# Benefits Transfer and Valuation Databases: Are We Heading in the Right Direction?

**Proceedings of an International Workshop Sponsored by the U.S. Environmental Protection Agency's National Center for Environmental Economics and Environment Canada**

March 21-22, 2005
Ronald Reagan Building
Washington, D.C.

*Prepared for*
Rich Iovanna
National Center for Environmental Economics
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

*Edited by*
Abt Associates Inc.
4800 Montgomery Lane
Bethesda, MD 20814

# Preface

This document summarizes the proceedings of a workshop cosponsored by the U.S. Environmental Protection Agency's National Center for Environmental Economics (NCEE) and Environment Canada. This workshop, titled *Benefits Transfer and Valuation Databases: Are We Heading in the Right Direction?*, took place in Washington, D.C., on March 21 and 22, 2005. The objective of the workshop was to provide a forum for informed discussion regarding the practice of benefits transfer, the use of valuation databases for such, and the general relevance of valuation and benefits transfer to environmental decision making. The workshop centered around a series of presentations delivered by a multi-disciplinary group of experts and practitioners from around the world. These presentations covered topics that included: (1) the current state and relative strengths of valuation databases such as EVRI, ENVALUE, Review of Externality Data, New Zealand non-Market Valuation Database, and Value Base Swe; (2) the need for and use of benefits transfer around the globe; (3) development and validation of benefits transfer methods; (4) alternative environmental decision making approaches; and (5) the premises underlying benefits transfer.

***Acknowledgements***
This proceedings document was prepared by Abt Associates Inc. under funding from the National Center for Environmental Economics through contract number 68-W-02-040. Abt Associates wishes to thank Rich Iovanna of NCEE, and Eastern Research Group.

***Disclaimer***
These proceedings are being distributed in the interest of increasing public understanding and knowledge of the issues discussed at the workshop. Although funded by the U.S. Environmental Protection Agency under contract number 68-W-02-040 to Abt Associates Inc., these proceedings have been prepared independently of the workshop. Views expressed are those of the authors, but do not necessarily reflect the views of the U.S. EPA. No official endorsement should be inferred.

# Contents

# 1. Introduction and Summary of Major Issues

This document summarizes the proceedings of a workshop sponsored by the U.S. Environmental Protection Agency's National Center for Environmental Economics (NCEE) and Environment Canada. This workshop, titled *Benefits Transfer and Valuation Databases: Are We Heading in the Right Direction?*, took place in Washington, D.C., on March 21 and 22, 2005. The objective of the workshop was to provide a forum for informed discussion regarding the practice of benefits transfer[1], the use of valuation databases for such, and the general relevance of valuation and benefits transfer to environmental decision making. The workshop centered around a series of presentations delivered by a multi-disciplinary group of experts and practitioners from around the globe. These presentations covered topics that included: (1) the current state and relative strengths of valuation databases such as the Environmental Valuation Reference Inventory (EVRI), ENVALUE, Review of Externality Data, the New Zealand non-Market Valuation Database, and Value Base Swe; (2) the need for and use of benefits transfer around the globe; (3) development and validation of benefits transfer methods; (4) alternative environmental decision making approaches; and (5) the premises underlying benefits transfer.

Although the sessions covered a variety of topics, a few common themes echoed through many of the presentations, discussant comments, and question and answer sessions.[2] First, benefits transfer is a widely practiced technique that can be a very useful decision-making tool. Second, valuation databases such as EVRI are valuable resources for academics, policy analysts, and other benefits transfer practitioners. Third, data limitations that currently hinder benefits transfer could be alleviated by improving the consistency of reporting of data and results in valuation studies, and by encouraging the publication of new valuation studies through the establishment of a peer-reviewed e-journal. Fourth, a variety of methodological advances are helping to reduce or quantify uncertainties associated with the practice of benefits transfer, although more research is still needed. Finally, in the policy-making context, other analytical approaches can be useful alternatives or complements to benefits transfer.

The first point, that benefits transfer is widely practiced, is borne out by the diversity of applications discussed during the workshop. For example, David Glover, Bob Davies, and Jim Laity discussed benefits transfer applications ranging from valuing forests in Indonesia and setting landfill taxes in the United Kingdom to valuing fish mortality in the United States. A number of speakers noted that because benefits transfer is relatively inexpensive, analysts often choose this technique over more costly alternatives such as a full-blown original valuation study. However, despite the ubiquity of benefits transfer in certain countries, it is not well accepted everywhere. Sébastien Terra noted that benefits transfer has not yet gained widespread acceptance within France, because of a deficit of French valuation studies, pessimistic results from some early French studies of the reliability of benefits transfer, and a lack of acceptance of valuation techniques by French policy makers.

---

[1] Benefits transfer can be defined as "the use of existing valuation information for one good or service to estimate the value of a similar good or service."

[2] The purpose of this introductory section is to provide an overview of the issues discussed during the workshop, to highlight common themes from the presentations, and to draw attention to unaddressed or unresolved questions raised at the workshop. For more thorough discussion of specific issues, refer to the papers and presentations included later in this document.

A second point made by a number of participants is that valuation databases, including EVRI, ENVALUE, Review of Externality Data, New Zealand non-Market Valuation Database, and Value Base Swe, are valuable resources for benefits transfer practitioners. Presentations by Van Lantz, Greg McComb, and James White highlighted the large amount of information available from these databases and discussed potential applications. However, the presenters also noted that administrators of valuation databases face challenges in maintaining and improving the quality of the information they provide. Primary issues include maintaining funding, publicizing the databases to increase their use, determining what level of documentation is useful and cost-effective to provide in the study records, encouraging authors to provide additional information not included in their written publications, and expanding coverage of valuation studies to include newly published peer-review journal articles, new and existing gray literature, and studies published in other countries and languages.

A third general issue discussed by many participants is the impact of data limitations on the practice of benefits transfer. A number of workshop participants mentioned that there is significant heterogeneity in the reporting of data and results in valuation studies. Because of this lack of consistency, it can be difficult to implement rigorous statistical benefits transfer approaches, or even single study adjusted value transfers. Additionally, many participants mentioned that benefits transfer is restricted by the limited number of valuation studies published, and that it is often difficult to find recent studies that are good matches for the resources and/or policy contexts being considered. This lack of valuation studies also limits research using statistical techniques (e.g., meta-analysis), which require many studies as input data. Finally, several participants noted that the applicability of existing valuation studies to benefits transfer applications is further limited by issues related to publication bias, i.e., the tendency of peer-review journals to choose papers based on their methodological contributions, consistency with previously published literature, and statistical robustness, as opposed to mere adherence to sound methodological practices. These criteria, although useful from the perspective of advancing the field of resource valuation, may lead to biases in the findings of studies and estimated resource values that are available to researchers for use in benefit transfers.

These data limitations could be mitigated in several ways. One key step, proposed by John Hoehn and Randall Rosenberger, would be to establish a peer-reviewed electronic journal dedicated to publishing original valuation research for the purpose of benefits transfer. Such a journal would help address all three problems listed above, by providing unlimited space to report data and results, encouraging the publication of more valuation studies covering a diverse set of resources, and evaluating papers based on their applications, not their methodological contributions. Other actions that would help resolve the problem of inconsistent reporting would be to encourage authors to describe data and results more consistently in submissions to academic publications, and to provide data and results to valuation databases, particularly information not available in their published work.

Another broad issue that arose in a number of the presentations, discussant comments, and question and answer sessions is the reliability of benefits transfer as a methodology. Although there was general consensus that benefits transfer can generate important information that is useful to decision-makers, participants debated the accuracy and precision of this technique. Presentations by Randall Rosenberger, Robert Johnston, Roy Brouwer, and Richard Ready all sought to characterize and quantify the different types of error inherent in benefits transfer estimates and the valuation studies on which this technique is based. Other presenters, including Ian Bateman, Matthew Wilson, V. Kerry Smith, and Carmelo León, demonstrated how new techniques, such as GIS approaches, structural benefits transfer, and Bayesian

approaches, can help to refine benefits transfer estimates. Many participants mentioned areas where additional research is still needed, for example, quantifying the potential impacts of publication bias, characterizing the effects of methodological choices in valuation studies, and refining the economic framework underlying benefits transfer methods.

The final point raised by a number of workshop participants is that although benefits transfer is frequently used to generate benefits estimates for use in cost-benefit analysis, there are many other decision-making approaches that do not make use of benefits transfer. Presentations by James Boyd, Tom Seager, Shana Heisey, and Clive Spash put forth a variety of alternative techniques, including cost-effectiveness analysis, multi-criteria decision analysis, consideration of ecological benefits indicators, ethical analysis, and participatory decision-making approaches. Although these approaches differ widely, they all seek to avoid certain issues associated with the use of benefits transfer and cost-benefit analysis, for example, reliance on comparison of non-market goods using a monetary metric, assumption of preference stability, and economic complexity and lack of transparency to the general public. However, these alternative approaches have their own problems and limitations. Ultimately, decision-makers and analysts must choose an approach or combination of approaches that is most appropriate for the particular context of interest.

In summary, further research is needed to improve the economic accuracy, decision-making utility, and public and political acceptability of benefits transfer. Additionally, steps such as the establishment of a peer-reviewed benefits transfer journal would significantly improve the quality and quantity of the valuation studies available to researchers. Nonetheless, workshop participants generally agreed that despite some methodological and data-related limitations, benefits transfer is a valuable technique and its use as a decision-making tool will continue to grow.

# 2. Welcome and Opening Remarks

## Section Contents:

# Chris Dockins, National Center for Environmental Economics, USA

## Opening Remarks

*[Chris Dockins is the acting associate office director of the U.S. Environmental Protection Agency's National Center for Environmental Economics.]*

Hi everybody. Welcome to the conference. My name is Chris Dockins. I'm the acting associate office director. Natalie Simon, our associate office director, is actually on maternity leave right now and so I'm more than pleased to give her the time she needs. And Al McGartland sends his regrets—he could not make it today. So I'll fill in. We've discussed, obviously, the conference with Rich and so forth.

I just want to give a few brief introductory remarks. I've noted before elsewhere that nobody leaves wanting more introductory remarks, so I'll try to make it relatively brief. First of all, thank you very much for coming. Some of you had a very long trip and we're very, very grateful that you made that trip and excited to have you here.

We're looking at this as a great opportunity to forge bonds with other organizations around the world wrestling with similar challenges, particularly in Canada and the UK but of course everywhere. And everybody all stands to benefit from hearing the lessons learned throughout the world as we grapple with those challenges. And so, we're looking forward to a frank discussion among analysts, researchers, folks in the private sector, consultants, and we're hoping to learn as much as we can.

I want to talk about a couple sets of thoughts. One is why we view this as important and our responsibilities in regard to benefits transfer; and second, some specifics on the US context. First of all, I think we can view benefits transfer as both expedient, in the sense that it fills a short-term need, and that need is for a quantitative benefits analysis; but it also has done well in that it helps us meet our larger responsibilities as analysts. I'll talk a little bit about that.

Benefits transfer obviously will continue to be the rule for us rather than the exception under regulatory analyses and elsewhere. Original studies—and this is not news to anyone here—especially original studies directed at specific policy relevance, are difficult to get underway…institutional barriers, budgetary hurdles, for a number of reasons.

So we do benefits transfer because we must, if we want quantitative benefits, monetized benefits. And we do. We can't always wait for that best study to be done if there is one, and to borrow a phrase, we can't let the best be the enemy of the good. We must produce at least a good approximation of what those benefits are, provide at least a good answer. And obviously, we'll be talking a great deal about how we do that and how to do that better over the next couple of days.

But I think we can also say that we do benefits transfer because we should as policy analysts. As a policy analyst it's our responsibility to assess these benefits and to do it in a way that best represents the range of science. And in talking about this, I find it useful to think of two sets of responsibilities that in practice probably many of us share—some of both.

One is a research responsibility, if you take primarily the researcher whose job it is to explore and expand the frontiers of science and the frontiers of knowledge. In that sense, perhaps it's okay, it's probably essential to have a narrow focus, at least for extended periods of time. It's essential and it's responsible, as a researcher.

For the analyst, and probably in particular the government analyst, the [second] responsibility is to represent good science and policy evaluation and to apply that science, apply good science, to evaluate policy outcomes, and to do it in a way that's meaningful for decision-makers and for the public.

And so benefits transfer done well helps us as analysts, particularly the government analysts, to meet our responsibility to represent good science, the spectrum of good science—because we're forced to deal with competing empirical estimates, competing methodologies, and to make sense of them.

So in a sense, we can engage in benefits transfer without apology in that regard. And obviously the evaluation database is going to be very useful, can be very useful to your potentially long or systematic search for a range of applicable studies, including empirical estimates and competing methods. And while you're mindful of abusing those databases by not probing deeper into the underlying studies, so you always have to be careful.

Some brief notes about the US context for benefits transfer. In terms of the Environmental Protection Agency, the world of benefit-cost analysis and benefits analysis varies by environmental statute…Safe Drinking Water Act as opposed to Clean Air Act. But Presidential Executive Order 12866 requires benefit-cost analysis of major regulations. So even when they cannot be considered for standard-setting, they're still an essential exercise, both as an organizational principle if you think of benefits versus costs, as well as to provide information to the public.

Our own practice at EPA is guided by our own guidelines and OMB's current guidelines in the form of circular A-4, which applies to all agencies. One thing I found interesting as I was getting ready for today is EPA's last economic guidelines were published in 2000, five years ago. Prior to that I couldn't find any mention of the true benefit transfer in EPA guidance on benefits analysis, nor did I find one in OMB's 1996 guidelines on economic analysis. However, there's a treatment of benefit transfer in both EPA's most recent guidance as well as OMB's. So it's fair to say it's getting more emphasis, at least in the documents that guide how we do analysis.

I wanted to make a couple points on circular A-4, which guides us in our analysis. One is there's this general sense of caution in that document for benefit transfer, and there's a warning that it should be considered a last resort, and of course it's one that one frequently must turn to. And it's a sense of caution shared by others, including a National Research Council report looking at the benefits transfer for aquatic resources. They advised proceed with caution. Currently we're working with our science advisory board, environmental economics advisory committee, on the question of valuing mortality risks and how to reconcile the literature out there, most of which doesn't speak directly to environmental health risks, and so we're faced with a benefits transfer problem. And this is going to take a while to work through.

But a couple of things drop out in terms of A-4. It places renewed emphasis and some new requirements on uncertainty analysis, and particularly being very explicit and quantitative in the analysis for very large rules. And this seems to put more of a premium on understanding the uncertainty inherent in alternative benefits transfer techniques and strategies. And it's something we're going to have to get a hold of very shortly.

Another point with respect to A-4, it notes the importance of considering benefits even when monetization isn't possible, and good practice speaks to this as well. And it suggests the door's open to consideration of alternatives to benefits transfer and alternatives to benefit-cost analysis. In fact, A-4 places heavy emphasis on cost-effectiveness analysis and has some new requirements in that regard. So I'm looking forward to the sessions that speak to these alternative methods.

By the way, I think, we say this workshop would be worth its while if it manages to shed light on at least some of the following issues. The utility evaluation databases. Are they sound investments? How can they be improved? How do alternative benefits transfer techniques balance sophistication and rigor with ease of use? Which approaches are better under various conditions? Also, how can original studies be designed to facilitate more robust benefits transfer? That's a key question. And finally, think about these alternative methods, if benefits transfer is too problematic in a particular context, then what are the best viable alternatives in the context of environmental decision making? All these and a list of

other key questions, too; but these are some of the ones that got our attention, and we're looking forward to hearing from you all. Thank you.

# Luis Leigh, Environment Canada

## Opening Remarks

*[Luis Leigh is the director of Environment Canada's Environmental Economics Branch.]*

Welcome, everybody. For us this conference, as well as doing what Chris just described, is also a way to launch a partnership with the US. And we have collaborated in the organization and conference with the US, in particular with Humana, working with Greg McComb, who is sitting somewhere in the audience, [inaudible] as well as in consultation with us.

The information database has currently 1,300 studies, and we have developed the software that's very easy to search with. To give you a real sense of what is in it, I've provided slides that I stole from Greg's presentation, which actually shows that we have roughly a number of studies, for example, on how and very much a sense that the interest and the origins of the database. The United States put a lot of records in at the beginning—I'm speaking of the late 1990s—and since then we have actually populated the database and it's grown from about 600 studies to, at this point, 1,300. And it's growing at the rate of about 300 studies per year.

Before I start, just a little bit of history. Canada started thinking about benefits transfer and the need for a database, so we essentially started the work. And at about the same time our colleagues in the United States were thinking of the same thing. We were slightly ahead and they and we got together and we agreed that we would continue to develop our piece and they would help by helping populate the database with American studies, which they did. Subsequent to that, and the fact that the birth of the EVRI club happened in Paris at a meeting of which John Dixon from the World Bank suggested that we should form a club as a way to continue this partnership between John Dixon and a fellow from what is now the European Commission. We started trying to get this partnership going, so we did that in 2002. The US rejoined the club in 2003 and we have a number of people from many countries, which we have partly in here. I should tell you all the club is open. In other words, any country that's interested can join.

The principles of the club are to maintain and expand for the benefit of member countries and their citizens, to promote the use of valuation. Very importantly, the members contribute both resources and most importantly expertise, and I think, for example, this kind of forum is very much in that spirit. The direction for the club is set by the members, and Canada has the lead but there's an understanding that there's accountability, particularly for the resources and the activities that we undertake with those resources.

Moving on to the Canadian context, we have been doing evaluation and benefit transfers since the mid-90s for regulations, legislations, and policies. We've done a number of studies. We have an air quality evaluation model, which uses benefit transfers in supporting air quality regulations and similar to the case with other countries, the reason now we're doing this is because it saves time and it saves cost. The timing sometimes is of the essence, as you are developing this and it takes a lot of time to do a primary study.

Evidently there are caveats and policy decisions need to be the best we can make them. It's a very good question to ask: if not this, then what?

I should comment, also, that the basis for this is requirements that we have in Canada to do cost-benefit analysis for each and every regulation. In our case the guidelines come from the office of our treasury board. But they don't provide specific guidelines on how to do the benefits side. We have a government-wide work and I should say network. We are at this stage, I believe, in that network, and it

includes ministries such as transport, agriculture, and natural resources. The ministry is developing a competitiveness and environmental sustainability framework. It is an initiative launched by our deputy minister about a year ago, with the objective of—I will read it—"to attain the highest level of environmental quality as a means to enhance health and well-being of Canadians, preserve our natural environment, and advance long-term competitiveness." That last part is a key. It merges sustainability; it merges as an element for competitiveness, and we are starting to finally link in very strong terms the environment and the economy. This is a national framework, Canada's federation, and we're trying to get commonality of objectives with the problems, and so we're trying to do this on a preferential basis.

I will just mention that valuation benefits transfer…I'll break along this. This conference will be very useful and will ask extremely good questions, which will allow us to think about the path forward for EVRI, for example, and we'll consider those in our meeting tomorrow from those countries that are represented today. And if you are interested, that meeting is open to you. We'd love to have you. But anyway, this conference does provide an opportunity for all of us in the room to learn and to think about these issues, and to improve what we do. Thanks very much.

# Bob Davies, DEFRA, UK

## Opening Remarks

*[Bob Davies is Head of Environmental Policy Economics at the U.K. Department for Environment, Food, and Rural Affairs.]*

It struck me while Luis was talking that essential to conventional economics is the concept of diminishing marginal returns, and it's applicable anywhere. It's applicable to introductory speeches at conferences. I will, as the other speaker said, try to keep it brief and focus very much on the UK's perspective and indeed our own experiences. Just to say that I'm pleased and honored to be invited to what is truly an awesome place to visit; it's my first time at the EPA. So thank you very much for inviting me to come and talk about what we do in the UK.

The issues I want to very briefly discuss are why is evaluation important to the national work on economics and the environment? Why benefits transfer? Plus some experience of the UK's use of benefits transfer. And lastly, some key issues that I'm hoping we will get down to discussing and indeed casting light on.

Relevance now, very relevant, coming off what Luis was saying about competitiveness. Competitiveness and better regulation is very high on the UK government agenda. As of course are environmental issues. But there's an issue of combining the two and addressing environment issues and better regulation through cost-benefit analysis. We have this sort of regulator impact assessment-based regime that I think many other countries have, and that's become essential to our policy making on the environment.

Increasingly there's a case to be made for environmental policy, not just nationally but also within the European Union, which has been a key to either the environmental policy for the UK, but there's something called the Lisbon Convention, which has sought to bring together the two issues of competitiveness and environmental quality. And indeed there's a major initiative within Europe on impact assessment. And of course part of impact assessment is being able to provide some quantification of environmental impact.

So, that's one reason why benefits measurement is increasingly important. The second reason is a greater emphasis on the possibilities and potential of economic instruments, eco-taxes, trading, those sorts of ideas are very high now on the list of priorities for my department. One reason is because the regulatory reforms are closing the options other than using economic instruments. And indeed, at the heart of economic instruments is the need to identify and value externalities. Guidance from our finance department is that in order for us to persuade them that it's valid to introduce a new tax or a new trading scheme is a measurement of the environmental impact. So it's a requirement for our conversation with finance department experts that we advance the techniques and the methods that we can use to value.

Thirdly, there's the whole emphasis that we have now on evidence-based policy, informing targets. Recent work that we've been doing, for instance, on the social cost of carbon, has been an important feeding to the work that we're doing on targets for climate change.

Why benefits transfer? Chris explained very well some of the reasons why benefits transfer has to be a reality in a lot of the work that we do. This issue of time—it takes time to do original research. The issue of cost—it's often expensive, particularly contingent valuation. And there's also the issue, not of practical expediency but of actual consistency of valuation across individual policy issues, looking at options but also across policy areas.

So those are all good reasons why we should do benefits transfer. We do of course do original research, and indeed air quality is an area where, particularly in terms of the impacts of air quality on health, we've got a major project underway at the moment and we've done work in the past on environmental taxation with original research. But there has to be some element of benefits transfer as well, we feel.

Just briefly again, in terms of the UK experience, actually going as far as monetizing environmental impacts, a technical and challenging process but one which has, in some examples I can cite, actually fed directly into policy decisions. One example being the landfill tax that we introduced in the mid-1990s. The rate of tax, the case of the tax is made largely on the back of a benefits transfer-focused valuation study. The actual rate of the tax was set in terms of that study, a so-called Pigovian tax for those who prefer environmental taxation [word inaudible]. That was the first example of actually using, I think, a valuation study to set a tax rate.

A second example is a tax we introduced early in the 2000s, which is a tax on quarrying, a so-called aggregates tax, which again was based this time on a piece of original contingent valuation research.

