarios and how that was treated in the language of the survey. Opaluch responded that focus groups did not seem concerned about uncertainty so the issue was not addressed in the survey. Another question referred to the interpretation of the constant term as a representation of symbolic bias, suggesting that there might be other interpretations of a statistically significant term. Opaluch responded that other interpretations were not pursued in focus groups or the survey. A final question referred to the fact that different individuals have tendencies to respond to ratings systems in different fashions, some tending to the extreme and others to the middle responses. Opaluch responded that ratings responses looked consistent across the board but that a more complete analysis might treat individual sets of responses as panels to address this point.

PAPER TWO:

“Methods and Applications for Ecosystem Valuation: A Collage”
Stephen Swallow, Michael Spencer, Christopher Miller, Peter Paton, Robert Deegen and Laurienne Whinstanley, University of Rhode Island and Jason Shogren, University of Wyoming

Presented by Stephen Swallow

Professor Swallow discussed the need for our discipline to take a more comprehensive approach to ecosystem valuation, particularly its role in policy-making. He suggested that we should listen more to conservation biologists and members of the public to learn *what* people value about ecosystems and that we need to have ideas for situations when benefits are unknown or risks are too great to rely on conventional benefit-cost analysis. He also discussed several of his recent valuation studies, one on a water quality monitoring program, one on open space preservation in rural Rhode Island and one on a more comprehensive watershed management program, and how he is pursuing these issues through them.

Professor Swallow began by presenting some basic concepts in conservation biology, particularly the ideas that ecosystem integrity should be given priority over services or benefits to humans and that conservation biologists lack faith that people have the ability to adequately understand ecosystems and human effects on them. Essentially, he argued that a precise benefit-cost analysis may not be possible given the state of knowledge about complex and large-scale ecosystems. According to some conservation biologists, it is unlikely that our state of knowledge will change sufficiently so that such an analysis could be a complete, comprehensive, accurate and appropriate stand-alone foundation for policy decisions. He suggested that economists consider taking a more interdisciplinary approach to valuation that considers the conservation biology perspective, especially in situations where monetary valuation is problematic, for example, in situations of high uncertainty when a safe minimum standard might be a sensible policy approach.

In reconsidering the traditional academic approach to valuation, Swallow argued that the literature is too focused on the question of “what *is* the value” and not enough on *what*, in particular, people value. Further, he stated that the current approach to valuation is somewhat flawed with possible influences of hypothetical biases and embedding, context or information effects. Such effects could possibly be avoided, he suggested, if we take a step back and investigate how utility functions are formed and what attributes belong in them as well as how people value tradeoffs between resource attributes or between attributes and money. He mentioned several studies being funded under the NSF/EPA program, for example studies of the use of “cheap talk” and provision points, that are improving our understanding of how people respond to valuation questions and how to better create incentive compatible willingness to pay questions.

Professor Swallow next discussed his experimental study of the valuation of a watershed watch program in Rhode Island. Additional ponds can generally be added to the voluntary program at a cost of about $500. Experimental participants evaluated ponds based on surrounding landscape, accessibility and the purpose of monitoring (either to obtain baseline data or to identify the source of a current pollution problem). The experiment involved a sample of undergraduates at the University of Rhode Island who were each paid a $10 participation fee. (The upcoming, larger part of the project will involve a survey of Rhode Island citizens). They were assigned randomly to either a hypothetical or real survey, that is, where the willingness to pay question was posed either hypothetically or with the expectation of a real dollar payment.

Consistent with the experimental economics literature (as discussed in Spencer et al., 1998), the willingness to pay questions had two attributes that were designed to encourage participants to provide truthful responses: a "provision point" that stated the amount of money that had to be collected for implementation of the program, and a money back guarantee that promised a refund if the provision point (set near $80.00) was not met. The results found no statistical difference between the willingness to pay responses of the "real" and "hypothetical" groups. This may be due, however, to the rather large standard deviation for the estimated hypothetical value. The willingness to pay point estimates, in fact, differed substantially in an "intuitive" sense: values for the real payment group were $9 to $14 and for the hypothetical group, $42 to $63. The results also showed higher values for ponds that would be used to identify current pollution problems.

In the next phase of this research, Swallow plans to study the effect that a rebate of excess contributions might have. Rebates can be provided based either on a respondent's proportion of the total contributions or on the proportion of excess contributions out of total contributions, where each respondent receives the same percentage rebate.

Swallow's second study had the purpose of identifying the attributes of open space land-parcels that are most highly valued for preservation. Attributes included in the study were location (proximity to roads, rivers or backland), land cover (forest, wetland, brushy fields or farmland) and ownership and public access (town, state/federal, or development rights through purchase). Results found higher values for preservation for land along a river than for farmland on backlands or near roads. An interesting implication of this result is that the public would even value less an ecologically unique farm, located on backland, for preservation than more accessible land. Results also showed that public access matters most in determining willingness to pay, potentially increasing it 10 to 75%. This indicates that the benefits of increasing public access might exceed costs and that public access can possibly convert a land parcel from having almost no public value to one with a positive preservation value.