And indeed we've used it to justify policies like the recently introduced access to the countryside legislation within the UK.

How do you use EVRI? And I'm coming to a close now. We have used it in part, I think, as a focus for evaluation work in the UK, not just within government, and it's been a way of engaging the faculty membership and can have, at latest count, 30 workshops within government on that. It's been used to connect within government, but also to reach out to the academic community. There's been a terrific response in terms of providing information for the database itself in the academic community. We've worked with them. And also internationally, we're talking the next workshop, which the French government organized, and we're attending this event, which is a truly international event.

So it's a question of doing together the network of community, doing together obviously a wide range of studies. And we're very keen that the database is enhanced and that we can play a part in that. It's used in guidance with regulatory impact assessments. The latest guidance that's promulgated by the government as a whole when it relates to environmental impact assessment has a link to EVRI. It's clear instructions that our own economists would always look at EVRI as a starting point when they're looking at RIAs. We've had the RIA methodology itself refined so that monetizing the environmental impacts where practical or where sensible is undertaken. So those are some reasons, and indeed we have specific examples of where EVRI has been used in order to form the actual figures that have gone into regulatory impact assessments, a recent study of biodiversity being one example.

Finally, can I just, like Chris, suggest some of the issues that I'm sure we'll want to discuss and which the UK will be particularly interested in seeing light thrown on as a consequence of this event. There's valuation methodology itself. I think we're interested to see to what extent the quality of work that goes into valuation can be maintained and indeed enhanced. There's a whole issue of contingent valuation and the quality of the survey data, to be very technical, the sample sizes. Is the methodology for the questionnaires adequate to the exacting task at hand? So there are those methodological questions. There's the question of specific issues that are generic to valuation. Value of life was mentioned. It's interesting that in the UK there's an almost accepted value of life, at least for transport issues, that is used across government. In other areas, value of life is highly contentious.

Benefits transfer I think works as compared to meta-analysis and how those two concepts and methodologies interact and ways one is appropriate or how does one overlap with the other? I would be very interested to hear more information discussed on those issues.

And finally, the lessons to be learned from the information that we have on different databases: How do the different databases interact? How might they be used separately or together? And most particularly, what are the latest developments in terms of EVRI, where is EVRI going, and is it going in the right direction? And that will bring us on to the first session this morning, which I'm very pleased that I'll be chairing. Thank you.

# 3. Valuation Databases (Session 1)

## Section Contents:

# "An Evaluation of Environmental Valuation Databases Around the World."

**Van Lantz[1*] and Greg Slaney[2]**

***Faculty of Forestry and Environmental Management***
***University of New Brunswick***
***Fredericton, NB, Canada***

*[1] Assistant Professor; E-mail: vlantz@unb.ca; Tel #: (506) 458-7775; Fax: (506) 453-3538*
*[2] Graduate Student; E-mail: w851s@unb.ca*
** Presenting author*

**Presented during Session 1.**
**Original report prepared for Environment Canada.**

## ABSTRACT:

Institutions around the world have established a number of environmental valuation databases that summarize the wealth of valuation studies that have emerged over the past few decades. Such databases, including ENVALUE, Review of Externality Data, New Zealand non-Market Valuation Database, Value Base Swe, and Environmental Valuation Reference Inventory, can serve a number of different uses. However, since each of these databases is unique in their set-up, they exhibit a wide array of characteristics that may or may not best facilitate the needs of a user. The purpose of this paper is to evaluate these databases using a criteria, element, and indicator framework in order to shed light on those that exhibit the most favorable characteristics for a diverse set of users. The framework includes a rating scheme that allows for an easy comparison of key components in each database. The scheme is based on the performance of the indicators derived from key elements of each criterion. Based on the rating outcome of each database, recommendations are made for further improvements.

## 1.0 INTRODUCTION

Over the last 30 years, one of the most significant and fastest evolving areas of research in environmental and ecological economics involves the valuation of non-market environmental goods and services (Turner et al. 2003). A recent study by Adomowicz (2004) found dramatically increasing trends in the number of publications using non-market environmental valuation methods. The use of such methods as contingent valuation has engendered a heated debate between proponents and critics (Carson 2000), however these methods are still widely used and promoted as effective ways to address market externalities. With the advent of green accounting, these valuation techniques have been increasingly included in policy research and formulation.

The purpose of this presentation is to evaluate five widely known environmental valuation databases using a criteria, element, and indicator framework in order to shed light on those that exhibit the most favorable characteristics for a diverse set of users. The framework includes a rating scheme that allows for an easy comparison of key components in each database. The scheme is based on the performance of the indicators derived from key elements of each criterion. Based on the rating outcome of each database, recommendations are made for further improvements.

## 2.0 DATABASE OVERVIEW

### 2.1 Environmental Valuation Reference Inventory (EVRI)

The Environmental Valuation Resource Inventory was developed by Environment Canada in collaboration with the US Environmental Protection Agency. Developed over the last decade and subject to much critique and review, developers are now confident that the EVRI is ready for large-scale entry of studies. The EVRI is intended primarily as a tool to assist policy analysts using the benefits transfer approach to estimate economic values for changes in environmental goods and services or human health. The EVRI database is available at http://www.evri.ca/.

### 2.2 ENVALUE

The ENVALUE environmental valuation database was developed by the New South Wales Environmental Protection Agency of Australia. The intended purpose of the ENVALUE database is to assist decision makers in government and industry as well as academics, consultants and environmental groups, to incorporate environmental values into cost-benefit analyses, environmental impact statements, project appraisals and overall valuation of changes in environmental quality. The ENVALUE database is available at: http://www.epa.nsw.gov.au/envalue/.

## 2.3 New Zealand Non-market Valuation Database (NZ NMDB)

The New Zealand Non-Market Valuation database was developed by Geoff Kerr of Lincoln University in Canterbury, New Zealand. This database enables easy identification of non-market valuation studies that have been undertaken in New Zealand. As it is limited to include studies undertaken in New Zealand the database contains relatively few entries as compared to other databases. The NZ NMDB is available at: http://learn.lincoln.ac.nz/markval/.

## 2.4 ValueBase Swe

The Valuation Study Database for Environmental Change in Sweden (ValueBaseSwe) was developed at the Beijer International Institute of Ecological Economics within a project funded by the Swedish Environmental Protection Agency. The database is available as an Excel spreadsheet and contains columns of information pertaining to the studies listed. ValueBase Swe is available at: http://www.beijer.kva.se/valuebase.htm.

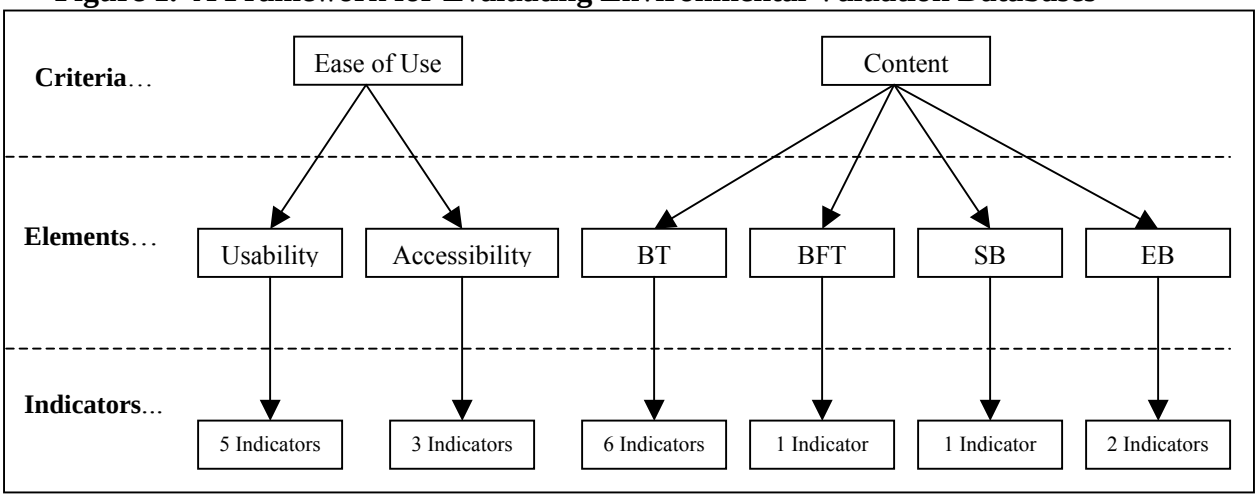
## 2.5 Review of Externality Data (RED)

The RED database was developed and funded by the European Commission under the Energy, Environment and Sustainable Development Program of the Directorate General for Research. The RED is intended as a tool to assist policy makers in capturing the effect of externalities produced from new policies which must have sustainable development as their core concern. The RED database is available at http://www.red-externalities.net/.

# 3.0 EVALUATION FRAMEWORK

Each environmental valuation database will be evaluated using a criteria, element, and indicator framework. The framework is intended to shed light on those databases that exhibit the most favorable characteristics for a diverse set of users. Figure 1 provides a schematic of this framework. Here, there are two criteria, six elements, and 20 indicators.

**Figure 1. A Framework for Evaluating Environmental Valuation Databases[a]**




[a] *BT=Benefit Transfer; BFT = Benefit Function Transfer; SB = Simple Bibliography; and EB = Extensive Bibliography.*

## 3.1 Criteria #1: Ease of Use

Two elements make up the Ease of Use criteria: (i) Accessability; and (ii) Usability. Under Accessibility element, there are five indicators: descriptive tags, navigation by TAB & arrow keys, help file or user tutorial, searching capabilities, and home page visual quality. Under the Usability element, there are three indicators: finding the database, accessing the database and database access cost.

## 3.2 Criteria #2: Content

In evaluating content, possible uses of the database from the user's perspective (elements) are included. Four elements make up the Content criteria. They include: (i) Benefit Transfer; (ii) Benefit Function Transfer; (iii) Simple Bibliography; and (iv) Extensive Bibliography.

A number of indicators are involved with each element. Benefit transfer indicators include: commodity description, population description, location details, comparable welfare measurement, validity test, and number of similar studies. Benefit function transfer indicators include: function description and number of suitable studies. The simple bibliography element contains one indicator: number of studies in each category. Lastly, extensive bibliography indicators include number of studies and datedness of database

## 3.3 Rating Scheme:

Each indicator is rated using a five-star scheme. Here, five stars represent an excellent coverage of the indicator considered, while one star represents a low, or an inadequate, amount of coverage. After each indicator is rated, the number of stars will be aggregated under each element and then divided by the number of indicators in that element to arrive at an average element rating. Then the number of stars under each criteria will be aggregated and divided by the number of elements in that criteria to get an average criteria rating. Finally, the number of stars under each of the two criteria will be summed and then divided by two to attain the average rating for the database.

## 4.0 EVALUATION RESULTS

**Table 1. Summary Evaluation Table of Environmental Valuation Database Ratings**

| | | Database | | | | |
|---|---|---|---|---|---|---|
| **Criteria** | **Element** | **EVRI** | **ENVALUE** | **NZ NMDB** | **ValueBase** | **RED** |
| Ease of Use | Accessibility | **** | ***** | **** | **** | *** |
| | Usability | **** | *** | *** | ** | *** |
| Content | Benefit Transfer | **** | *** | ** | *** | * |
| | Benefit Function Transfer | **** | ** | * | *** | * |
| | Simple Bibliography | ***** | ***** | ** | *** | *** |
| | Extensive Bibliography | ***** | *** | **** | *** | ** |
| **Average Rating (number of stars/5)** | | **4.25** | **3.63** | **2.88** | **3.25** | **2.38** |

## 5.0 STRENGTHS, WEAKNESSES AND RECCOMENDATIONS

### 5.1 EVRI

The EVRI database was rated one of the two highest out of six databases reviewed. It contains a vast array of values, regions and evaluation methods that lend themselves to benefit and benefit function transfer. Its search functions allow easy retrieval of relevant studies and the content is up to date. It is comprehensive in content and is very user friendly due to its instructive tutorial.

The EVRI database requires a relatively large amount of information from users prior to access, and there is about a one-day wait for a user name and password. This might deter simple or extensive bibliography users due to the time required to access the database. Additionally the EVRI database requires a subscription fee for some users (non-EVRI club member countries). Researchers requiring brief access to the database might not subscribe due to a high access cost for limited use.

While the EVRI database shares the highest ranking among the six databases reviewed, improvements can be made. Automation of the subscription process would ensure quick access to the database. Additionally, the incorporation of more detailed validity test information would increase the applicability for this database to be used in benefit transfer.

### 5.2 ENVALUE

The ENVALUE database was also rated one of the highest out of the six databases reviewed. It is fairly comprehensive in content with a straight-forward and easy to use sort function. The conceptual studies section provides information on state of the art environmental valuation techniques while the annotated bibliography contains important characteristics identified for the majority of the use elements.

The ENVALUE database is relatively dated, as the newest entry found was for the year 2000. In addition, data fields are incomplete in some entries. This poses problems to researchers seeking complete and up to date studies. Additionally, this database does not include a typical search module. The addition

of a key word search would allow users to search for relevant words that may not be included in the hierarchy based search.

## 5.3 NZ NMDB

The NZ NMDB was rated in the mid to low range of the six databases reviewed. The database comprises a comprehensive representation of environmental valuation studies in New Zealand. The search function is straightforward and easy to use. However, it lacks several critical aspects required for successful benefit transfer and benefit function transfer. Since this database is limited to studies conducted in New Zealand, its potential for benefit transfer is also limited. Additionally, the results page only includes a brief description of the study with limited information.

Expanding on the information contained in the results page would increase the applicability of this database for each use evaluated. This would require the addition of more detailed commodity, population, and location descriptions.

## 5.4 ValueBase Swe

The ValueBase Swe database was rated in the mid range of the six databases reviewed. This database comprises a comprehensive representation of environmental valuation studies in Sweden. It contains a wide array of values and includes information pertaining to validity tests and details of functions used in certain studies. The database download feature is advantageous to due its portability.

The ValueBase Swe database, however, is limited by its spreadsheet design. The nature of a spreadsheet does not lend itself to substantial amounts of text within individual cell boxes. Searching this database is limited to built in search tools found in spreadsheet software. Being limited to studies conducted in Sweden this database has limitations in benefit transfer applications.

Transferring this database from spreadsheet to searchable database format would allow for more efficient querying of studies in addition to the possibility for additional information not suitable to spreadsheet format (figures etc.).

## 5.5 RED

The RED database was rated in last out of the six databases reviewed. This database contains a wide array of studies and values reported internationally. The guided search function contains detailed lists by which the user can query studies.

The RED database, however, is difficult to navigate and requires a great deal of time to grasp the guided search concept. The terminology within the guided search module is vague and confusing. This database does not take advantage of leading edge website design technology.

A glossary or more informative guided search module is needed to make this database more user friendly. Descriptions of the environmental value in question are vague and need better explanation. Technical issues relating to internal errors need to be addressed as these were frequent and not results of the evaluator's computer configuration as multiple computers were used with up to date web browsers.

## 6.0 CONCLUSIONS

To design environmental valuation databases to their full-use potential, it is suggested in this paper that an established evaluation framework be used. This presentation has introduced a criteria, element, and indicator framework through which databases can be evaluated and improved.

Environmental valuation databases are used by a diverse set of users ranging from researchers, to teachers, to government officials. These individuals use the databases for a number of purposes ranging including a simple bibliography, an extensive bibliography, benefit transfers, and benefit function transfers.

Overall, the databases reviewed in this presentation can be said to provide a vast and relatively comprehensive resource of environmental valuation studies conducted throughout the world. While environmental valuation may not be fully established in the mainstream economics discipline as of yet, the improvements recommended to the databases reviewed above could allow these databases to serve as the foundation from which future economic policy decisions are made.

## 7.0 REFERENCES

Adamowicz, W.L., 2004. "What's it worth? An examination of historical trends and future directions in environmental valuation." *The Australian Journal of Agricultural and Resource Economics*. 48:3, pp 419-443.

Carson, R.T., 2000. "Contingent valuation: A user's guide." *Environmental Science and Technology*. 34, pp 1413-1418.

Turner, R.K., Paavola, J., Cooper, P., Farber, S., Jessamy, V. and Georgiou, S. 2003. "Valuing nature: lessons learned and future research directions." *Ecological Economics.* 46, pp 493-510.

# Question and Answer Session

## For *Session 1: Valuation Databases*

*This section presents a transcription of the Q&A session for the following presentation from Session 1:*
*Van Lantz, University of New Brunswick, Canada.* An Evaluation of Environmental Valuation Databases Around the World.

*Responses to questions are coded as follows:*
*VL: Van Lantz, University of New Brunswick, Canada*
*BD: Bob Davies, Department of Environment, Food, and Rural Affairs, UK [session chair]*

Q: [name inaudible], University of Washington. Could you explain the criteria by which you arrived at these particular databases?
VL: That's another factor. Basically, when I was considering the contract with Environment Canada, we went through and the databases that came to mind, as far as I understand, were the ones that were considered in this evaluation. I would be very open to expanding the analysis, including other databases, if there were other databases. I know that there are a few out of Vermont and other places that are currently coming online, and those could most definitely be included in this document. But as to answer your question, there wasn't really a very refined set of ways in which we went about selecting these. It was very much a "Did we know of it?" And then we included it.
Q: My name's Pamela Kavel. I work in New Zealand at University Waikato. This is more of a comment, not really a suggestion, but I do work with Jeff Perr, sometimes on that New Zealand database. And you're suggesting he expands the studies, but that's all the studies there are in New Zealand, so we can't really add any more.
VL: I tried to discuss that, I think throughout the talk, in that the evaluation criteria that we set could be thought of as being quite biased to some of the objectives set forth with the purposes of the databases. So as a result, then, in the evaluation of a database like that, it might be a good idea to revise the way in which we would evaluate that database. This is one of the difficulties in providing a general scheme. You leave out some of the intricacies, and if the purposes don't match up with the evaluation criteria, then we've got some issues. So thank you for that point.
Q: I'm Ian Bateman from University of East Anglia. Some expansion of what the previous speaker said. What you've got is -- what you do here is pretty biased against items like New Zealand. What you've actually got there is a database which covers an area which I'm trying to guess at about 1/25th of the area of the US. And EVRI actually covers Canada and lots of other countries as well. What you've actually got is a database in New Zealand which is far more accurate and detailed for the purposes that it was set up for, than really EVRI actually is. I think evaluating it for the purpose that you set out for, you'd actually come out with a very, very different rating. And you could do it quite easily, just by weighting by the size of the area considered.
VL: Thank you.

Q: Just stating facts, I notice you listed EVRI as not being free, and I suppose just for the benefit of this audience, it is free for all the member countries. So for all intents and purposes, Americans, Canadians, French, UK citizens, it is free. So you're right; there's a day's worth of wait.
BD: Could I just ask if there are any representatives, in the loosest sense, of any of the other databases other than EVRI?
Q: I'm James White from the New South Wales Department of Environment and Conservation, and we manage the Envalue database. Of course, I think it's cruel to bring me up here like that. I do have a comment, which probably works against that database more than anything else, that to give an overall four-star rating with EVRI I think is overrating it. I think that the really important things in the content are actually the benefit transfer and benefit function transfer. I'd give those the heaviest weight and you can see from the star scheme up there that Envalue doesn't go so well in that sense. I'd reiterate the points made by the previous speakers as well, that the New Zealand's non-market valuation database, if what Pamela said is correct, is actually covering 100% of the studies. It's a census. So, assuming that it's only New Zealand researchers who are going to be interested in it, then everything that's ever been done out there is in the database, and you're not missing anything. Whereas EVRI and Envalue may be covering a relatively small percentage, like a third or something of the studies that might have been done in their areas. And the other comment I notice you made was about the datedness of the Envalue database, which I think the most recent studies under the year 2000, that's a very fair comment. And when I give my presentation later on today you'll understand why that's the case. You'll probably find it's an interesting story.
Q: My name is Christina McLaughlin; I'm with FDA. And I've never really used these databases, but one of the questions that comes to mind is it looks like you have a collection of databases that intend to do the same thing. And what I was wondering is, is there any talk about forming some type of a consortium so that you can put together, use a lot of these criteria that you're using, to determine accessibility, ability, how easy they are to use? I'm sure all of these are built in a different architecture. Probably some are dynamically generated; probably some are hard-coded in HTML, whatever. But I think that it would be beneficial to have some type of another site that would help consolidate all the search terms, all the databases, how to use them. Have a glossary that more or less is universal for all of them. Also, another thing, basing how easily accessible something is on Google hits really is determined not so much by the quality of the database but as more a property of how many hits the site gets. So if you go to Google and do bottled water consumption, you're going to get everybody that sells you bottled water before you get any information on bottled water consumption. And kind of like the same thing you can do with environmental valuation database, you're going to probably get a different -- the things that will pop up first are not going to have anything to do with environmental valuation. You're probably not going to get that on first, second -- I'm surprised that EVRI actually got it on the first page, because that's a property of Google.
Q: Clive Spash, University of Aberdeen, Scotland. I thought it was a very interesting analysis, and I worked with stuff on benefit transfers. Quite interesting to see your doing an evaluation here and you're actually using a multi-criteria analysis approach to that evaluation. You didn't actually go out and ask people how much they are willing to pay for these databases. I wonder if you could comment on that.
VL: Maybe a next step might be just that, to have study groups and ask them to actually perform some searching and so on, at least to get the criteria set up more succinctly. We'd like to get a diverse set of users and look at what their values are and you can look at it from a scientific perspective. But as of right now I haven't given much thought to that.
BD: Can I just point out that there is a market there. There is actual payment in a sense people actually put their money where their mouth is in terms of what the value is that they give to the particular

database. On the previous point, there's a big question about how the databases fit together. Consortia and all that. I don't think that's really for you to address. I think it's for people like Luis and I and the EPA to consider how the databases are used and how they might be brought together.

Q: I'm Ferdinand Villa, Gund Institute for Ecological Economics in Vermont. I thought we already have another database that could have been in this list as well. My comment was a follow-up to the other comment of the lady before. Basically, many of those evaluations would look very different in a coordinated context. I would think it productive as a criterion for evaluation to think about each database, how much value would they add to a global landscape if the database were coordinated? In that context probably something like the New Zealand database that looks pretty good and pretty complete would have a very high rating that would change something. I've been thinking about a coordination proposal and some coordination technology would be nice to talk about that during this meeting. Another little comment that I have about the accessibility and usability criteria that you used, I notice that some of your criteria were basically the same criteria that a usability engineer would use when doing an evaluation of a web site or a program, except that a usability engineer would rate them the opposite way. For example, using Java, [inaudible] and things like that are not normally considered by usability engineers as pluses; they're usually minuses. So I would, if you go on with this approach, I would suggest you coordinate with the common approaches with how to evaluate certain things, particularly in the usability range, because there have been a lot of studies done about that, and they usually go in a different direction than you had assumed.

Q: Kerry Smith. I just wanted to ask a couple of questions about the overlap between databases. That is, it would be very interesting to look at, below the level of water, and ask were there studies that appeared in multiple databases, and how were they treated across databases? That is, consistency in the representation of what was done. What was there and what was not there? Another issue that is related to that is in terms of your usability from the perspective of economics, most of the studies that you see in the literature are somewhat vague on the exact timing of the survey, and the economic circumstances in which the survey took place. That is just basic economic data about the location, not just the region. But what other things were going on? Things like what time of year was the study done? What year was the study done? What were measures of price indexes in the location where the study was done? Things like that, that most researchers at the benefit transfer level have to guess at. Be interesting to know whether that was there or not.

VL: Thank you very much. To that last point, when we were doing the rating scheme, again we were looking at it very qualitatively and saying, "How much description of things like location is there?" But you could actually nail that down, I think, a little more explicitly in quantifiable terms, saying what are the exact specifics that we're looking for, that are important?

# "The Environmental Valuation Reference Inventory (EVRI) Valuation Database: History, Overview, and Applications."

**Greg McComb**

***Environmental Economics Branch***
***Environment Canada***

**Presented during Session 1.**

*[This section presents a transcription of Greg McComb's presentation. The slides from presentation follow the transcript.]*

Thank you, Bob. I'm the lead economist for the valuation database. I've been working on it since 1999, and I've been responsible for populating the database, site development, getting input from club members, and so forth. So I guess it's awkward to say…I'm "Mr. EVRI."

This presentation is going to be a little bit different than other ones in that it's more of a training session. I was very surprised that half the people are already using EVRI. For the other half who haven't used the database, I'd like you to have a sense after this presentation is done how to, for example, navigate the site, how to do searches, and how to use it to do simple benefits transfer.

So it's kind of a how-to demonstration of the EVRI database more than anything else. I'll start out by talking about what EVRI is, and then I'll provide a little bit of historic background. I'll go to what is the kernel of EVRI, which are the study summaries of the EVRI records, and try to really drill down what these records are and how we do study captures. And then I'll show you the breakdown of what the type of study summaries are in EVRI, based on various categories. More recently, with what the Internet is involving, we've been putting more online resources that are being developed at the EVRI site. And then we'll start doing some searches, and we'll explain the steps for a very simple benefits transfer.

I think that both Van Lantz and Luis Leigh, my director, have already talked about EVRI to some extent. There are about 1,500 studies on the Internet site right now. These are study summaries, where we pick out the most salient aspects of a study. We read them very carefully and pull out what we think will be the information that will help an analyst who wants to do a benefits transfer. So we pick out the values, we make sure that we have the correct year, exchange rate, study information, and so forth. So we're really drawing out the most important information of a study and putting it in a database, so that instead of having to go to a library and search for a study, you can probably read an EVRI record in about two or three minutes and get an idea of what the study is about.

The original idea was to facilitate benefits transfer, and we set it up in a certain way. We facilitate this through something called matching and quality checks and so forth. The design of this is to facilitate benefits transfer.

What we have been finding in the last few years is that as a valuation database it's been used somewhat like a library. People doing any type of research, any valuation research, may just go into EVRI and look around to see what there is. If you're a researcher out of a university or even if you're a government analyst in a policy group—you may have a policy moving forward—and, "so, what have we got here?" And we use that. So we're seeing it use that way instead of for full-blown benefits transfer; we're seeing it being used more and more over the last few years.

As I say, it's a free site for U.S./U.K./France citizens as part of EVRI Club, and it's also a bilingual site. If you click on the Français button on the opening page it will take you to a full-blown French site, where if you're from France or Quebec, in Canada, you can navigate that way. We have a number of French studies. Generally we enter a study in the language in which it was written, so if it's a French study it's entered in French, and if it's English it's entered in English, so we don't have to translate. There has been an effort in recent years to enter more French studies in partnership with France.

So here is the splash page. For this presentation, I'm showing a series of screen captures. I've used an Internet connection for presentations in the past, and I've found that usually about halfway through, the Internet connection crashes. So I've perfected the method of doing screen captures, and you'll see these throughout.

I'll give you a very brief history of EVRI. In the early 1990s, my predecessors at the environmental economics branch, Paul Swida, [name inaudible], saw the need to develop an alternative to primary studies. There was a group at the time that was talking about benefits transfer, and there were a couple of important things that went on. The journal *Water Resources Research* did a series, and there was a workshop sponsored by the Association of Environmental and Resource Economists. This predates me, but I'm giving you this by way of historic record of what was going on at EVRI.

After this spark, our branch had a series of meetings with some of the better valuation experts in North America—Richard Bishop, Richard Carson, John Loomis—over a period of time in the early 90s. And they came to the conclusion that what we really need is some sort of library. At the time, the Internet wasn't advanced. I've seen some of the early copies of EVRI; it was kind of a DOS-based tool but you could use it on your desktop, and it was pretty rudimentary. Over the 90s it evolved into a fairly good Web-based tool that we use today (in a modified version).

So here's a quote from the OECD: "In the long run the successful and widespread use of benefits transfer requires a well-documented, easily accessible library of high-quality valuation studies." So those sorts of things that were going on in the mid-1990s led to the development of EVRI.

I think the speakers before me have talked about the partnership between U.S. EPA and the EVRI Club and so forth, so I think I can skip this slide.

So what is EVRI? The kernel of EVRI is something called an EVRI record. We enter data into these EVRI records. This is a screen shot of what an EVRI record is, and this is a capturing module. You press this button called Submit, and in this you'll get a whole series of modules in which you click on information. There are text boxes, various categories, and so forth. Here's the module where you enter data for the various tables. The kernel of EVRI is these EVRI records.

This is actually what went through the heaviest scrutiny during the 90s. [inaudible; coughing] prediction, and they said, "We need benefits transfer. We need to pull out certain areas." They threw around ideas of what should be in these records and academics said, "We need this and that" and so forth.

I'll briefly go over what some of these areas are. One is called Study Area and Population. This field talks about what the actual study site is: in other words, whether it's the Grand Canyon or a park or a lake. The study site is defined very carefully, because it's very important to benefits transfer. The field also talks about the sample population. That's something a little different, because that's something you're sampling, so it might be a wider area.

The Environmental Focus of Study field includes two things that I'll explain here. First, it includes something called the environmental stressor. This is a broad interpretation of the notion of pollution and it will encompass pretty much anything, for example, congestion and noise, any sort of stress, resource depletion. The second item included is called Extent of Change. Usually, for a policy, there's some sort of change attributable to a regulation or legislation or something like that. This quality change has to be very carefully defined in the record in order for this to be a good study record.

The General Type of Environmental Good field defines what kind of environmental good is being analyzed. Is it an extractive use? In other words, do we take something away? Is it a non-extractive use, for example, hiking, where you're not doing anything to disturb the environment? Is it something that only has existence value?

The Study Methods field defines very carefully what sort of instrument was used. Was it a dichotomous choice survey? What was the sample size? Was a revealed preference method used? And so forth. We very carefully define hedonic methods.

The Estimated Values field defines the year, type of value, and includes the most relevant values. I know from doing several hundred of these captures that a lot of the time it's not very clear what the final willingness to pay values are, so we take great care at capturing studies.

That's the kernel of the EVRI record. We have an ongoing process to make sure that this database is up to date. We do literature searches, including peer-reviewed and gray literature. Just a side-note: we talk about the notion of quality, which is very important for benefits transfer. While peer-reviewed literature is very good literature, we find that it tends to be somewhat abstract and theoretical at times. And what we find is gray literature–in other words, studies that are commissioned by governments or other people for a specific policy issue–tend to be better for policy, but at the same time they're not quite as robust as peer-reviewed literature is. They are also harder to find, because a lot of times whoever commissions a study put it in their library and made it difficult to locate. You can't just go into a search engine and get it. So part of our work with the EVRI Club partners is for them to pick through their libraries, tell us what they have, and send it to us. That's one of the benefits of this partnership.

Generally, we get graduate students to do these captures. We have them on an ongoing basis, and we train them and edit their work. We do quality checks with our EVRI project staff. We have a series of contracts to do these captures.

As I said, EVRI was developed in the mid-90s, and it's going through an ongoing period of revision. We have a software expert who actually in the past year has done a complete overhaul and tune-up of EVRI. It was put together during the 90s, and in order to tune it up and make sure that it works really well, he's going to go over all the code and make sure it works and doesn't give us any error messages.

At the same time, we're continually getting input and adding things. For example, when we partnered with the UK we noticed that the water where they have the most recreational uses is canals, and that noise in large cities is a much bigger issue in Europe than it is in the US.

We have also added a number of other things. For example, in the late 90s, the text boxes were quite small because everybody had to cut and paste it back. Now, with cable connections, we have large text boxes and we also added some links to studies, non-copyright studies on EVRI.

So what use is the EVRI record in terms of benefits transfer? It's actually set up to facilitate this as best as possible. I'll go over a demonstration later, but these records are one of the key things that emphasize the notion of matching the conditions at the study site. Is it from a fairly similar geographic area? What is the extent of change? Is this similar? What type of pollutant is being used? What is the environmental focus? And so forth. The way the screen module is set up is very important for benefits transfer.

The study method field is set up so that you can look at the quality of the study. What sort of methods did they use? Did they use recent psychological techniques? And so forth. It is somewhat subjective. You can't just say, "Well, a large-sample study is better than small-sample study." Some newer methods with choice experiments, for example, use more in-depth psychological methods. So even though it's a small sample it could be of better quality. So the study method field allows you to look at that and judge of whether it's a good quality study for a transfer.

We also set up the currencies. We make sure that we have the currency set up if there's international transfer, and make sure we have the year of the actual data for the transfer. It's also set up so that [inaudible] the title of the study, so that you can do transfer easier that way.

One of the ways EVRI facilitates benefits transfer is that it's fairly comprehensive. In other words, there isn't one little specific type of information that we have. We have a series of categories, so, for example, if you want to do a function transfer, there's a category on functions, and then you can draw on that information. If you want to do meta-analysis, there's a very large population of studies that do meta-analysis. And if you want to do an average transfer, you can use it that way. It's probably the best in average transfers, but it's still flexible enough to be used for a variety of things. EVRI is a fairly

comprehensive database and flexible enough so that we can adapt and change as theories and methods for benefits transfer shift and change over the coming years,.

We put a lot of effort into populating the database. If you want a study that's a fairly good match to what you have or a method you want to look at, there's a very good chance that you're going to find it in EVRI.

We've seen over the last few years that EVRI has been used a lot, not only for benefits transfer, but as a first step for any researcher who wants to do some valuation research. Oftentimes with public policy, a policy may come down the line, and we may get questioned on it as government economists. A lot of times we'll flip through EVRI to identify relevant studies and then make a presentation using EVRI. So we use it as a first step to see whether valuation in general is a useful thing for whatever policy is coming on line. So you can use it for both simple and sophisticated benefits transfer techniques.

Let's take a look at what's in EVRI. I'll also tell you about each record, and generally how useful they are for benefits transfer. I'll go through this in a number of categories.

As I said, journal articles are the best sources, but EVRI includes a lot of gray literature. About 22 percent of the studies are government reports. And four percent are conference papers, which I consider gray literature, so there's probably a good quarter of gray literature in there. About 15 percent are dissertations and five percent are chapters in books. So there's a good variety of literature; we don't just concentrate on journal articles.

These are geographic characteristics. This is a screen capture from EVRI; you can go there any time and generate this if you want. When we first started actually talking with Europeans we found that there were mostly North American studies. This green bar here, for example, was much lower about two years ago. We've put a lot of effort into capturing some of those studies, and it's over half now. So that's a very encouraging sign for our European partners.

And as well, we've had sort of an informal partnership with environment quarters in Southeast Asia. You'll hear David Glover speak later on. They've been capturing studies there for about the last five or six years and on a formal basis we've been granting them some access. So you see quite a number of studies. They do very good quality studies and some of the environmental assets are very interesting, their concern being East Asia.

Environmental assets: as I said, the largest is water. When we started out we had a partnership (which predates me) with the Office of Water in the United States Environmental Protection Agency, and you see large numbers of water studies. I don't think it's too unfairly representative. You'll see a fairly diverse listing of environmental assets. We make an effort for that. We also make an effort to try to include studies that are needed for policies. For example, the UK government needed some climate change valuation studies, and we've captured some of those. So in addition to randomly picking out articles, we also try to respond to what the policy needs are of a lot of our partners.

Van Lantz talked about these most recent studies. It's not [inaudible] database, it's not going out of date by any means, called [inaudible]. It's a very [inaudible] used database. It's probably about 60-65 studies since about 1990, and you can very optimally leave it up to developing a core. I think we're probably in the process of doing a literature search for 2005 shortly, so you'll see more recent studies fairly soon.

Dr. Lantz talked about the tutorials. I'll point them out to you right now. There are two tutorials. One is more cursory and it's on the public side on Tour EVRI. The other is called the EVRI Tutorial, and that's more in-depth. And if you want to run through what it would be like during an oil spill scenario, you can go onto that particular tutorial and work your way through. For example, here's a tour on the public side, and it would take you through all the various modules and so forth and the search engine and explain how to use those. And then if you want to get more in-depth, go into the subscription side and

there are actually two screens here. The top screen here will roll forward, and the bottom screen here is active, and you can start using the various search techniques. It will explain how to use them, so you can work your way through and learn how to use EVRI as well.

During the last couple of years we've gotten more and more e-documents. Through the commissioner's office, we're trying to get more of them online. We've created a benefits transfer bibliography. We've also set up a study link field in the EVRI record to make studies available for non-copyright literature.

For example, there's an e-library where you can click on, say, David Barton's study. And then what will pop up is a separate box here, and if you want to save this to a file right here, you can.

That seems to be a big demand from the people that use the database. Unfortunately, because of copyright, we can't make studies available unless we have permission from the authors. So we have a limited number of studies.

We've also set up what's called a study link field. It's a special field in here where, for example, we have links to popular literature. And also Web sites as well, but a lot of Web sites like the Web search, social and economic research in the global environment – they do a pretty good job. They've been doing a pretty good job of loading up their own electronic literature. So we've got a study from here instead of loading it and worrying about copyright; we just simply take you to the site and then you can search on the site and get the article that way.

So let's get into it. We've got the EVRI records. I've got some online resources and so forth. So let's take a look at some of the ways we can search.

The first line is the free text search. You look for articles; that's simply a search engine like Google or so forth. You can enter any words you want in there, any number of them, and they will come up. And if you have a record, maybe 1,000 words, you can just scan the entire record for whatever words you're giving in. So it's pretty straightforward, rapid.

However, we actually recommend the searching protocol if you have the time to use it. It's set up to search specific categories and fields, instead of just scanning the whole record. This is useful, for example, to search by year or geography. You click on the geography field, say "I want a study from the UK, I want it from 1995 to 2003, I want recent literature," and you can click it that way. There's a screening module as well, to view records, and I'll go through that. It allows you to do some of these techniques.

Here is a very simple example. Say you were interested in canals in the United Kingdom. As a first step you might just want to type in "canal" and "United Kingdom." I've put a picture here for humorous relief, but if you look at the literature on water in North America as opposed to the UK, what you see is that canals are one of the biggest sources of recreation. There are a lot of canals, and over the years, they've invested a lot of money (I think since about the 50s). They recognized there were these canals that weren't commercial any more. Last time I was in the UK I hiked along a canal. I saw a number of people fishing, and they have these little canal boats, sort of puttering up and down the canals, with a few pints underneath the tarp there and a small kitchen and so forth. There's about a three mile per hour speed limit. It's recreation, what the British like, as opposed to in North America, where people go to the beach and fish and that sort of thing. Canals are part of recreation.

But like all things, although there is commercial recreation, there are also unmarked values. People just get into the water and you really need to know nonmarket valuation to get a handle on what the value of this is to UK people. So there's a growing literature on canal valuing and recreation, and you can access it. I think over a period of years, the water authority has reached a point where they want to have a better look at this if possible, and think about rejuvenating canals.

Another way of doing this, supposing that I would like to see more recent studies, is to enter 2003 to 2005. And I can put "canals" in the Water General field and I can get a result. And here's the result. You get this search map tree. As you can see, there's a total of 11 studies in the whole database on canals. And if we relate this to the United Kingdom, there's 195 studies from the United Kingdom, and then of those 11 there are four that aren't from the United Kingdom, so there are seven. And then you have a screen for language, and then you have all the dates. So you see that three of these seven are from dates previous to 1995. So we end up with approximately four recent studies on canals.

That's essentially the way the search engine works for EVRI. [short missing section during change of audiotapes] … series of buttons. I've put the type of data, which is the survey method, and you can screen just this section or at least part of the record and have it roll forward. If, for example, you're doing an exercise where you want to look at the quality of a study that's being done, then you would scan through and see what kind of quality is there. But if you want to actually use your values you can click on this value button, scan through, and see what arises there. If you want geographic detail, or want to look at spatial issues related to benefits transfer, then you can click on that.

You can click on these buttons here, called Navigation, and there are a number of other tools where you can actually click on some of these and they'll take studies, bibliographies, and so forth. And there's also a Help button here. If you press on this Help button it'll take you through the way the searching module operates. We recently upgraded it so it's quite helpful.

During the session, if I want to get every record I right-click on this box here or I right-click and take it to a separate screen and print out the entire record. So if you want you can just print out the record that you have and I actually find that is probably a little better method to manage your record. If you're considering using EVRI as well as tutorials I'll work with you through this Help screen and work through a number of these functions and so forth.

So talking about research and policy, we often get people calling us up. For example—this is an anonymous electric utility—someone phoned me up a couple of weeks ago, and said, "Well, we have the capacity to do pricings for electricity, but recently our government's been asking us what are the environmental impacts and can you help us find valuations to help us along?" And I actually spent about half an hour with them working through EVRI and showing them how they might in the future build an valuation capacity in these groups. Particularly he was concerned with some of the impacts, especially when water levels change when hydroelectric dams let water in and out.

Most people might know that, for example, dams are regulated so that they don't block off all of the water. For example, an awful lot is let out so there's a certain amount of tourism at Niagara Falls. So there's a tradeoff in that respect between recreation and electricity. But there are other benefits that are being considered as well. For example, there may be recreation being in some way disturbed by Baker dam in Western Canada. There are benefits and recreation at beaches, for example, that require proper flows. There are also ecological benefits that often are associated with dam use.

So this is an example that we got from the government. I'm trying to give you a glimpse into the questions we get and the way the valuation databases are used. We often answer questions like this, and EVRI is often used as a library to help policy analysis. And people who are interested in benefits transfer, they use this and other stuff to get a handle on what's going on.

So take the example on the dam, where there's a stream being used for recreational purposes, with downstream effects on fisheries and so forth. EVRI gives us 21 studies that might apply to this case, and we get a few studies for this specific dam. This is a study where they asked people about the salmon fisheries downstream. Here's another one on talks about water levels. You can see that this is a very old study, and although it may not be useful for a benefits transfer, its methodology may be useful for this person at the electric utility. What sort of methods were used? What were the outcomes? In this

particular facility there were problems caused by droughts and so forth, so they used a number of things for evaluating these.

So, if you don't want to do a function transfer or something else complicated, you can do a simple benefits transfer using several steps. We use the dam example because there are a myriad of environmental impacts as well as economic impacts. The first step you would take would be to define the service or asset being valued, including defining the impacts as best as you can. It helps to be interdisciplinary. There may be impacts to visibility, there may be other impacts, ecological impacts where you have to consult with scientists. There may be some recreational impacts that require you to consult with some parks people, and so forth. So the first part is an interdisciplinary exercise.

The next step is research. The way to do research in EVRI is to input as many key words as you can, in combination, just like you would in any other library source. Use multiple key words, different years, different combinations, and so forth. You will probably spend a bit of time on this step.

If you've got five or six studies and you've got candidates for benefits transfer, the next step is to look at the nature of each study. Is it similar geographically? What about the year? Is the focus similar? What about substitution effects that are similar? You can look at any number of things.

The fourth step is to look at the candidate study, do a quality check on it, and see whether or not it's a good enough study to use with for benefit transfer. What about sample size? Did the authors use a professional survey firm or was it just a survey done off the back of an envelope somewhere? If it looks like it wasn't done very carefully, then maybe reject it.

The next thing is to provide a rationale for selection and a table of values. What we like to do is to take all the studies and create a table. This is a very simple table and you may actually want to include more writing than simply the box outline, maybe provide some rationale for what you do here in terms of accepting or rejecting a study. If there is a reservoir that's being talked about, how big is it? Is the quality good? What type of recreation is being studied? What is the focus of your study?

The sixth step is adjusting international values. In this case we've already developed a spreadsheet to adjust values for other countries. This was actually done for the U.S. and Canada and papers were written about this. Presumably in a European context, by [inaudible] how useful or how awkward you can do this [inaudible] module so you can do this fairly quickly.

If you have more than one study, the next step would be to average the values for benefits transfer. And then you're going to aggregate these values using whatever method you want. You may want to use visitor data or something else. There is also the issue of spatial aggregation in an extensive market, where you apply factors to the values from the studies that you choose—there's been some distance analysis work done in the UK. Then apply discount rates and confidence intervals as well.

This could apply to any study but I'll stick with the reservoir because it's an interesting case. Reservoir water levels were controlled by a dam, and the purpose was to create a stable water supply from this reservoir and irrigation for drinking water. However, there were some environmental impacts associated with this and these environmental impacts were not being accounted for, for example, the recreational use of the dam. There were a variety of impacts, some positive and negative. There were some constructed wetlands, and there were effects on a municipal water supply. At the same time there was some loss of recreational fisheries and there was some impact on habitat for endangered species. And then there were some benefits from irrigation for crop production. This would be the sort of first step for simple benefits transfer research—to cite what your impacts are.

The next step in the benefit transfer is to do a series of searches. You would use, for example, this text search and you would also use the searching protocol to find studies that satisfy your criteria as best you can.