In returning to his question of what is valued, Swallow concluded that the conservation biology approach that looks at the trade-offs between local or regional amenities and how they contribute to local and regional biodiversity, if considered alone, can be inadequate. Public land values more generally are functions of location (proximity to other resource amenities), uniqueness as a contributor to biodiversity, role in connecting ecosystem reserves and potential public access. He suggested though, that economists should try to understand the perspective of conservation biologists and possibly incorporate policy configurations recommended by conservation biologists into their own benefit-cost studies.

As one example of this, Professor Swallow discussed a possible policy solution to compensate for the lost value of open spaces: imposing an impact fee on developers. Such a fee would encourage developers to purchase land that has the least public value. Swallow suggested that the attributes of open spaces valued by the community, as determined in his study, might be correlated with the attributes valued by conservation biologists, such as the expansion or connection of existing reserves or buffers and the existence of unique species and/or habitats.

Finally, in a watershed management study, Swallow looked at how attributes of the payment mechanism affected willingness to pay responses. In comparing the use of the statement, "fees are constitutionally guaranteed to pay for watershed management" versus no explicit guarantee, Swallow found that willingness to pay for most packages was higher with the guarantee. He also compared the use of strength of preference indicators with a simpler accept/reject/neutral response format and found no real difference.

Papers and Manuscripts by Swallow et. al.

Johnston, Robert J. and Stephen K. Swallow, "Asymmetries in Ordered Strength of Preference Models: Implications of Focus Shift for Discrete Choice Preference Estimation," *Land Economics,* forthcoming, 1999.

Johnston, Robert J., Stephen K. Swallow and Thomas F. Weaver, "Estimating Willingness to Pay and Resource Tradeoffs with Different Payment Mechanisms: An Evaluation of a Funding Guarantee for Watershed Management," manuscript in progress.

Spencer, Michael A., Stephen K. Swallow, and Christopher J. Miller, "Valuing Water Quality Monitoring: An Economic Experiment Involving Hypothetical and Real Payments," *Agricultural and Resource Economics Review*, 27(1): 28-42, 1998.

Swallow, Stephen K., "Economic Issues in Ecosystem Management: An Introduction and Overview," *Agricultural and Resource Economics Review,* 25(2): 83-100, 1996.

Panelist Discussion and Audience Q&A

Thomas Stevens, Department of Resource Economics, University of Massachusetts

Professor Stevens began his discussion by remarking that the research presented offered improvements in the field of stated preference valuation. He noted that there are few studies that compare the alternative valuation methods such as contingent valuation and conjoint analysis and he discussed the advantages and potential problems with conjoint analysis.

One advantage of conjoint analysis is that it makes explicit the choice between resources and their substitutes, something that is very difficult to do with contingent valuation. Additionally, the ratings approaches also make expressions of ambivalence or indifference more straightforward. Finally, the approach allows estimation of relative values (e.g. values expressed in terms of another resource attribute rather than in terms of dollars) and the trade-offs posed tend to avoid yea-saying in responses and allow the investigation of possible symbolic bias.

On the other hand, there are potential problems with the method. Because of the large number of choices that must be presented for full identification of the model, researchers tend to pose multiple questions to each survey respondent, generating panel data with multiple responses per individual. The panel nature of this data was not addressed in the research presented. Further, the process of making choices may differ from the process employed for making standard market decisions. This leads to a difficulty in interpreting results: respondents might not be in the market for the goods or resources in question, so their choice responses might not accurately reflect their true intentions.

Professor Stevens went on to demonstrate the difficulty in interpreting conjoint ratings approaches with two examples. In a water quality example, he showed that treating ratings responses as a pure binary choice, where only respondents who attribute the highest rating to the program are considered to be willing to pay for it, mean willingness to pay estimates range from $9 to $35. On the other hand, if the researcher allows all positive responses, even mild ones, to be considered as positive willingness to pay responses, estimates range from $3 to $242.

In an example of forest ecosystem management, the results are similar. A traditional contingent valuation format estimates a willingness to pay value of $86 while a conjoint ratings analysis estimates a range of negative $287 to $280, depending on how the “maybe” responses are interpreted. Steven’s conclusion is that people are not necessarily willing to pay for something that they rate highly in a survey.

<u>George Peterson, Forest Service, Valuation of Wildland Resource Benefits</u>

Dr. Peterson lamented that we had been focusing too much on the details of the research methodology and were, perhaps, losing sight of the big picture. He felt it was important to begin looking at the issues of how to work between disciplines and begin integrating and synthesizing what has been done and defining what needs to be done. He suggested, for example, that we need people in our field to begin writing textbooks that lay out the principles we have learned. We also need to look more seriously at non-economic research and journal articles.

Dr. Peterson discussed the need to understand the role(s) that values play in the policy process. In the case of natural resource damage assessment, it is clear that monetary values must be placed on damages to assess compensatory penalties on responsible parties. Such clarity is rare though: in most policy-making processes, the economic perspective is only one information input to what is otherwise a complex, political process. In some cases, monetary values fail totally, for example when dealing with populations that are not oriented toward monetary concepts at all.

Peterson emphasized that it is time for funding agencies, such as EPA, to begin orchestrating programs of research that systematically address the issues at hand. Currently, he feels the process, as represented by the research presented at the workshop, is taking place in a piecemeal manner that is not forwarding the agenda as it should.

Brian Heninger, Environmental Protection Agency, Office of Policy

Dr. Heninger considered the significance of the research presented in terms of his own needs as an EPA employee. In particular, he has been working on a prospective benefit-cost study of the Clean Air Act. He noted that a retrospective study has already been completed but that it contains no dollar values for ecological benefits. The benefit-cost ratio was large without them, however. Still, he expressed a desire to be able to predict the changes to the ecosystem resulting from the Clean Air Act and the consequent changes in service flows and values placed on them. Obviously, this is an extremely complex problem but Dr. Heninger argued that trying to get some information on these benefits is better than just using an estimate of zero, which is essentially the default figure.

In commenting on the research presented, Dr. Heninger praised Swallow's work for trying to get at what it is that people value about natural resources and for looking to public preferences, as expressed in the surveys and focus groups, as well as to experts in other fields, such as conservation biology. He singled out the idea of an impact fee on developers as providing a step in the right direction to impact behavior, although the idea could be perceived as elitist.

Dr. Heninger admired the work of Opaluch for looking more deeply into the cognitive process, for example, in identifying the tendency of people to assume that programs with higher price tags are better programs. He also noted that, although Opaluch argued that hypothetical bias is mitigated when looking at relative values as opposed to monetary, it is the monetary values that he needs in his benefit-cost analysis. As an alternative, Dr. Heninger must use physical measures (e.g., number of species or tons of carbon) in his work.

Audience Q&A

The question and answer session focused on three issues: benefits transfer, the free-rider problem and the general problem of how we proceed in developing a cohesive structure for our discipline.

The first question referred to the problem of a policy analyst's occasional need to transfer benefit estimates from specific valuation studies to other applications that have not been studied to the same extent. The question was whether conjoint analysis lends itself to such a procedure. In response, Swallow said that since contingent valuation is a simple version of a conjoint analysis, the issues in using conjoint analysis in a benefits transfer are generally the same as those for contingent valuation. A principal advantage in using conjoint analysis though is that, since it takes a number of resource attributes as variables, it is more flexible in being applied to situations where resource attributes differ from the original example. On the other hand, an audience member from NOAA argued that it is most important to transfer information from the closest example to the one being valued, no matter what type of study was originally performed.

A long discussion ensued following a question of whether and how the Swallow et al. study addressed the free-rider issue, that is, that participants may have understated their own values knowing that others would pay enough to provide the resource. It was agreed that there are experimental approaches that address this problem. Swallow responded that in his pretest setting, the issue did not seem to be of high importance and that particularly when one is interested in obtaining relative (non-monetary) values, the free-rider problem might emerge in a different way that has yet to be investigated. He acknowledged though, as he had in his presentation, that the hypothetical values he estimated were higher than the real money values, at least in absolute terms.

It was further suggested by Peterson that subjects in an experiment or survey might be playing all sorts of "games" in their responses and that some do not comply with the utility-maximization framework assumed in our models. He suggested that to some extent, these responses can be addressed by looking at alternative distributions for willingness to pay. It was also suggested that most valuation surveys include questions, following the willingness to pay questions, that try to get at a respondent's logic, particularly when he or she rejects a scenario. In this sense, the researcher tries to determine what kind of "game" the respondent was playing. It was also argued that willingness to pay questions are carefully worded to obtain incentive compatibility, that is, to give the appropriate incentive to respondents to provide their true willingness to pay responses.

A final discussion appropriately wrapped up the day by considering the possibility of developing a more cohesive structure to this new disciplinary move toward coordination of economic and ecological concerns. It was generally agreed that there can be no single person to coordinate such an effort as the subject matter is too extensive and far-reaching. It was suggested that EPA, through a special committee, take the lead in laying out the issues and encouraging research along the specific lines they lay out. A final comment pointed out that, although we were trying to talk about better coordinating separate disciplines, primarily economics and conservation biology, that the attendees of the workshop were predominantly economists.