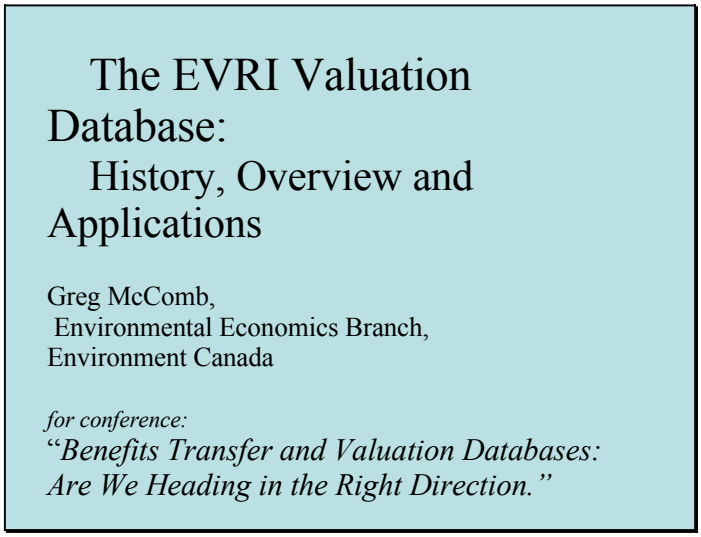
So for example, say we did this. We came up with four studies which we will include in this table. As I said, this is somewhat subjective, but I think this is a pretty good start for benefits transfer if you want to do one, or to try to analyze it in terms of water quality or type of recreation and so forth. This is somewhat qualitative as well as quantitative. I don't think there's any absolute criteria for the year the study was done, but I think if you're looking at a study from 1984, obviously you can certainly reject it, whereas more recent studies may be useful to benefits transfer.

This is our database set up for in use. We can do these transfers if you want, using these international adjustments to currency. So take another look. In this case they use recreation and user days. If you have 30,000 user days, just multiply that by five dollars per user day, and then apply a discount rate and hypothetical time horizon. The study authors used similar methodologies to estimate the value of services for other uses, and then summed for total economic value.

In closing, let me emphasize that EVRI is a valuation database that is useful for various purposes: first, for benefits transfer; second, as an e-library and storage of knowledge; and third, for policy screening. We've made a long-term commitment to adding new study entries. Moreover, in the last three years we've had the EVRI Club, which has helped fund EVRI, populate the database with new records, and develop the site.

So that's about it.

*The following slides accompany this presentation:*



# Outline

- What is EVRI?
- History
- EVRI Records
- Database Breakdown
- On-line Resources
- Finding Studies in EVRI
- Steps for Benefits Transfer
- Conclusions

# What is EVRI?

***Environmental Valuation Reference Inventory***

- Internet infobase of valuation studies on environment and health: http://www.evri.ca
- Currently, ~ 1,300 study records or study summaries that can be easily searched
- EVRI design facilitates benefits transfer, which is the transfer of values from "study site" to "policy site."
  - Design of records facilitates matching; quality checks; selecting values
  - Search engines allows for quick location of studies
- Free site to U.S., U.K., France and Canadian citizens as part of "EVRI Club"
- Bilingual site

## History

- In early 1990's, need identified for alternative to primary studies on environmental valuation.
  - which are time consuming and costly.
- *Benefits transfer* developed in early 1990's:
  - Journal of Water Resources Research series
  - Association of Environmental and Resource Economists conducted workshop.
- EC sponsored series of workshops in late 1990's:
  - advice from leading North American experts: Bishop, Carson, Loomis, Adamovicz.
- Developed as web-based tool to distill and organize previous findings of valuation studies to facilitate benefits transfer.

## History (con't)

"In the long-run the successful and widespread use of benefit transfer requires a well-documented, easily accessible library of high-quality valuation studies," OECD, 1994

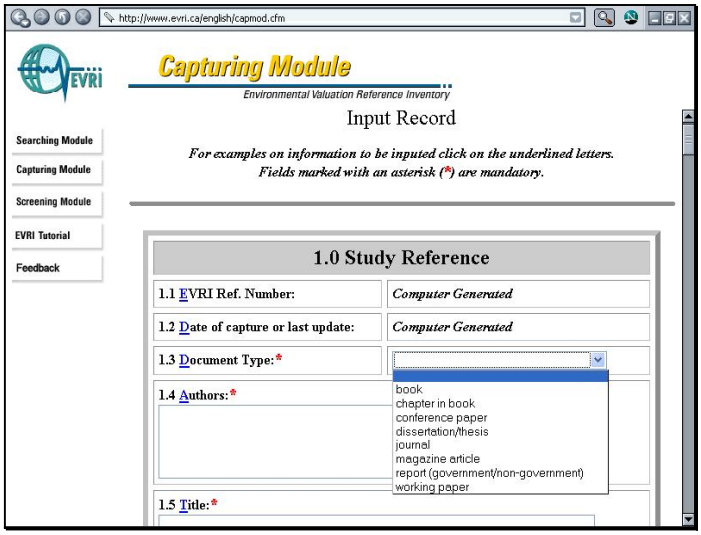
## History (con't)

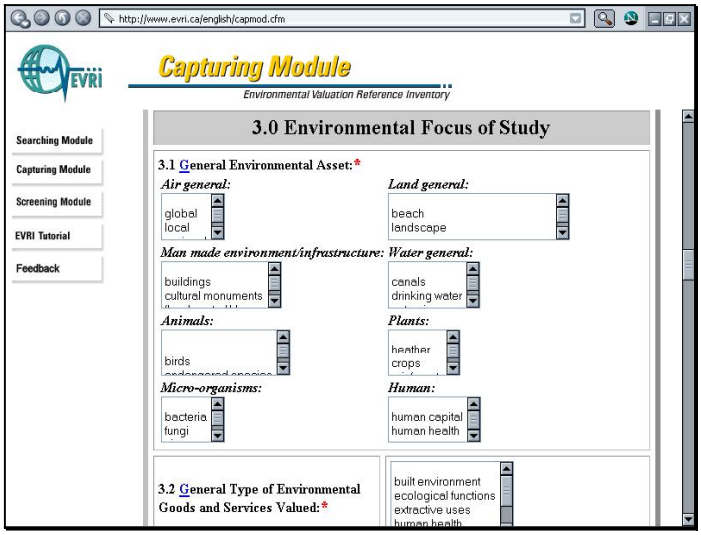
- U.S. EPA, Office of Water, collaborated with Environment Canada 1997-99 to develop EVRI.
- Launched to the Internet in 1999.
- European Commission sponsored assessment in 1999.
- Assessment positive: found EVRI to be user-friendly and could facilitate benefits transfer.
- Main recommendation: capture more European studies.
- Commission acted as catalyst for discussions between Canada, U.K., and France
- "EVRI Club" agreements signed by UK, France and US, starting in 2002.
- Acitivities of club include:
  - Access to citizens; policy direction; workshops; funding to develop and populate database.

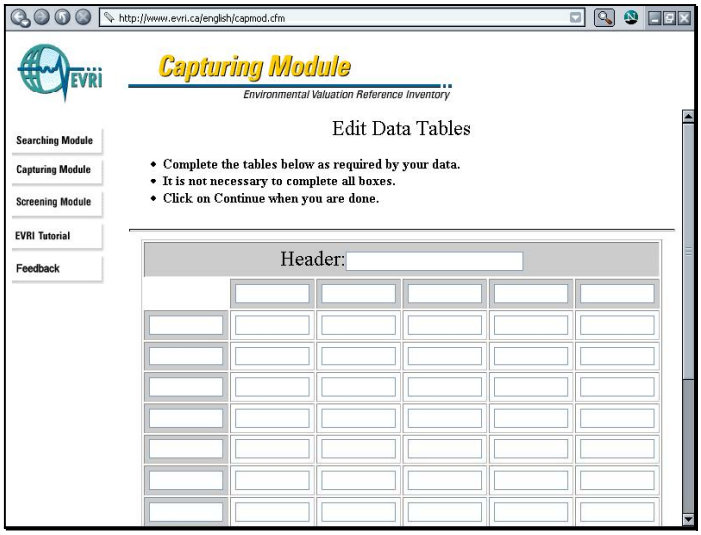
# EVRI Records

Info-base data contained in EVRI Records

- Records are broken into categories and sub-categories called fields where data and info is entered:
  1) Study Reference
  2) Study Area and Population
  3) Environmental Focus of Study
  4) General Type of Environmental Good or Service
  5) Study Methods
  6) Estimated Values
  7) Abstract






# EVRI Records (con't)

**Study Captures**

- Regular literature searches of both peer-reviewed and gray literature.
  - Assisted by "EVRI Club" partners to find gray literature
- Captures done by graduate students; consultants
- Training, editing and quality-checks done by EVRI project staff
- Capture module and *study capture guide* undergo continuous revisions and improvements:
  - Add new keywords: canal, heather, noise
  - Enlarge text boxes to facilitate on-line captures
  - Add link to actual studies in records

# EVRI Records (con't)

Structure of EVRI Records facilitates benefits transfer:

1) *Match* conditions of study site (geography, pollutant etc.) with policy -> geography; environmental focus and type
2) Quality of original study -> study methods
3) Currencies, year of values -> international transfers
4) Unit values -> /month /hectare /tonne

# EVRI Records (con't)

**EVRI facilitates benefits transfer:**

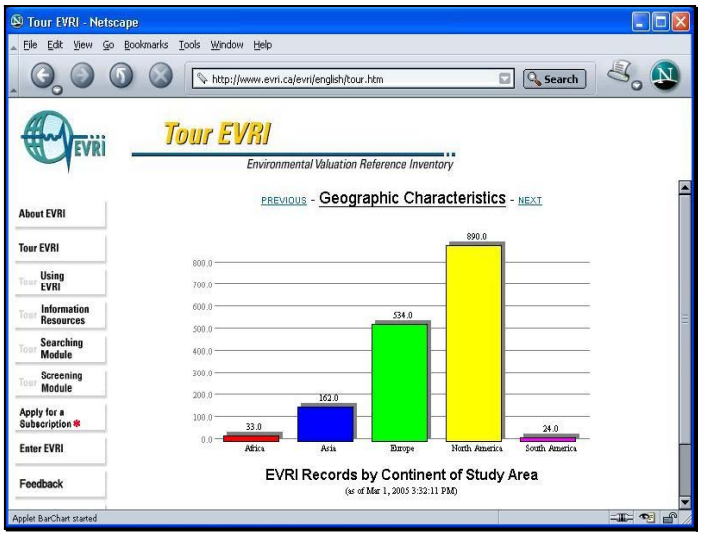
- Comprehensive data/info. allows for variety of BT methods → flexible
- Efforts to populate database mean large number of study records can be quickly accessed:
  - improves chances of matching conditions; finding quality study
- *However*, experience has shown EVRI used for variety of purposes:
  - e-library for research and reports;
  - screening of government policies, and
  - Both simple and sophisticated BT.

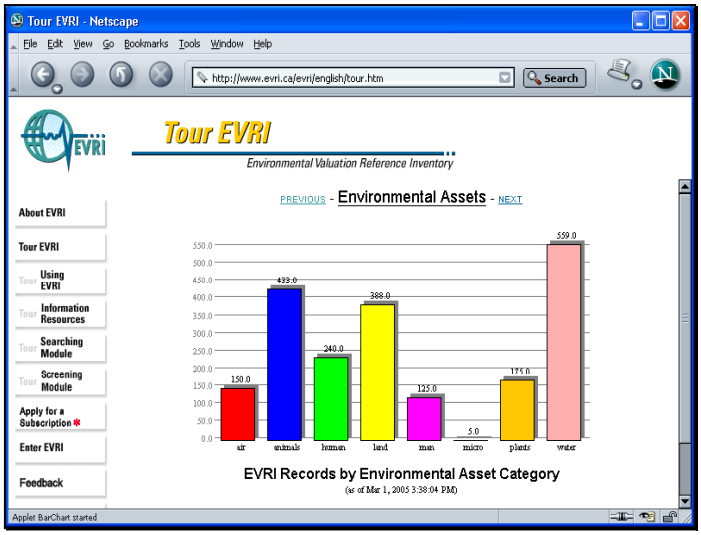
# Database Breakdown

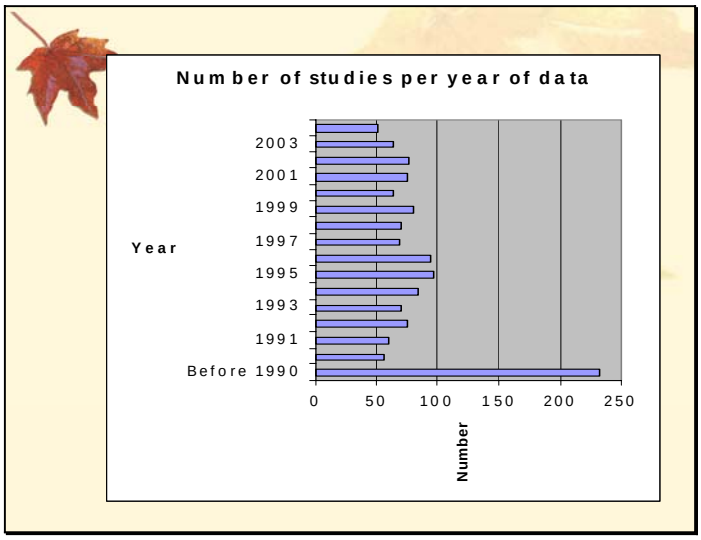
**Table 1 - Type of Documents in EVRI**

| Document Type | Percentage (Number of Study Records) |
|---|---|
| Journal Articles | 56% (710) |
| Reports | 22% (271) |
| Dissertation or Thesis | 13% (159) |
| Chapters from Books | 5% (66) |
| Conference Papers | 4% (48) |
| Total | 100% (1,254) |

15



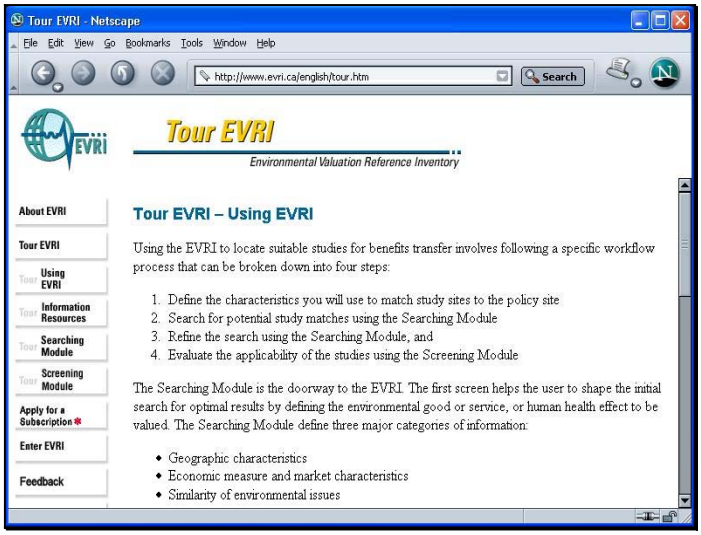


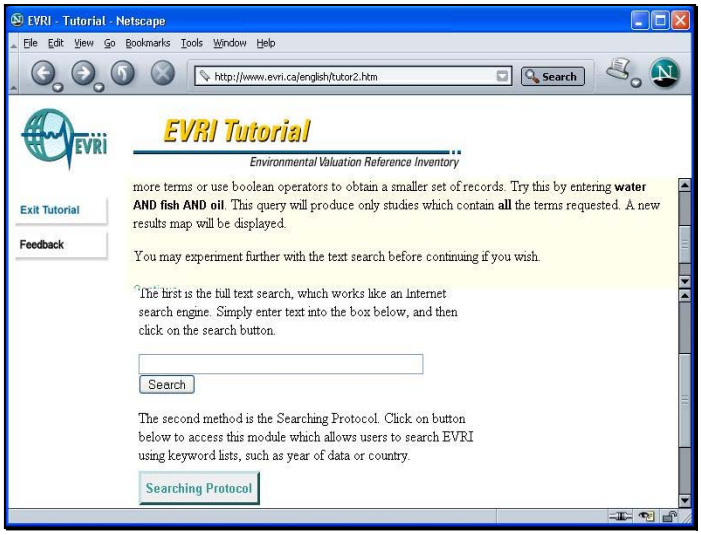




## On-line Resources

Two tutorials on EVRI

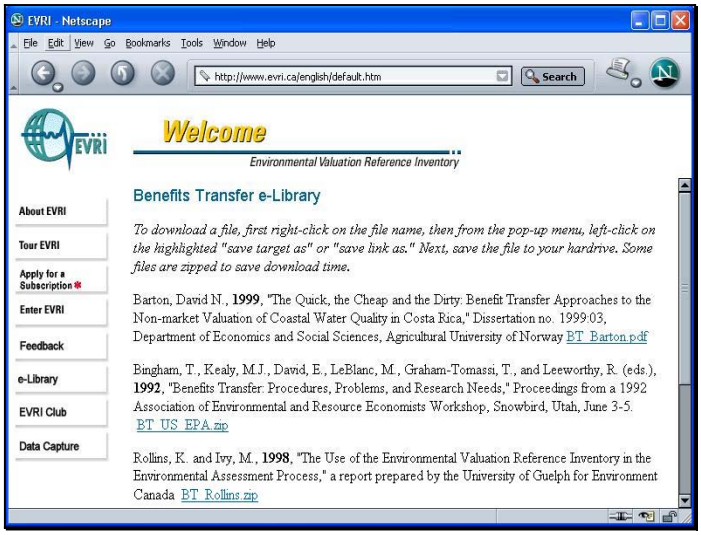
- On public side is “Tour EVRI” overview
- “EVRI Tutorial” on subscriber side uses hypothetical “oil spill” scenario

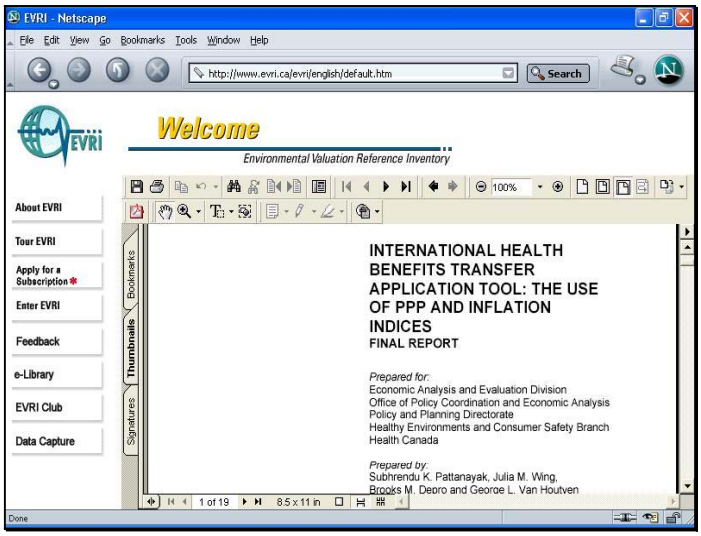


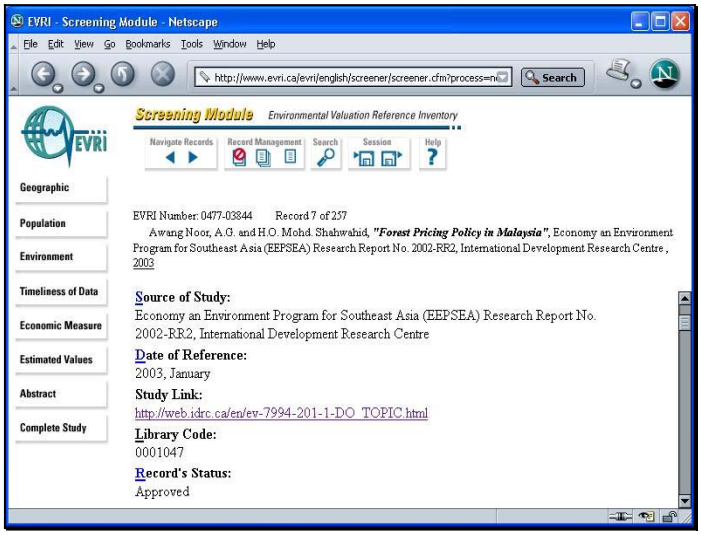



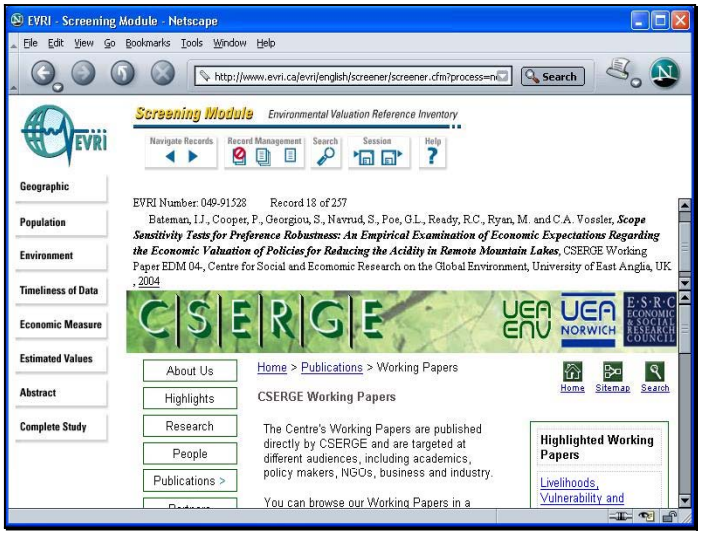

## On-line Resources (con't)

- e-library resources
  - benefits transfer bibliography
  - downloadable valuation studies in "study link" field in EVRI record


EVRI - Netscape
File Edit View Go Bookmarks Tools Window Help
http://www.evri.ca/english/default.htm
Search
Welcome
Environmental Valuation Reference Inventory
About EVRI
Tour EVRI
Apply for a Subscription
Enter EVRI
Feedback
e-Library
EVRI Club
Data Capture
Benefits Transfer e-Library
To download a file, first right-click on the file name, then from the pop-up menu, left-click on the highlighted "save target as" or "save link as." Next, save the file to your hardrive. Some files are zipped to save download time.
Barton, David N., 1999, "The Quick, the Cheap and the Dirty: Benefit Transfer Approaches to the Non-market Valuation of Coastal Water Quality in Costa Rica," Dissertation no. 1999:03, Department of Economics and Social Sciences, Agricultural University of Norway BT_Barton.pdf
Bingham, T., Kealy, M.J., David, E., LeBlanc, M., Graham-Tomassi, T., and Leeworthy, R. (eds.), 1992, "Benefits Transfer: Procedures, Problems, and Research Needs," Proceedings from a 1992 Association of Environmental and Resource Economists Workshop, Snowbird, Utah, June 3-5. BT_US_EPA.zip
Rollins, K. and Ivy, M., 1998, "The Use of the Environmental Valuation Reference Inventory in the Environmental Assessment Process," a report prepared by the University of Guelph for Environment Canada BT_Rollins.zip


EVRI - Netscape
File Edit View Go Bookmarks Tools Window Help
http://www.evri.ca/evri/english/default.htm
Search
Welcome
Environmental Valuation Reference Inventory
About EVRI
Tour EVRI
Apply for a Subscription
Enter EVRI
Feedback
e-Library
EVRI Club
Data Capture
Bookmarks
Thumbnails
Signatures
INTERNATIONAL HEALTH BENEFITS TRANSFER APPLICATION TOOL: THE USE OF PPP AND INFLATION INDICES
FINAL REPORT
Prepared for:
Economic Analysis and Evaluation Division
Office of Policy Coordination and Economic Analysis
Policy and Planning Directorate
Healthy Environments and Consumer Safety Branch
Health Canada
Prepared by:
Subhrendu K. Pattanayak, Julia M. Wing,
Brooks M. Depro and George L. Van Houtven
1 of 19
8.5 x 11 in
Done


EVRI - Screening Module - Netscape
File Edit View Go Bookmarks Tools Window Help
http://www.evri.ca/evri/english/screener/screener.cfm?process=n
Search
Screening Module
Environmental Valuation Reference Inventory
Navigate Records
Record Management
Search
Session
Help
Geographic
Population
Environment
Timeliness of Data
Economic Measure
Estimated Values
Abstract
Complete Study
EVRI Number: 0477-03844 Record 7 of 257
Awang Noor, A.G. and H.O. Mohd. Shahwahid, "Forest Pricing Policy in Malaysia", Economy an Environment Program for Southeast Asia (EEPSEA) Research Report No. 2002-RR2, International Development Research Centre, 2003
Source of Study:
Economy an Environment Program for Southeast Asia (EEPSEA) Research Report No. 2002-RR2, International Development Research Centre
Date of Reference:
2003, January
Study Link:
http://web.idrc.ca/en/ev-7994-201-1-DO_TOPIC.html
Library Code:
0001047
Record's Status:
Approved

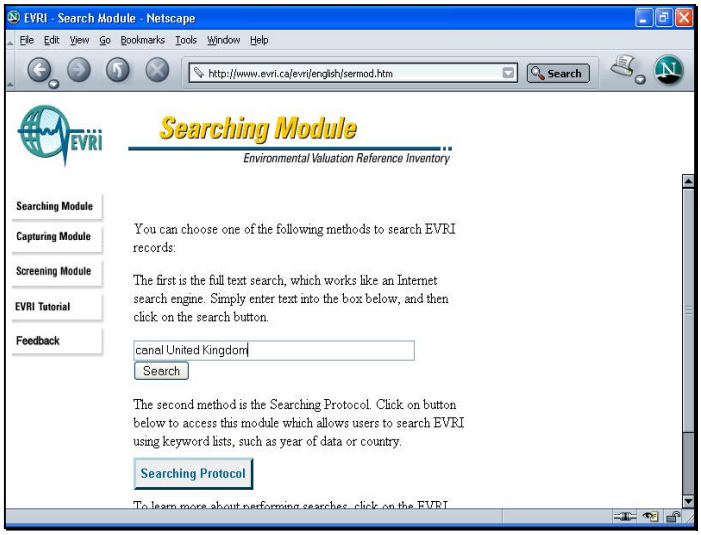


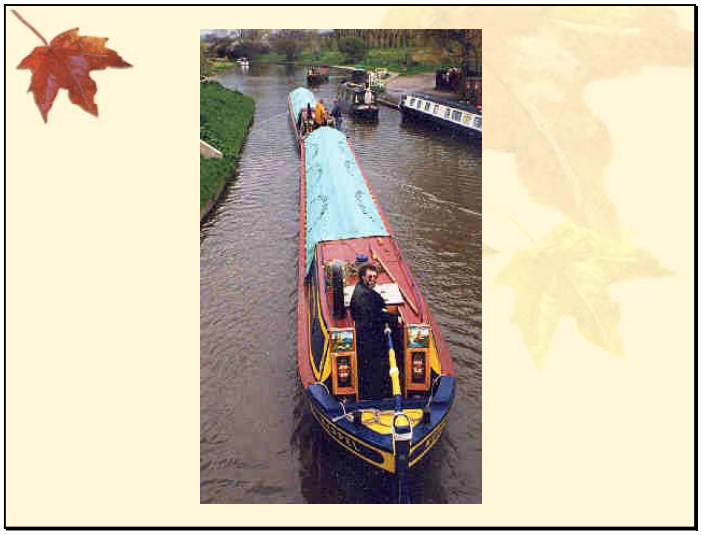

# Finding Studies in EVRI

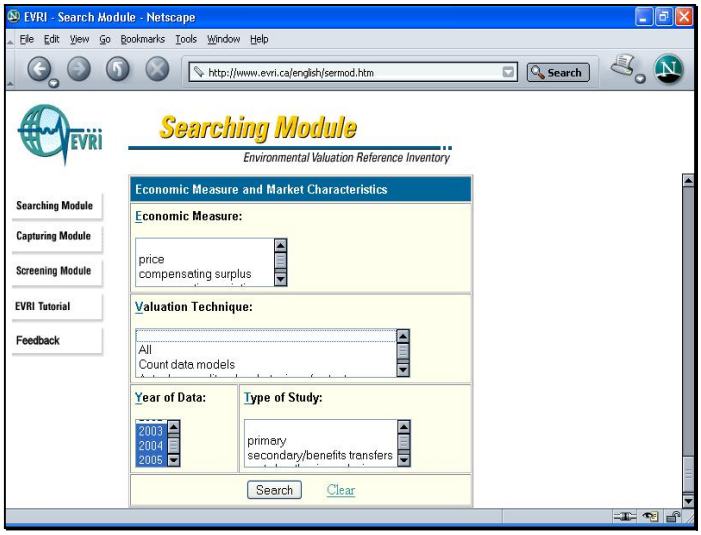
Two search engines:

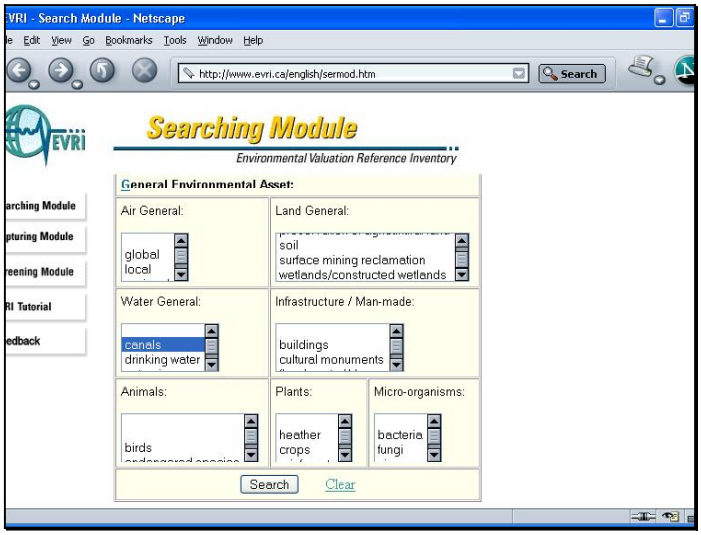
- ***Freetext Search*** -- searches text in entire record
- ***Searching Protocol*** -- Keyword searches based on fields in record. Generates search map.

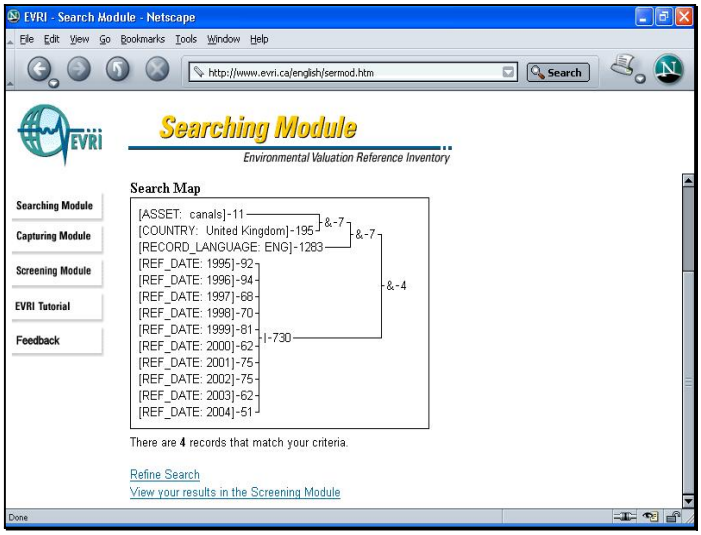
- Screening Module
  - Navigation features allow viewing of record fields or entire record → facilitates matching, quality control and locating values

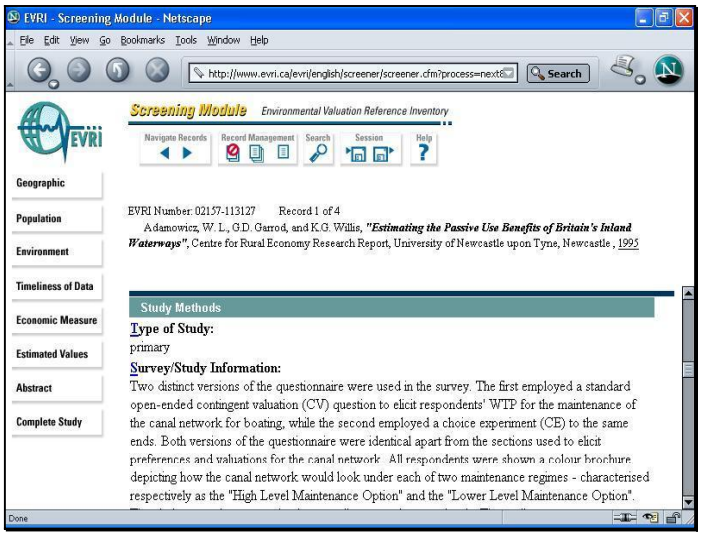





EVRI - Search Module - Netscape
File Edit View Go Bookmarks Tools Window Help
http://www.evri.ca/english/sermod.htm
Search
Searching Module
Environmental Valuation Reference Inventory
Searching Module
Capturing Module
Screening Module
EVRI Tutorial
Feedback
Economic Measure and Market Characteristics
Economic Measure:
price
compensating surplus
Valuation Technique:
All
Count data models
Year of Data:
2003
2004
2005
Type of Study:
primary
secondary/benefits transfers
Search
Clear


EVRI - Search Module - Netscape
Edit View Go Bookmarks Tools Window Help
http://www.evri.ca/english/sermod.htm
Search
Searching Module
Environmental Valuation Reference Inventory
General Environmental Asset:
Air General:
global
local
Land General:
soil
surface mining reclamation
wetlands/constructed wetlands
Water General:
canals
drinking water
Infrastructure / Man-made:
buildings
cultural monuments
Animals:
birds
Plants:
heather
crops
Micro-organisms:
bacteria
fungi
Search
Clear



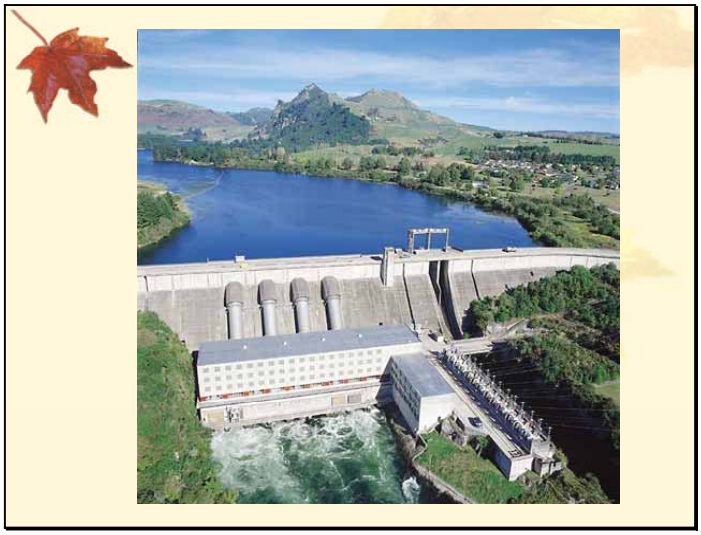



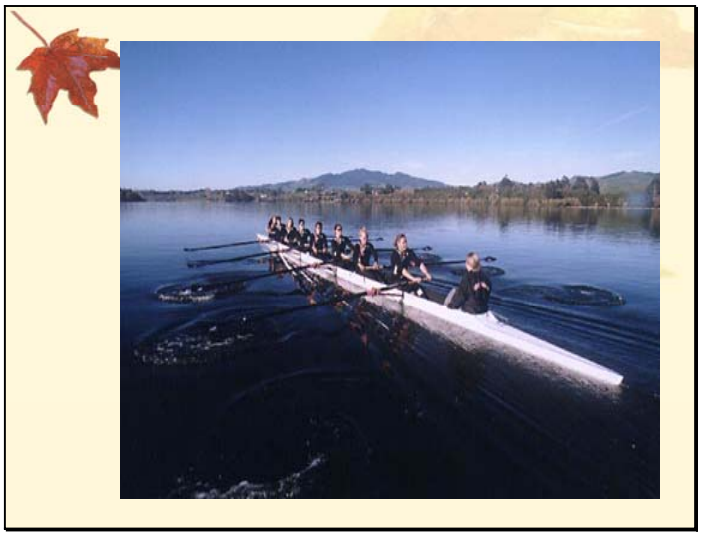

# Application

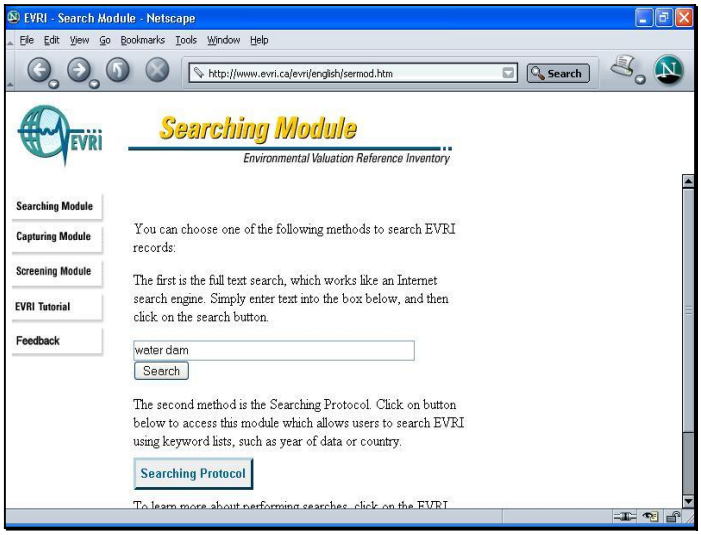
**Policy Question: Screening**

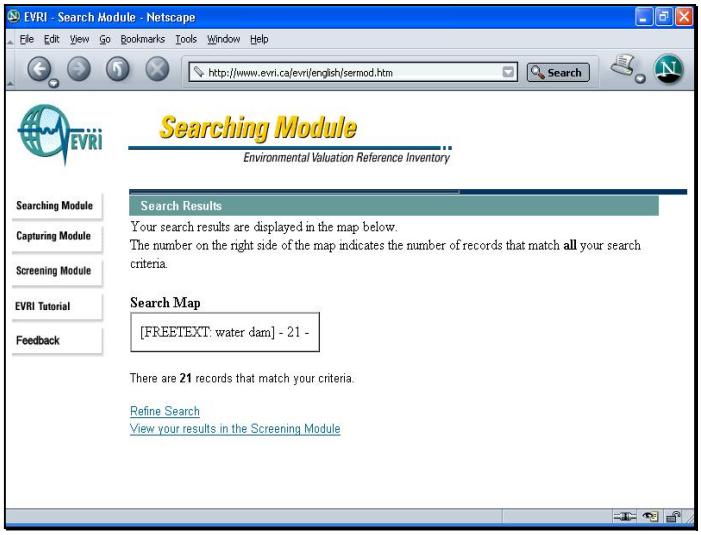
1) An official from an electricity utility wants to examine the impacts of hydro dams on a variety of water uses: recreation, ecological, tourism.

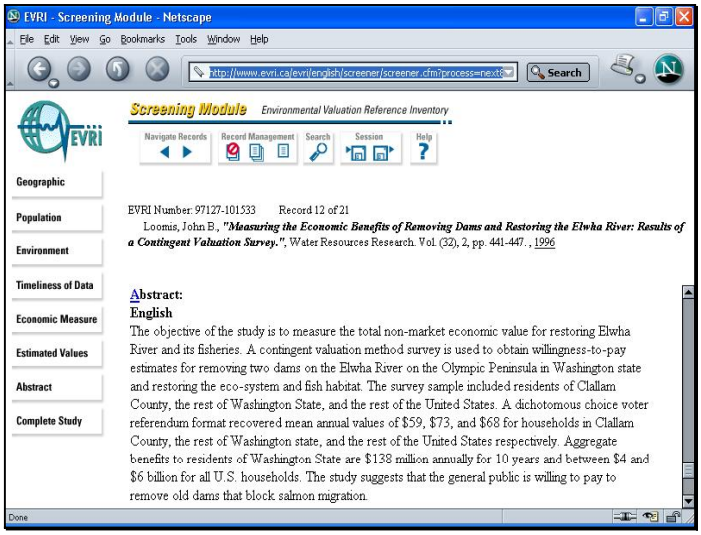
- Wants to develop long-term analytic capacity to weigh impacts for policy purposes.
- May want to commission studies or develop benefits transfer estimates in short-term
- Utility currently uses physical indicators for decision-making.

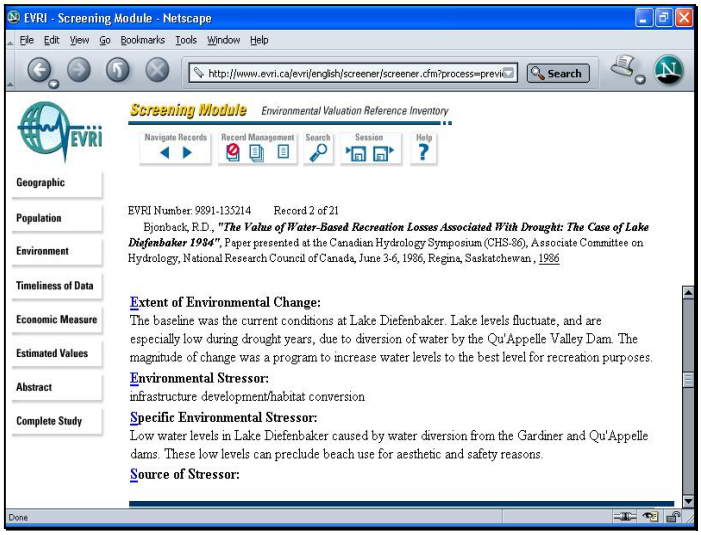





EVRI - Search Module - Netscape
File Edit View Go Bookmarks Tools Window Help
http://www.evri.ca/evri/english/sermod.htm
Search
EVRI
Searching Module
Environmental Valuation Reference Inventory
Searching Module
Capturing Module
Screening Module
EVRI Tutorial
Feedback
You can choose one of the following methods to search EVRI records:
The first is the full text search, which works like an Internet search engine. Simply enter text into the box below, and then click on the search button.
water dam
Search
The second method is the Searching Protocol. Click on button below to access this module which allows users to search EVRI using keyword lists, such as year of data or country.
Searching Protocol


EVRI - Search Module - Netscape
File Edit View Go Bookmarks Tools Window Help
http://www.evri.ca/evri/english/sermod.htm
Search
Searching Module
Environmental Valuation Reference Inventory
Searching Module
Capturing Module
Screening Module
EVRI Tutorial
Feedback
Search Results
Your search results are displayed in the map below.
The number on the right side of the map indicates the number of records that match all your search criteria.
Search Map
[FREETEXT: water dam] - 21 -
There are 21 records that match your criteria.
Refine Search
View your results in the Screening Module


EVRI - Screening Module - Netscape
File Edit View Go Bookmarks Tools Window Help
Search
Screening Module
Environmental Valuation Reference Inventory
Navigate Records
Record Management
Search
Session
Help
Geographic
Population
Environment
Timeliness of Data
Economic Measure
Estimated Values
Abstract
Complete Study
EVRI Number: 97127-101533 Record 12 of 21
Loomis, John B., "Measuring the Economic Benefits of Removing Dams and Restoring the Elwha River: Results of a Contingent Valuation Survey.", Water Resources Research. Vol. (32), 2, pp. 441-447. , 1996
Abstract:
English
The objective of the study is to measure the total non-market economic value for restoring Elwha River and its fisheries. A contingent valuation method survey is used to obtain willingness-to-pay estimates for removing two dams on the Elwha River on the Olympic Peninsula in Washington state and restoring the eco-system and fish habitat. The survey sample included residents of Clallam County, the rest of Washington State, and the rest of the United States. A dichotomous choice voter referendum format recovered mean annual values of $59, $73, and $68 for households in Clallam County, the rest of Washington state, and the rest of the United States respectively. Aggregate benefits to residents of Washington State are $138 million annually for 10 years and between $4 and $6 billion for all U.S. households. The study suggests that the general public is willing to pay to remove old dams that block salmon migration.
Done


EVRI - Screening Module - Netscape
File Edit View Go Bookmarks Tools Window Help
Search
Screening Module
Environmental Valuation Reference Inventory
Navigate Records
Record Management
Search
Session
Help
Geographic
Population
Environment
Timeliness of Data
Economic Measure
Estimated Values
Abstract
Complete Study
EVRI Number: 9891-135214 Record 2 of 21
Bjonback, R.D., "The Value of Water-Based Recreation Losses Associated With Drought: The Case of Lake Diefenbaker 1934", Paper presented at the Canadian Hydrology Symposium (CHS-86), Associate Committee on Hydrology, National Research Council of Canada, June 3-6, 1986, Regina, Saskatchewan , 1986
Extent of Environmental Change:
The baseline was the current conditions at Lake Diefenbaker. Lake levels fluctuate, and are especially low during drought years, due to diversion of water by the Qu'Appelle Valley Dam. The magnitude of change was a program to increase water levels to the best level for recreation purposes.
Environmental Stressor:
infrastructure development/habitat conversion
Specific Environmental Stressor:
Low water levels in Lake Diefenbaker caused by water diversion from the Gardiner and Qu'Appelle dams. These low levels can preclude beach use for aesthetic and safety reasons.
Source of Stressor:
Done

## Steps for Benefits Transfer

**1)** Define service(s)/asset(s) to be valued for policy

**2)** Iterative search for studies using multiple keywords with both search engines.

**3)** Screening module to match study sites to policy using criteria:

- Geographic
- Similarity of environmental focus
- Substition effects

**4)** Quality check using study methods category in EVRI record: techniques; age of study.

**5)** Provide rationale for selection and table of values

## Steps for Benefits Transfer (con't)

**6)** Adjust international values using Health Canada spreadsheet program.

**7)** Average if multiple studies or use point value if one study

**8)** Aggregate using selected methods

- **e.g.** visitor days; /tonne; /hectare
- spatial aggregation or "extent of market."

**9)** Apply selected discount rates and confidence intervals.

**10)** Aggregate "total economic value" if multiple services.

## Steps for Benefits Transfer (con't)

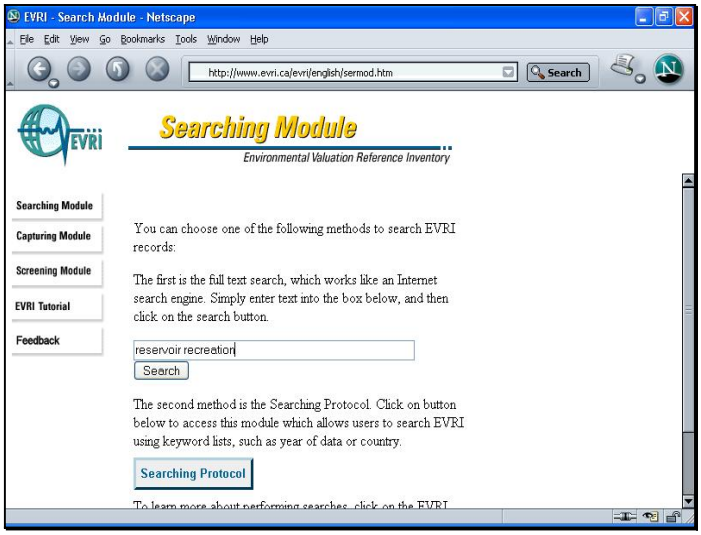
**Case Study**

- Environmental assessment triggered by dam and reservoir.
- Purpose of reservoir to create stable water supply : irrigation and municipal drinking water. However, environmental impacts.

# Steps for Benefits Transfer (con't)

**Environmental Services Identified**

1) Recreational use of reservoir**
2) Constructed wetlands (20 hectares)
3) Municipal water supply
4) Loss of downstream fisheries / flow
5) Loss of woodland habitat - endangered species.
6) Improved irrigation – crop production; hay feed




# Steps for Benefits Transfer (con't)

Results of Reservoir search:

- Keywords: reservoir, recreation, dam
- 4 studies located after analysis for similarity with policy site.

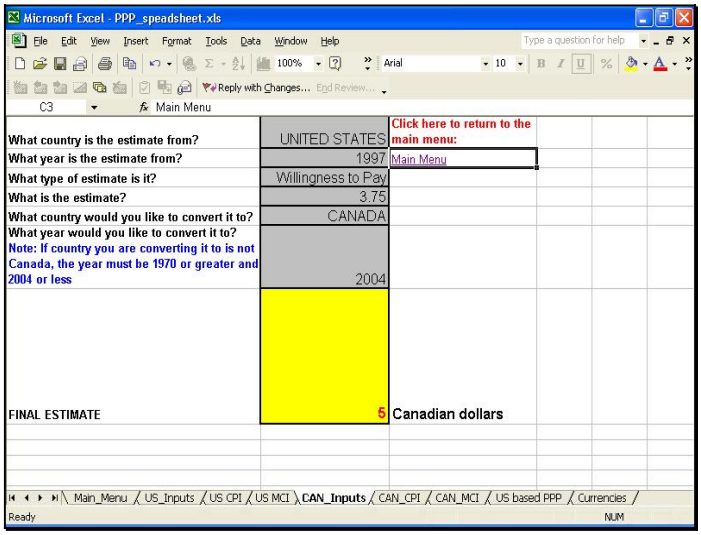
Rationale for accepting/rejecting studies

- See table

# Steps for Benefits Transfer (con't)

Table 1 -Analysis of Study Site Estimates

| Author | Year | Quality | Geography | Type of Recreation | Benefits / trip day | Reject/ Accept |
|---|---|---|---|---|---|---|
| Author a | 1984 | good | Size of reservoir, proximity, substitute | Boat, Hiking viewing | 5 U.S. | reject |
| Author b | 1999 | good | " | boating | 6 Cdn. | accept |
| Author c | 2001 | poor | " | boating | 4 Euros | reject |
| Author d | 2004 | moderate | " | swimming | 2 Br. Pounds | |




# Steps for Benefits Transfer (con't)

- Project managers estimated 30,000 user days per year in new reservoir.
- Annual benefits estimated by multiplying mean benefits per trip day by 30,000
- Used range of discount rates 4% to 6% to estimate benefits over 30-year time horizon
- Used similar methodology to estimate services of other uses, and then summed for "total economic value"

## Closing Remarks

- **As a valuation database, EVRI useful for a variety purposes:**
  - **benefits transfer**
  - **e-library or store of knowledge**
  - **policy screening**
- **Long-term commitment to populating and upgrading the database:**
  - **with support of "EVRI Club"**

# Question and Answer Session

## For *Session 1: Valuation Databases*

*This section presents a transcription of the Q&A session for the following presentation from Session 1:*
*Greg McComb, Environment Canada.* The Environmental Valuation Reference Inventory (EVRI) Valuation Database: History, Overview, and Applications.

*Responses to questions are coded as follows:*
*GM: Greg McComb, Environment Canada*
*BD: Bob Davies, Department of Environment, Food, and Rural Affairs, UK [session chair]*

BD: Greg, thank you very much indeed. That was a very thorough discussion and explanation of the EVRI manual. I've got a question to ask just to start us off. Is there some setting mechanism for studies within the [inaudible].
GM: They get very old.
BD: Maybe they're just going to have to die quite quickly because of advances.
GM: Not yet. That's something we may consider but I was referring to these very old studies. Some of them you might want to consider about transfer. Some of the older studies, though, depending what they are, even the methodologies that are used, you may have a problem [something about weight?]. Even though some of the CV methods may be outdated, the problem itself may be useful to look at. Maybe something to talk about; maybe some of the very old studies you may want to delete them.
BD: I thought just with you in terms of EVRI and then perhaps bringing the earlier presentation in later on.
Q: I'm Lewis Queirolo; I'm with NOAA fisheries. I just wanted to respond to the proposal that you called the older studies, and object to that or plead that you not do that, and leave it to the researcher to make the decision as to whether there is useful material contained in those older studies. Oftentimes historical material that's critical that you won't find elsewhere.
GM: I think that's where the emphasis is put on. We do quality check there quite a bit. The study emphasis is on the researcher who provided enough information, presented the quality study, the interim study; we leave it up to the analyst to make the decision on whether he wants to keep that [inaudible].
Q: Bill Mates, New Jersey Department of Environmental Protection US. In your talk your examples focus mostly on continued valuation and willingness to pay type studies. At my agency and my state, decision makers tend to be skeptical about that. They want to see things like replacement cost, damage cost, that sort of thing. I'm a non-user, obviously. Does EVRI include those types of studies as well?
GM: Yes, it certainly does. There's a way of getting at that information; click on the various fields. If you would like that information you can click on one of these fields. If you want to click on the study [inaudible; coughing] you click on that and it will pull all the CV studies. There's also replacement cost, hedonic value, travel cost. Actually it's fairly extensive. When the fathers of this database [inaudible] they made a point of making sure to include all the myriad valuation methods as well. And we have, too, I think. Choice experiment is something recently that is being used for adding a field variance and so forth.

Q: Christina McLaughlin, again. I'm very interested in the information structure in your site. You have a lot of -- here on your searching module you have key terms. Have you developed something like a thesaurus, or maybe a combination of existing thesauri that would more define broader terms to narrower terms, that would help people find -- let's say somebody's looking for a particular building, not necessarily -- or something more broad -- I'm thinking right now that some of the terms you have in your search model might not particularly apply to what somebody's looking for.

GM: As I said, the searching protocol has been tailored and previewed to the environmental economics literature, but there's the free text search there and you're free to plug in anything you want. It essentially just goes through the record. If you have "neighborhood" and you plug "neighborhood" in there, go for it. You'll get any record that has "neighborhood" in it.

Q: Do you have two different types of search engines?

GM: Yes, we do.

Q: So one is for the pretext and the other one is the one that uses the keywords.

GM: That's the pretext search here; it works like an Internet search engine. And this, you plug in anything you want in there and this is searching protocol, which could be a little more effective, but as you say you may have a specific example that you can't find here. You may want to narrow it down to certain years, say you want a certain study type, if you want to just get ultimate prices and so forth or hedonic price and so forth. You just want to click on those. You can narrow it down that way. If you have something that's a little bit different and you want to plug it in, there may be a new area of valuation research that's coming out; you might pick it up that way. We do periodically add. People, especially [inaudible] partners, there's no "canals" there and there's no header there. There's no other environmental amenity there that may be unique to their specific country. There's a fairly easy way just to add those keywords into there as you move along. If you have something you'd like to add that you may be interested in that might be in the database, you can add it to one of these fields if you like. Easily done.

Q: Klaus Moeltner, University of Nevada, Reno. I've never used EVRI so this is very eye-opening; thank you very much. I certainly will poke around as soon as I get a chance. I have a question regarding the econometric specifications of the underlying papers or sources. You mention that there is a module that shows a functional form, I would assume something like log or log-linear. Is there also a field that captures the econometric specification of the model in the most basic sense, a distribution of the error term or full distribution support, or only positive values allowed? That would be enormously helpful.

GM: As somebody who actually did his graduate in econometrics I would very much like to include a lot of that information. But we had a brief period where we took some input and we tried to start adding that to the database and actually put the coefficients in there and more information about the regression, but we found first of all it's too onerous on these graduate students to try to pull that stuff out. We also have extra tables, and it also just cluttered up the record as well. So when we started to include a lot of that information it just wasn't working. What we have right now is a field that essentially has the dependent variable and independent variables, and then it lists the specification and any other unique information, that is, multiple regressions in there and so forth. We used to have just one field in there that outlines that. I would suggest you just go back to the original article.

Q: How do you handle single sources with multiple models? That is oftentimes the case. People present different approaches.

GM: We try to put as much salient information as we can. If there's five models we'll maybe pull out the average case or the best example of the case and say there's three other models like this in the same thing. We try to explain this as clearly and simply, the information that's in there. We call it the art of summary in EVRI; some graduate students will actually put way too much information but some of them

will be able to very quickly get to the heart of what the model is and put that down fairly simply. Of course I would like to, but we tried it and it didn't work very well.

Q: I'm Greg Poe at Cornell University. I was thinking about looking forward, after you've done all these captures, Greg, you must have a sense of, if you were to do a study what you would like to be included as variables that, in the description, is like what Kerry asked earlier. What time of year was it done? If anything was done in the States I'd like to have the questions correspond to Census data-type questions I could transfer very easily. Is there a point in time now that you've been doing this now for x-number of years, that EVRI can make a recommendation, perhaps working with EPA or working with Doug Frey and a couple other things to say this is what we think every study that they're geared and hoping for benefits transfer in the future would include in their questions.

GM: I think that's a very good question and it's certainly been raised in the past. We've had that trouble. Sometimes we got studies and we're looking for the year of the data and it's just not there. Sometimes you're looking for really obvious things in journal articles and they're missing it, and it kind of irritates me because it's not very useful for benefits transfer then. It is a good standardizing mechanism -- I think by the process of osmosis in some respect this database has been around for six years now. I think half this group actually lifted their hands and said they're using it. So I think by the process of osmosis people using this database will see what the most important things to include are. But no, we haven't had any particular discussions about -- it might be useful, for example, for us who are writing contracts on valuation to make sure to include this. I know one of the most recent ones I've been doing on the side for the Environmental Protection Service in Environment Canada on wastewater, we actually just read through EVRI a number of times and said we want a [sounds like "deconis"] choice study and here's how you're going to do it and so forth. So we kind of wrung EVRI out and then we based the study out on PEI on that. This can set a standard of what are the important things you need in a study to begin studying transferable, in terms of the formal ways of doing this. No, we haven't done it. It's an idea we can bring up at an EVRI club meeting afterwards.

Q: [*Greg Poe*] That's why I suggest some standardizing just in the US, in Canada, in the UK. Here's x number of questions that would help someone transfer something in the future to Census data.

BD: An excellent point.

Q: Kerry Smith again. I just want to follow up on Greg's comment and then raise something else. I think that's just a really terrific idea. If there might be a process by which the club evaluates with Greg and others' help what information they've learned from doing this over the years would be very valuable to have. Set up a spreadsheet. Set up a web page where authors could enter this at the point at which they complete their studies but before they go through the peer review process, because a lot of that stuff would just be cut out. As Matt in the front there was saying, we just lose it. Editors don't think it's important. And if we could enter it when it's done, and then you could decide whether you're going to include it in the database later, it's there. There's a repository. A more general question, that is, at least in the United States, and I suspect this is true in the other club member countries, there are a series of environmental databases that are being developed. The one that comes to my mind is the National Survey of Recreation in the Environment. That's been repeated several times. And with Al McGartland's help and some folks in EPA, we're talking about setting up a platform where these data would be accessible to any researcher in our web. You can sign up and get access to the data. Again, an issue that the club might think about is the possibility of linking the information that you have on past studies with databases that might be available through the web. So this generalizes Greg's point on Census links to all the databases that are becoming publicly available, and asking what are the links that we might establish?

GM: I think it's something worth discussing. I was discussing it on the side with a few other people. I think the first step, you could simply just set up a page of links with all these studies on, but we had an

interesting discussion that it would be good to provide links. But I think there are certain benefits to keeping some divergence in the literature and letting it develop in terms of continuing that way; like Sweden may have a certain number of uses that they want from the database. And other countries and so forth. But I think linking and growing from running this, maybe then we can deal with that in the same discussion. Do you want to talk about that, Ben?

Q: I don't think I have too much to add to it. I think this issue of copyright, that may be one thing we'd like to do with. The idea of linking up the database to the actual studies. I think that would be really nice. I was speaking to an individual previously, that if you can actually get the data from the studies, that would be the ultimate, if we could do something like that. But again, with all the copyright issues and so on and conversations that would need to take place with the authors, that may not be feasible. But obviously it's a first best case scenario and I suppose if we can get to that, it's possible.

Q: [*Kerry Smith*] I wasn't clear. I actually meant the data. There are surveys that are available, the National Survey of Recreation in the Environment. I'm talking about actual survey responses, so that one could think about going beyond the meta-analysis, where you're essentially summarizing with statistical models complicated averages, basically, as a function of characteristics. Why not do that jointly with new data that's associated with pre-existing surveys that have comparable measures and are trying to measure the same parameters? You can do that. There's nothing that prevents you from doing that. You can also get more updated, following up on something that Matt and others said privately, you can get more updated information from a given geographic region that would allow you to take current use patterns and try them out with an existing past study of a comparable area, if you could link the data. There's lots and lots of dimensions that are possible if we thought about the design.

GM: It might be useful to have maybe a separate module that will [inaudible] this thinking and get some of the original data and whatnot. You're welcome to sit through the EVRI club at the end of the day and discuss that with some of the partners as well.

Q: I think there's a real opportunity here in linking up with maybe some of the journals, because I know for some journals, when you submit your abstract or your manuscript, some journals require you to provide your data set with that. If we could link up somehow with those specific journals and start to build that kind of database with the agreement of those journals, that may be another option.

GM: As I was saying, we'll certainly provide some links to these journals or to the web sites that are offering web pages. For copyright reasons we can't offer journal articles there, but we can offer links to their sites, for example.

BD: These are certainly terrific ideas for tomorrow afternoon's meeting.

Q: Add to the same discussion. Bruce Lippke, University of Washington. There are many LCA databases out there being established that are very good metrics on environmental performance measures. Not many of them have been taken to the final step of willingness to pay, but the reality is those databases are out there and there are some studies being done using those databases to get them into a benefits transfer mode. So you have both the luxury of linking to these kind of databases and then finding the studies that in fact bring them into your domain of benefits transfer. Seems to me that's a very fertile area, and those databases are available both in the US and in Europe.

Q: Matthew Wilson. I'm going to call out the elephant in the room. These are wonderful ideas, but having run a project which we'll see at three o'clock, we're talking funding, this is not going to be cheap. I run a couple graduate students -- time and money, you're all talking wonderful ideas but to sustain something like this and have the security over the Web, I recommend that the club think about sustainable funding, because we are in DC but the reality is to do this and to do it well. It's not going to be cheap.

GM: Actually, we're very lucky in the fact that we've had a couple of countries come together. There's [inaudible] from France and then the US EPA. Yes, it is expensive. For example, we had a contract for

$20,000 last year just to tune up the software. And then our university students took a full day to do them well. So it's very arduous and very time-consuming and it takes some funding, but we've been very lucky with the EVRI fund. We have a series of agreements with them and we hold workshops and so forth to develop the methods around it. It's a good question, but right now we're pretty lucky with the EVRI fund.
BD: It may be a timely moment to call things to a halt for the morning with a warning about funding. Of course, just on funding, the original research itself is enormously expensive. The [inaudible] aggregates taxation cost well over a million dollars. So it's making use of that information in a cost-effective way. I think we're out of time.

# 4. The International Context (Session 2)

## Section Contents

# "Benefit Transfer in France: Towards Better Recognition."

**Sébastien Terra**

***Department of Economics Studies and Environmental Assessment***
***Ministry of Ecology and Sustainable Development***
***France***

**Presented during Session 2.**

## Introduction

The relationship between France and Benefits Transfer (BT) has been so far an ambivalent one. There is, indeed, a growing need for environmental valuation and values in France. At the same time, not enough financial resources are devoted to this task because of the pressure on public finances. In theory, this should open the way for benefits transfer. In fact, so far there has been quite a widespread reluctance to use benefits transfer in environmental decision-making.

This paper will mainly deal with the use of EVRI and benefits transfer in France, focusing on its recognition as a valid tool for environmental valuation. More precisely, the following points will be discussed:

- First, the use of EVRI in France from the double perspective of users and studies;
- Second, the use of benefits transfer in France both from an academic point of view and from an applied one. I'll try to explain why BT is still relatively unused. I'll also point out the areas where BT is needed the most.
- Finally, I'll conclude by outlining our current activities and the prospects for the development of BT in France.

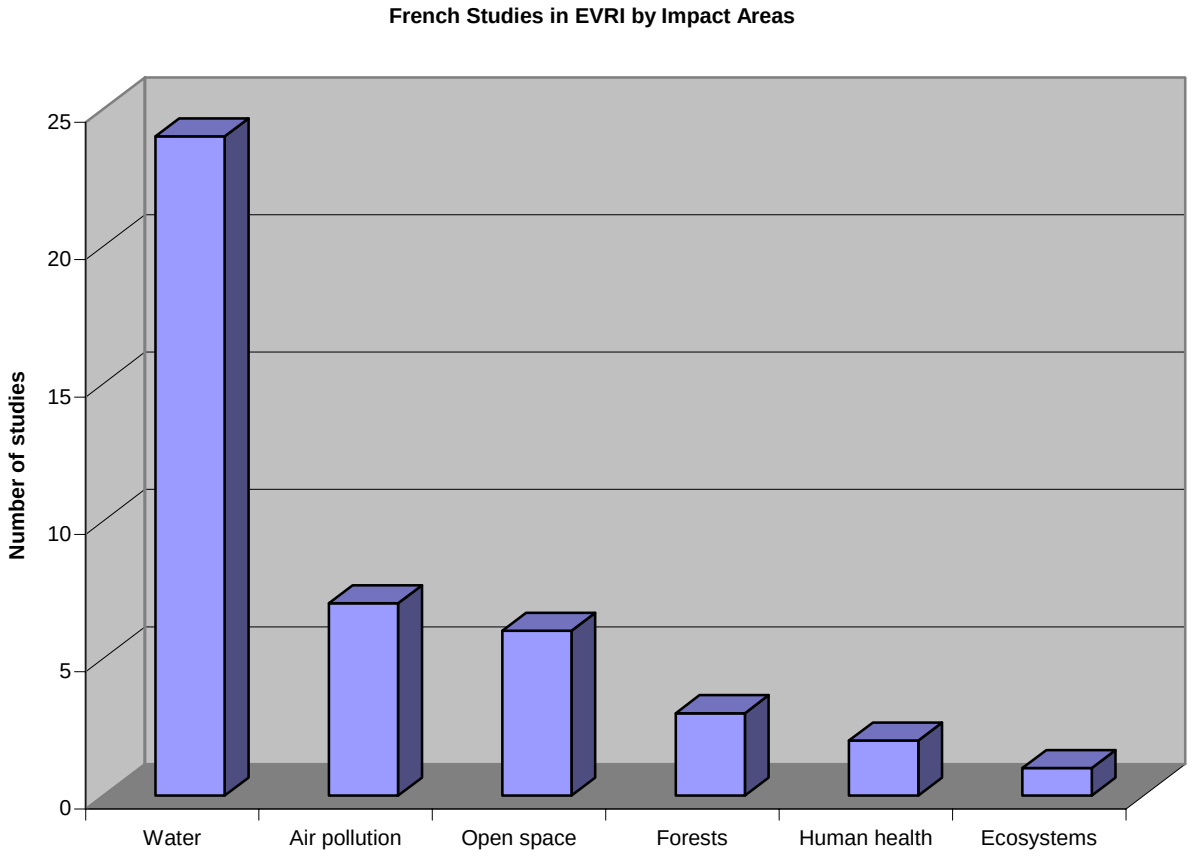
## 1. EVRI in France

France has been a member of the EVRI Club since October 2002. We were very proud to host the first meeting of the EVRI Club in May 2003. On that occasion, we also organized a Workshop on the Economic Valuation of Environmental Goods.

As of March 1, 2005, nearly 50 valuation studies concerning French environmental goods were in the EVRI database (less than five percent of the studies in the database). French subscribers of EVRI accounted for around 10 percent of total EVRI subscribers.

### 1.1. The French studies in the EVRI database

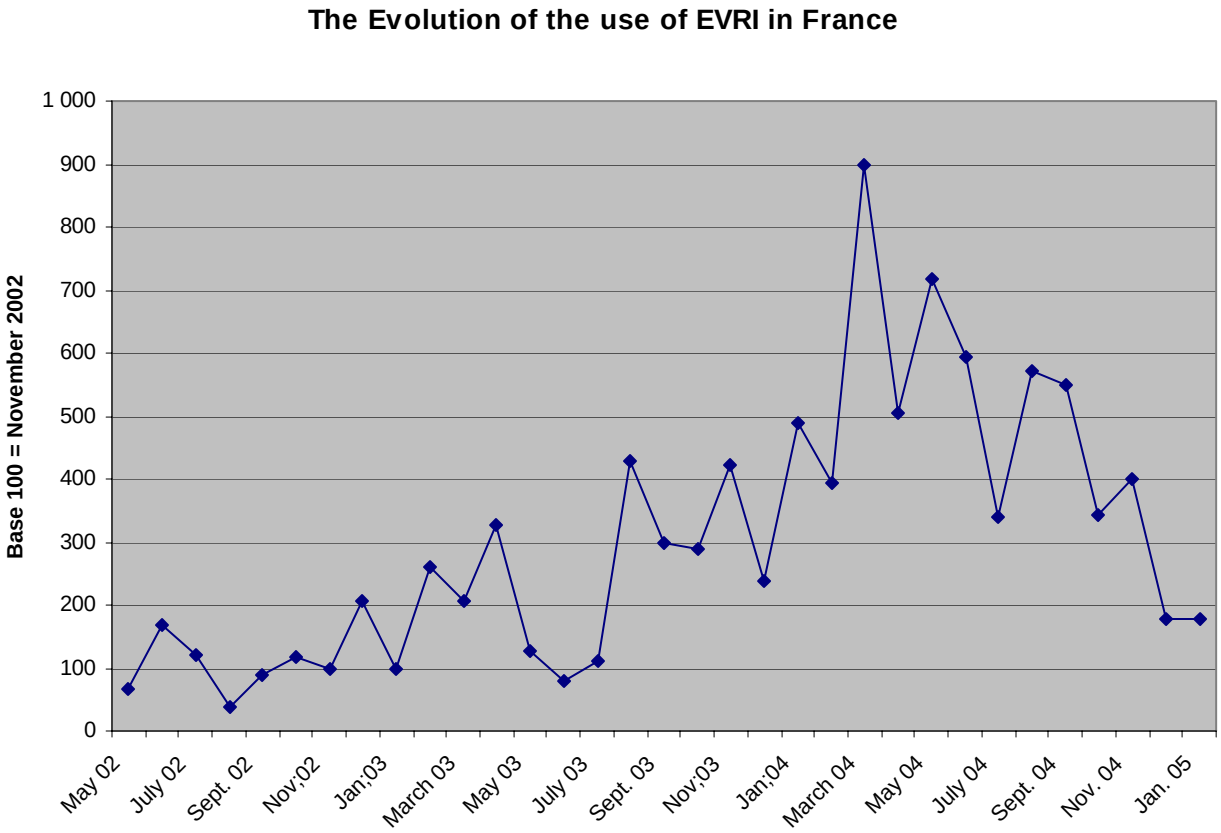
As can be seen on the following chart, the most commonly studied resource is water—with topics such as aquifer preservation and freshwater (lakes and rivers). Half a dozen studies seek to value air pollution or to study open spaces. A few studies look into the value of forests. For instance, the Ministry of Ecology and Sustainable Development carried out a study to estimate the loss of welfare implied by tempests in 1999.




## 1.2. The use of EVRI in France

Now let's describe briefly the French subscribers of EVRI. Around 30 percent of the subscribers are from the Government or from Governmental Agencies. Another 30 percent are researchers from the university and from research institutes, such as the National Institute for Agricultural Research. One subscriber in five belongs to environmental NGOs. Fifteen percent are from private firms, for instance, electricity utilities.

The following chart shows the evolution of the use of EVRI in France since May 2002. Until March 2004, there has been a steady increase in the number of visits by French users. However, since then, the visits by French users have plummeted, though I can find no particular or credible way of explaining this decline.




## 2. Benefits transfer in France

Let's turn to the practice of BT in France. I'll examine three points. First, I'll evoke the initial scepticism concerning BT, a scepticism fuelled by early academic studies. Then I'll explain why there is a growing awareness of the need for BT. Lastly, I'll present our current activities and the prospects for BT in France.

### 2.1. Academic studies

The first academic inquiry into BT in France was a study by Rozan, Stenger, and Willinger in 1998. They elicited the willingness to pay of inhabitants of 10 Alsatian cities for the preservation of the quality of the Alsatian aquifer, the largest aquifer in Europe. They also investigated the possibility of transfer between Alsatian users. The hypothesis of transferability is rejected in three out of four cases. The error rates are generally between 30 and 50 percent. The conclusion drawn by the authors is that extreme caution is required when transferring these values to other French aquifers.

More recently, Rozan (2004) used a CV study to value air quality in Strasbourg (France) and in the city just across the border in Germany (Kehl). She noticed that, on average, air quality was the same in the two cities. Moreover, the same good is valued in both cities. This so-called "intra-site" transfer is somewhat an ideal situation for Benefits Transfer. The main finding of her study is that the method of BT is generally not valid. For example, German respondents reported higher WTP than their French counterparts. The error rates are close to 30 percent. In her conclusion, she states that one should be

cautious about the use of BT. However, she adds than in some cases, BT may be appropriate for some policy analyses when error rates of 30 percent or more are acceptable.

### 2.2. Applied studies in France

So far, there have been relatively few applied BT studies in France. This stems from at least three factors. First, the results of academic studies led many economists and practitioners to have a pessimistic view of BT in applied studies.

Second, as I told you at the beginning of this presentation, the EVRI database contains few French studies (around 50). The lack of French studies means that one must rely on Anglo-Saxon ones to do BT. But many practitioners are really reluctant to do so. This originates in the firm belief that French and, for example, American people do not have the same valuation habits. In France, promoting environmental quality is mainly a prerogative of the state. People are not used to paying for environmental quality. For example, the entrance to French national parks is free of charge. The high proportion of protest votes or responses in CV studies epitomizes this. All these elements explain, at least in part, the suspicion towards the transfer of Anglo-Saxon values.

The third element is the limited diffusion of valuation methods (such as CVM, TCM, HPM) among stakeholders. In the best case, people are simply unaware of these methods. In a worst-case situation, people are quite hostile to the very valuation of environmental goods. The ethical concerns raised by the use of these methods are often put forward by opponents of valuation methods.

### 2.3. Where BT is needed

In at least two areas, BT is particularly needed. The first one is "water". The European Water Framework Directive (WFD) paves the way for Cost-Benefit Analysis in water. For "highly modified rivers", there is a need for a valuation of environmental amenities. For instance if there is a hydro dam on a river, the WFD requires a comparison between the costs of removing the dam and the environmental benefits this removal would bring. Therefore, too many studies are required to complete this daunting task. That is why BT is particularly recommended and useful. The high number of French valuation studies of water-related goods should make the use of BT easier.

The second domain is the valuation of biodiversity. The French National Strategy for Biodiversity explicitly recognizes EVRI as a useful and unique tool to achieve one of the goals of the Strategy, namely "acknowledging the true value of the living system" (Ministry of Ecology and Sustainable Development, 2004). Some people even put forward the possibility of estimating the total value of the French biodiversity through BT. In the case of biodiversity, BT may be useful in order to make it easier to promote markets for biodiversity.

## 3. Current activities and perspectives

### 3.1. Current activities

As for our current activities (at least in the Ministry of Ecology and Sustainable Development), I'll name just a few of them.

- First, we are drafting guides to standardize method and survey practices for primary studies. A common protocol for designing and implementing studies would enable us to make things similar in methodology and way of presenting the results. These guides are a permanent compromise between high-level research (good science) and operational capabilities. We try to find ways of presenting

things and methods that are at the same time as accurate as possible and easily tractable by practitioners. These guides are primarily intended to economists in Water Agencies. They aim at providing simple guidelines to make studies comparable and to make BT easier. They are also a welcome result of the 2003 Paris Workshop; indeed, Brigitte Desaigues, a French economist, pleaded then for such documents.

- The second domain in which we are currently working is the valuation of biodiversity. We are designing two studies to value the Natura 2000 program, which is a European conservation program. We'll study the possibility of transfer between two French ecoregions. This will allow us to explore the performances of the choice experiments method as regards BT.
- We are also planning to investigate the impacts of wind farms and to compare the results with those of a previous study carried out in 2001.
- Lastly, we are also funding research studies in BT, with an application to the valuation of forests.

### 3.2. Perspectives

To conclude, I'd like to sketch a few perspectives on the use of BT in France. First, we should foster the use of EVRI in France. To this end, we should find a way of promoting both primary valuation methods and BT as a valid method to obtain values. Second, as regards the applied work, the European WFD paves the way for a widespread use of BT in France. Last, in the medium to long run, we may investigate the relationship between BT and national accounting. Incorporating environmental values and valuation methods into national accounting would completely change the nature of primary studies. It would also bring proper recognition to valuation and BT methods. Whether it is possible or even desirable remains an open question.

## References

Ministry of Ecology and Sustainable Development. 2004. "French Strategy for Biodiversity: Stakes, Purposes, and Directions."
http://www.ecologie.gouv.fr/IMG/pdf/FRENCH_STRATEGY_FOR_BIODIVERSITY.pdf

Rozan, Anne. 2004. "Benefit Transfer: A Comparison of WTP for Air Quality between France and Germany." *Environmental and Resource Economics* 29(3): 295-306.

# "Envalue and Benefit Transfer in Australia."

**James White**

***Department of Environment and Conservation***
***New South Wales, Australia***

**Presented during Session 2.**

**Abstract**

Envalue is the principal database for environmental valuation studies (and hence benefit transfer) in Australia. Hosted by the New South Wales (NSW) Government, it contains over 400 studies, one third of which are Australian, covering nine different environmental media.

The aim of Envalue is to enhance decision-making by encouraging improved valuation of environmental resources, and improve the credibility of those valuations. However, Envalue has been affected by software problems and limited resources, and has remained substantially unmodified since 2001. Despite this, Envalue appears to be widely used in Australia due to the number of Australian studies it contains.

Benefit transfer in Australia varies in its level of sophistication, although simple transfer of mean values is probably the most common benefit transfer technique used. However, an increasing number of more sophisticated primary studies is being undertaken with an eye to their results being available for use in benefit transfer at later dates.

The NSW Department of Environment and Conservation (DEC) continues to use the data in Envalue but is increasingly relying on more recent Australian studies than those found in the database. The Department also searches the international literature to ensure that the most up-to-date valuations are available to it, and to locate studies relevant to specialised areas of DEC's regulatory function that are not covered by the Envalue database.

The Department of Environment and Conservation is currently considering options for the future of the Envalue database.

# Envalue and Benefit Transfer in Australia

## The beginnings of Envalue

The New South Wales Environment Protection Authority established Envalue out of concern that environmental considerations were being undervalued throughout private sector and government development decision-making and planning. The aims were to:

- enhance decision-making by encouraging improved valuation of environmental resources
- reduce the scarcity of environmental valuation estimates by providing access to Australian and overseas valuations of a wide range of environmental goods
- improve the credibility of environmental valuation by reporting estimates in a systematic way.

Envalue also assisted the then-EPA to meet two key requirements of NSW legislation:

- The *Subordinate Legislation Act 1989*, which required that all new regulations made in NSW first be subject to a cost benefit analysis, including analysis of intangible and non-quantifiable benefits; and
- The *Protection of the Environment Administration Act 1991*, which required the EPA to promote improved valuation and pricing of environmental resources.

## "Envalue One"

"Envalue One" began its life in 1995 as a set of four floppy disks containing a searchable MS Access database of valuation studies and a 140-page handbook that summarized the valuations and gave guidance on benefit transfer.

Envalue One contained around 250 studies. Environmental values covered included air, water and land quality; avoidance of noise and radiation exposure; and recreation and other values for natural areas.

Envalue was limited by a lack of user friendliness, by the need for potential users to go to the effort to obtain and install the disks and handbook – at a cost for many users – and by the fact that it could not be updated without sending out a replacement set of disks. The EPA also found, from a survey of users at the time, that more people were using the handbook than using the disks – including the Economics staff of the EPA!

## "Envalue Two" (Envalue as everyone now knows it)

In 1997 the then-EPA decided to proceed with "Envalue Two" as an on-line database. In doing so, this would immediately enable:

- improved accessibility
- addition of new categories of environmental amenities
- consistency of evaluation criteria across valuation methods
- addition of references to related studies
- updating of currency conversions
- the addition of new studies.

It was also intended to give the EPA – now DEC (the Department of Environment and Conservation (NSW)) - the ability to update the database as new studies became available, and potentially provide extra features in later versions of the system, such as maps and links to full-text papers and reports on the web.

In putting Envalue on line, the agency:

- engaged around a dozen academic and professional economists to review 280 additional studies for inclusion in the database (150 were eventually included)
- spent A$25,000 developing the web application and the supporting software
- ended up with over 400 studies, over 140 of which were Australian
- provided the world's first free on-line environmental valuation database.

Studies were identified for possible inclusion through literature scanning and requests to Australian universities. The initial selection of studies was refined through review by academic and professional economists, and the resulting selection fine-tuned by peer review.

**Features of Envalue**

There are presently over 400 studies on the database, from 11 different countries and regions as shown in Table 1.

**Table 1: Source countries/regions for Envalue studies**

| **Country/region** | **Percent of studies** |
|---|---|
| USA | 46 |
| Australia | 31 |
| United Kingdom | 9 |
| Scandinavia | 3 |
| Other Europe | 3 |
| New Zealand | 2 |
| Canada | 1 |
| Latin America | 1 |
| Asia/Pacific | 1 |
| Africa | 1 |
| Global/other | 2 |
| **Total all countries/regions** | **100** |

The environmental areas covered are shown in Table 2. Over 75% of studies relate to natural areas, air quality, water quality and land quality.

**Table 2: Topics of studies in Envalue database**

| Topic of valuation study | Percent of studies |
|---|---|
| Natural areas | 27 |
| Air quality | 24 |
| Water quality | 15 |
| Land quality | 11 |
| Noise | 8 |
| Urban amenity | 4 |
| Radiation | 1 |
| Non-urban amenity | 1 |
| Risk of fatality | 1 |
| Conceptual studies | 8 |
| **Total all topics** | **100** |

The methods used in the studies in the database are shown in Table 3. The most frequently used method in studies held in the database is contingent valuation. However, direct market or revealed preference methods make up around 60% of studies in the database, with stated preference methods accounting for nearer 40%.

**Table 3: Valuation methods used in Envalue**

| Valuation method | Percent of studies |
|---|---|
| Contingent valuation | 29 |
| Dose response | 25 |
| Hedonic pricing | 20 |
| Travel cost | 11 |
| Replacement/repair cost | 9 |
| Preventative expenditure | 2 |
| Conjoint/choice modelling | 1 |
| Other | 4 |
| **Total all methods** | **100** |

Searching in Envalue is carried out by a process of elimination. Users sort studies by country of study, author, environmental medium or valuation method, then further sort by sub-fields as needed.

The default first level sort is by the nine environmental media shown in Table 2. These can be further sorted by sub-media. Envalue then lists the final selection of studies, which users assess visually.

An example of Envalue's study records is shown in Attachment One. It is a US hedonic pricing study. Envalue provides the valuation from the study in the original currency and also in year 2002 Australian dollars. The conversion is carried out using purchasing power parity in the original year, then updated using Australian CPI. The figure can also be shown as the equivalent in eight other currencies.

The record also contains an annotated bibliography that gives detail of the study including technique, location, socioeconomic characteristics, key results and commentary. The final component of the record is the reviewer's assessment of the study against pre-determined evaluation criteria.

## Benefit Transfer in Australia

Benefit transfer is a virtual necessity in Australia because of a relatively low number of primary studies in a country with high levels of growth and development. Transfer of study results from other countries is frequently problematic because of significant differences in the environmental and socio-economic context of Australia compared to the countries that are the greatest sources of environmental valuation studies.

### *Use of Envalue for benefit transfer*

Despite the limitations described above, DEC's available information is that Envalue remains widely used by government economists, consultant economists and academics in Australia.

The key reason stated for this is that it contains a large number of studies that were conducted in Australia, hence avoiding the need to attempt, or attempt to justify, benefit transfer of northern hemisphere studies into Australian conditions. A likely second reason is that access to Envalue is free of charge.

However, this does not necessarily indicate that study results from Envalue are frequently used to provide environmental value estimates for Australian benefit-cost analyses. Envalue is also used to scope literature and to provide bibliographical information.

### *Benefit transfer techniques in use*

Environmental costs or benefits can be estimated by transferring:

- mean benefit estimates
- adjusted mean benefit estimates
- demand functions

Simple transfer of mean values is probably the most common benefit transfer technique in use in Australia, although there is an increasing number of more sophisticated primary studies being undertaken with the intention that results will be available for benefit transfer in later studies.

### *Use of benefit transfer by DEC*

In assessing regulatory or policy proposals, DEC also relies on benefit transfer since like most agencies, it does not have the resources to carry out or commission primary research into environmental valuations in every instance.

DEC uses Envalue to obtain initial information on environmental benefits for proposals and policy analysis. As Envalue's study collection and results display does not lend itself greatly to adjusted transfer or demand function transfer, DEC also:

- periodically commissions primary studies designed specifically to enable benefit transfer
- searches international literature for studies into sometimes very specific areas of policy for which DEC is responsible. (For example, Envalue does not contain valuations associated with pesticide

use or misuse, but DEC requires these in order to assess the costs and benefits of its pesticide regulatory programs.)

**Where to for Envalue?**

DEC is currently reviewing options for the future of Envalue, including the feasibility of options such as:

- maintaining the status quo
- allocating additional resources to Envalue to improve functionality
- adopting an alternative system of delivering environmental valuation results.

The future approach with respect to Envalue and on-line delivery of environmental valuation study results will depend on the outcome of the review, which is expected to be complete in 2005.

# ATTACHMENT ONE: EXAMPLE OF ENVALUE STUDY RECORD

**Study Detail**

**Leggett & Bockstael (2000).**

| Country | USA | Location | Anne Arundel County, Chesapeake Bay, Maryland |
|---|---|---|---|

| **Measured** |
|---|
| Effect on house prices of changes in the faecal coliform concentration |
| **Units** |
| $US |
| **Method** |
| Hedonic Price Method |

| **Key Results** | | | | | |
|---|---|---|---|---|---|
| **Values** | | | | | |
| | **Currency** | **Year** | **Value** | **Australian$ 2002** | **Other Currency** |
| Effect on property prices, change of 100 faecal coliform counts per 100 mL | US$ | 1997 | 5,114.00 | A$7,731.13 | (choose) |
| Click (choose) in a row above to display a Key Value in another currency | | | | | |
| **Dose Response Relationships** | | | | | |
| | | | | | |
| **Hedonic Price Relationships** | | | | | |
| | | | | | |
| **Transfer ?** | | | | | |
| **Click here if you are you considering transferring these estimates to another site** | | | | | |

**Annotated Bibliography**

STUDY (FULL REFERENCE)
Leggett, C.G. and Bockstael, N.E. (2000). Evidence of the Effects of Water Quality on Residential Land Prices. Journal of Environmental Economics and Management, 39: 121-144.

TECHNIQUE
Hedonic Price Method

FOCUS AND LOCATION
Effect on house prices of changes in nearby faecal coliform concentrations in Chesapeake Bay, Maryland

SITE & SOCIOECONOMIC CHARACTERISTICS
Mean house price $378,540 ($US1997), mean value of structures $125,290, mean lot size 0.68 acres, mean distance to Baltimore 26.8 miles, mean distance to Annapolis 12.27 miles, median faecal coliform concentration 107.66 (counts/100 mL) (state regulations require closure of beaches if concentrations exceed 200 counts/100 mL).

KEY RESULTS
A change of 100 faecal coliform counts per 100 mL is estimated to produce about a 1.5% change in property prices.

(US$ 1997)
Effect on property prices, change of 100 faecal coliform counts per 100 mL: 5114 - 9824
(across eight model specifications)

COMMENTS/SUMMARY
The authors estimate a single stage OLS hedonic model to demonstrate the effect of changes in water quality on property prices.

A range of alternative model specifications were trialled, with the better models achieving explanatory power of greater than R2=0.70. Some specification problems were identified (eg heteroscedasticity and autocorrelation. However, the correction of these problems did not have substantial effects on value estimates.

The models were relatively detailed, however the specific attributes of houses were not modelled. Rather, a variable that represented the value of the structure was used in the regression equations.

One of the primary objectives of the paper was to demonstrate the relevance of "emitter effects" i.e. the presence of emission sources not just emission levels. The model estimates reported above were obtained by including a range of variables aimed at representing "emitter effects". When omitting these variables and re-estimating the hedonic equations, the estimated coefficient on faecal coliform was larger in absolute value and the level of significance greater. Hence studies that omit "emitter effects" are likely to overstate the final value estimate.

**Evaluation Criteria**

Benefit transfer

Potential for benefit transfer given the good specification of the environmental attribute and provision of some sociodemographic data

Evaluation

HEDONIC PRICE METHOD (HPM)

WAS THE ENVIRONMENTAL GOOD CAREFULLY MEASURED?
Yes, based on counts at 104 sites

WAS PRIMARY DATA USED TO MEASURE ECONOMIC IMPACT?
Yes, data supplied by the Maryland Office of Planning.

WERE RESULTS AFFECTED BY HOUSEHOLD INCOME?
N/A

WERE RESULTS CORRELATED WITH OTHER FACTORS?
Yes, value of the structure, lot size, distance to major centres, distance to significant point sources of pollution, density, area of wetlands and open water

WERE SOCIOECONOMIC DIFFERENCES ACCOUNTED FOR?
Yes

OTHER ECONOMIC/ECONOMETRIC PROBLEMS

SURVEY SIZE
1183

OTHER
Agricultural workers, dual jobholders, employers and self-employed workers were excluded from the sample.

28 June, 2001

# "Benefit Transfer: An Asian Perspective"

**David Glover**

***Director***
***Economy and Environment Program for Southeast Asia (EEPSA)***
***International Development Research Center***
***Canada***

**Presented during Session 2.**

## Benefit Transfer: An Asian Perspective

I manage a program that supports research and training of researchers in environmental economics in Southeast Asia. We are both users of and contributors to benefit transfer: Many of our projects make use of benefit transfer. Others carry out primary research and the values they come up with are all entered into the EVRI database.

Today and going to talk about our experience in using and contributing to benefit transfer. I'll illustrate this with a description of a couple of our research projects - one that's completed and one that's in the planning stages.

The most visible project our organization has done was a study of the damages that resulted from Indonesia's forest fires and haze in 1997. Some of you may remember that at that time El Nino produced a drought in Asia that caused a large number of man-made forest fires to get of control. This produced two kinds of environmental damage - damages directly caused by the fires; damage caused by the smoke that covered large parts of Indonesia, Singapore and Malaysia.

The first outbreak of fires was in late 1997 ... then we had a short rainy season ... after which we expected widespread fires to resume. So during that brief rainy season we had about six weeks in which to assess the damages from the first outbreak. We wanted to do that for a couple of reasons:

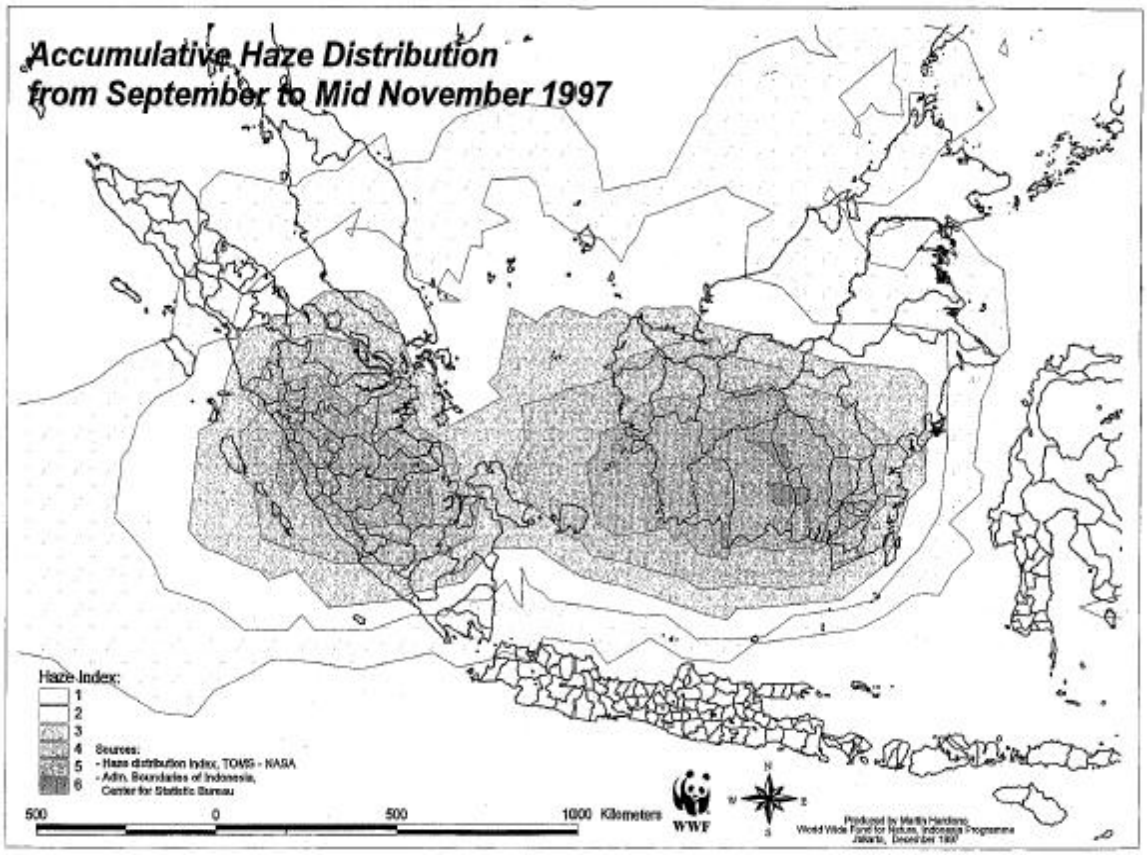
First, there was really no solid information about what was being damaged, what the relative magnitude of the different kinds of damage were, which countries were most affected, and so on.

For example, as we started the study, we found out that about 70 million people had been affected by the smoke and 5 million hectares of land had been burned. But we had no way to compare the relative importance of those damages without a common unit of measurement. Monetary valuation would give us that.

Secondly, we wanted to draw attention to the problem by putting it in terms that might have more impact policymakers. If we could express these damages in monetary terms perhaps that would add something to the anecdotal information in the newspapers.

The starting point for the work was two maps constructed from aerial photographs. One was a map of the distribution of smoke haze. The second was a map of the area burned, broken down by vegetation type.

This is the first map:




Concentric circles show increasing intensity of pollution towards the center. We collected information on the incidence of smoke-related illnesses in some of these zones to estimate a dose-response function. Then we collected information on typical costs of treatment. We overlaid this map on a population map to find out how many people lived in each zone. From that, we could estimate total medical costs, work days lost and so on. (I've brushed over the methodology pretty quickly because it didn't involve any benefit transfer - it was original research although it was pretty quick and dirty.)

This is the second map:

FIGURE 5.1
Map of Fire Burn Scars in Sumatra, Derived from the August–December 1997 SPOT Quicklook Mosiac (© 1998 IEEE)

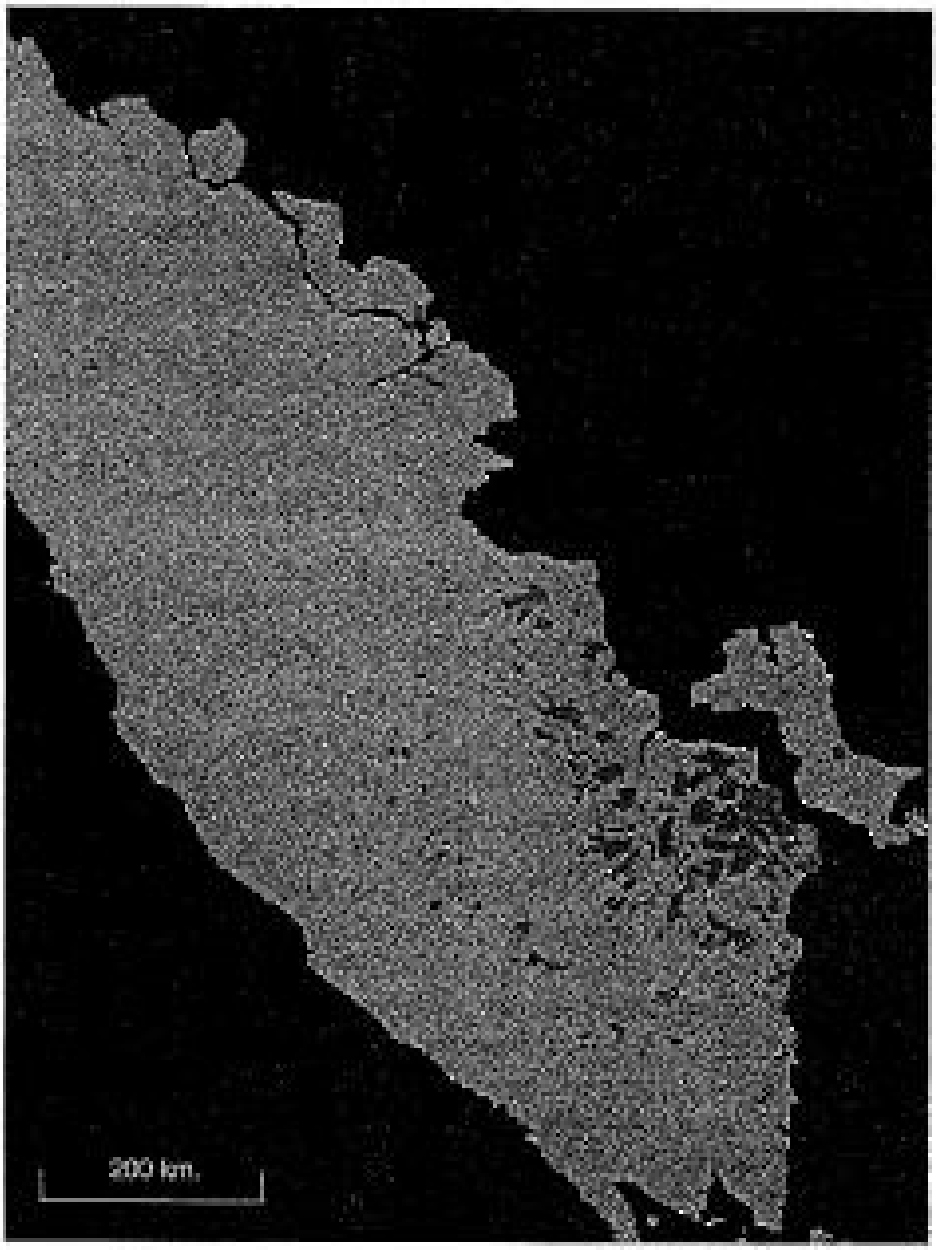
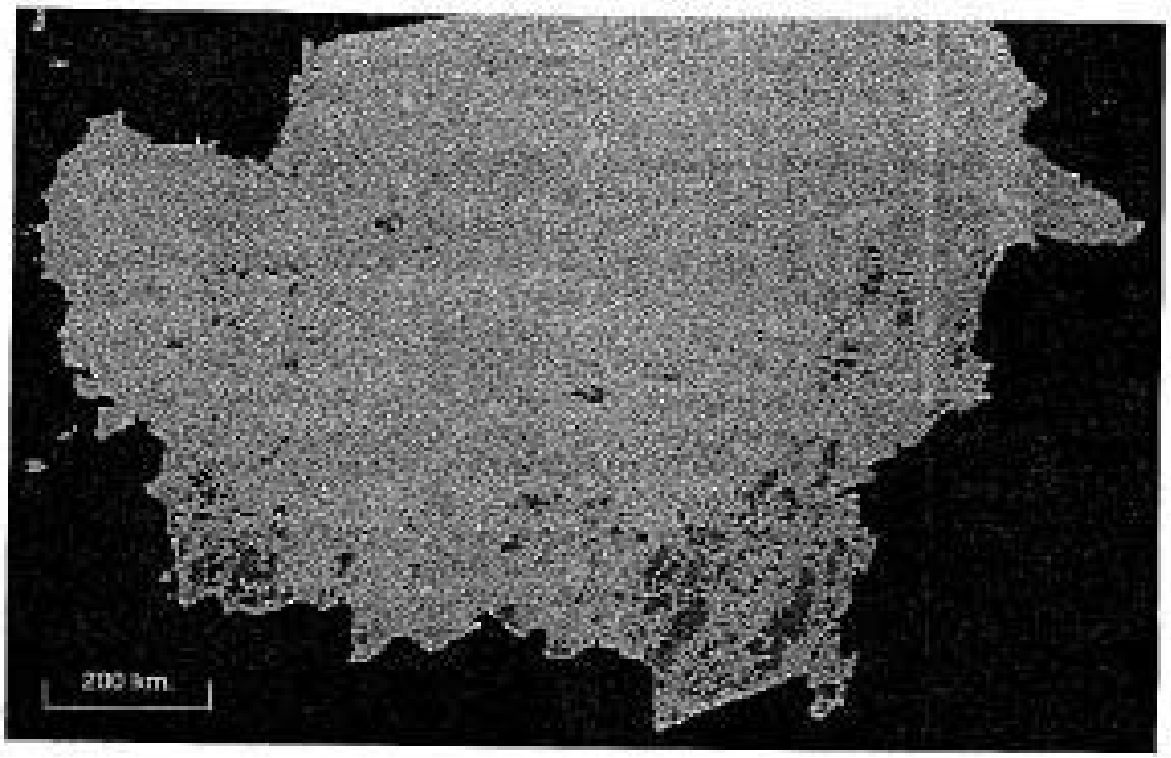


FIGURE 5.2
Map of Fire Burn Scars in Kalimantan, Derived from the August–December 1997 SPOT Quicklook Mosaic (© 1998 IEEE)




It shows the areas burned, divided into three vegetation types. This is where we did use benefit transfer. We knew the total area burned for each vegetation type; we used market values of land for the commercially productive land and transferred values from another study for the primary forest. The values for forest included a wide range of ecosystem services. These are the results. I'll show the haze results briefly, more to satisfy your curiosity than anything else, because they don't tell us anything about benefit transfer.

| **Fire and Haze-related Damages from the 1997 Indonesian Forest Fires (in USD millions)** | | | |
|---|---|---|---|
| **Type of Loss** | **Lost to Indonesia** | **Lost to Other Countries** | **Total** |
| **Fire-related Damages** | | | |
| Timber | 493.7 | - | 493.7 |
| Agriculture | 470.4 | - | 470.4 |
| Direct Forest Benefits | 705.0 | - | 705.0 |
| Indirect Forest Benefits | 1077.1 | - | 1077.1 |
| Capturable Biodiversity | 30.0 | - | 30.0 |
| Fire Fighting Costs | 11.7 | 13.4 | 25.1 |
| Carbon Release | - | 272.1 | 272.1 |
| ***Total Fire*** | ***2787.9*** | ***285.5*** | ***3073.4*** |
| **Haze-related Damages (summary)** | | | |
| Short Term Health | 924.0 | 16.8 | 940.8 |
| Tourism | 70.4 | 185.8 | 256.2 |
| Other | 17.6 | 181.5 | 199.1 |
| ***Total Haze*** | ***1012.0*** | ***384.1*** | ***1396.1*** |
| **Fire and Haze-related Damages** | | | |
| ***Total Fire and Haze*** | ***3799.9 (85%)*** | ***669.6 (15%)*** | ***4469.5*** |

The fire damage estimates are bit more interesting. The ecosystem service values for forests are extremely high - much higher than the timber values. Of course, environmentalists loved us when we pointed this out in press releases. But frankly, I don't have a lot of confidence in these numbers. The per hectare values we used came from the infamous study by Costanza et al about a decade ago on the total value of nature. We didn't have a lot of time to look for good original studies for the total economic value of different ecosystems - this one had just come out and it seemed to have all the numbers we needed in one place so that's what we used. When the Costanza study and the supporting references for it had been out for a while and were subject to critique, these numbers started to look a bit shaky.

This was not an easy study to do. The phenomenon we were examining was huge and the nature of it made it very difficult to collect information - you couldn't go into the areas that were on fire because it was too dangerous and often you couldn't see the ground from the air because of the thick smoke. And we have had only a few weeks and a small budget to do it. But we did manage to get it done before the end of the rainy season and in time for a meeting of the Asian environment ministers. And it seemed to have some impact on what they said they were going to do – if not on what actually did.

We could not have done the study without benefit transfer. I think we could have done better if it had access to a high-quality database like EVRI. So I guess my conclusion is that EVRI is a useful service because it makes it easier for people to this kind of high profile study and do it well.

The study was not a typical project for EEPSEA - it dealt with a much bigger problem and was done at a regional level. Most of our projects are by individual researchers based in universities looking at local problems. They have used benefit transfer fairly often, particularly when looking at the health damages from pollution. In some cases, they transfer dose-response functions; in others, they might transfer final

values and adjust for differences in income level.

The most difficult part is always the question of how to treat mortality. Putting a value on human life is always controversial. Using a human capital approach - looking at foregone earnings - isn't conceptually correct, but there are some numbers available for various developed countries. There are also some numbers on the value of a statistical life, which is conceptually preferable. These numbers are usually derived from wage differential for risky occupations. But when people have tried to transfer these numbers - for example, to the Philippines - they found big differences between the human capital and VSL numbers. They weren't convinced that either was a reasonable estimate for the Philippines.

The value of a statistical life in particular seems to me to be difficult to transfer. I can't articulate a sophisticated scientific reason for this, but it seems to me that people in countries with very different cultures and very different income levels may have quite different tolerances for risk. A very poor person in Asia who's living one day that time is probably much more willing to tolerate risk than the average North American. If we did original studies in Asia on the value of a statistical life - from wage differentials, for example - I suspect we would get lower values than we do from benefit transfer.

Another set of problems we've encountered is broader than the problem of transferring values from one country to another. It's a set of problems we run into when extrapolating from the respondents we survey in an original study to the broader populations they're drawn from. We run into this particularly in trying to value biodiversity conservation.

Most studies that attempt to value biodiversity use stated preference methods to do so. And most of the stated preference studies nowadays used sound methods - they carefully and objectively inform the respondent about the species or ecosystem in question, explain its contributions, the degree of uncertainty about it, the measures necessary to conserve it, and so on. The trouble is that once respondents have had this briefing, they are no longer typical of the general population. The general population is usually very uninformed - many people may not have heard of that species.

Other well-known problems with stated preference surveys include the following:

a) discrepancies between hypothetical and real willingness to pay. (People often say they're willing to pay something during a survey, but don't come through when actually given a chance to.)

b) differences between willingness to pay, with and without time to think. Often people will state a relatively high willingness to pay if asked to give an immediate response ... but will report a lower WTP if you go back to them a day or two later and ask the question again.

c) differences in willingness to pay, depending on whether you ask a household member for his or her individual opinion on behalf of the household ... or allow household members to consult and present a consensus response.

d) All of the stated preference studies we've done in Southeast Asia show that respondents are very sensitive to the choice of payment vehicle. In particular, they're extremely mistrustful of taxes or fees collected by the government. They know that a high percentage of people evade taxes, and that tax revenues are often used for illegitimate purposes.

The payment vehicle people trust most is voluntary contributions through well-known NGOs. But there's a well-known problem in using voluntary contributions as a payment vehicle – respondents fear that others will free ride. They want to know how much other people will pay and be assured that everyone will pay their share. So most researchers now prefer to use a referendum format where you ask people whether they would vote in favour of a measure that would require everyone to pay X amount. But that's not compatible with voluntary contributions.

We've faced all these methodological problems in trying to carry out stated preference studies about conservation in Southeast Asia. So we are going to launch a set of studies that will explicitly explore these issues and see if we can find ways around them. Were going to look at the local willingness to pay for five different species in three countries, and do some split samples to see how much difference these things make. So we'll use two or three different payment vehicles, give some respondents time to think and time to consult, try to devise some experiments that will give people a chance to contribute real money, and so on. We'll also include somebody detailed de-briefing questions to find out how important these factors were to the respondents. Perhaps we'll see some differences across countries.

Ideally, what we would like to get out of these studies, and others going on around the world, is the ability to calibrate - to adjust not only for things like income when we do benefit transfer, but for other factors as well - time to think, and so on.

Our study by itself won't be big enough to do that. But we hope it will at least put the results we get into perspective. Maybe we can establish some ranges or confidence intervals for the values we come up with. That in turn would make the values we come up with in Southeast Asia a bit more useful to other countries for benefit transfer purposes.

It would be nice if we could do so, because there is a lot of potential for benefit transfer from developing countries to develop countries, for one practical reason: the cost of primary research in developing countries is a fraction of what it is in Europe or North America. I've been told that a contingent valuation study with a large sample in North America can cost half a million dollars and that most researchers have pretty much given up on in-person interviews. In Asia, we can do in-person interviews with good sample sizes for USD 30,000. Survey respondents don't expect to be paid, and labour costs are a fraction of what they are in developed countries. Researchers' familiarity with these methods has also improved a lot. Perhaps valuation is another industry that's right for outsourcing?

In any case, it is a field in which Asia has lots to contribute and I hope you'll see more Asian research appearing all the time in EVRI.

# Discussant Comments on Presentations from Session 2

**Marc-Antoine Kleinpeter**

***Ministry of Ecology and Sustainable Development***
***France***

I'll comment on these three stimulating presentations from my French point of view. (I should perhaps apologize for my accent.)

As Sébastien said, in the French Ministry of Ecology there is a strong demand for BT, because in France we have gotten off to a slow start in developing valuation studies. In fact, these studies are not very popular. However, the need is increasing, and France may be an example of what we call "avant-garde" for further EVRI developments. I think continental European countries such as Germany, Spain, and Italy are also going to change their views about valuation studies.

But nowadays, there is still strong reserve, mainly for cultural reasons. Across the board, people accept strong links between monetary valuation and property or even purchasing. However, when a good isn't on the market, people question the valuation process. Barriers between public and private are heavily entrenched in mentality. For example, I used to work in finance, and even though Paris was an important place for many market instruments (such as derivatives), I noticed a lot of people in central bank or regulatory institutions were still unhappy when a new instrument was released. In Anglo-Saxon countries ("common law" countries), the extension of markets is considered more of a "natural process".

Other juridical or political reasons could be put forward—for example, the importance of ecological parties in France and Germany. For many French ecologists, valuation of an environmental good may reduce its "specific" (idiosyncratic) qualities.

I don't want to insist about reserve about valuation, but in contrary, point to reasons to hope for developments of valuation studies, BT, and databases like EVRI. First, France is perhaps becoming only a "region" in European Union (!). And more seriously, there is a strong tradition in France of using statistical and accounting techniques, and thus there is great confidence about cost-benefit analysis. We are very concerned by the bridge between local and global problems. And thus, we think that each valuation study will help to extend BT, and that cross-country studies that merge or concatenate data should be encouraged.

I'll conclude with the accounting perspective (in my youth, I also worked in national accounting). With environment, we know there is a "conflict" between two forms of valuation: costs of avoiding damages, and costs of compensating damages. The ways of getting knowledge on these costs differs, in a deep epistemic sense. A common response is to invocate the general microeconomic equilibrium, with efficient markets, perfect expectations, and so on. However, we are not very confident about this argument. Thus, we are very attentive when valuation studies refer to different kind of market failures: transaction costs, asymmetries of information, strategic behaviors, etc. These approaches are perhaps the best way to develop and improve valuation in France.

# Question and Answer Session

## For *Session 2: The International Context*

*This section presents a transcription of the Q&A session for the following presentations from Session 2:*

*Sébastien Terra, Ministry of Ecology and Sustainable Development, France.* Benefit Transfer in France: Towards Better Recognition.

*James White, New South Wales Department of Environment and Conservation, Australia.* Envalue and Benefit Transfer in Australia.

*David Glover, Economic and Environmental Programs for Southeast Asia, Singapore.* Benefit Transfer: An Asian Perspective.

*Responses to questions are coded as follows:*

*ST: Sébastien Terra, Ministry of Ecology and Sustainable Development, France*
*JW: James White, New South Wales Department of Environment and Conservation, Australia*
*DG: David Glover, Economic and Environmental Programs for Southeast Asia, Singapore*

Q: My name is Greg Poe, Cornell University. I have a question for Jim as well as for Greg McComb, earlier. One of the things that seems to be missing, or maybe I just missed it, is when you're developing these databases you have these students go look at everything, and you assess the papers and you get all the data together. At that point it would seem to me once you've accomplished all that, is you might want to go back to the individual researchers. For example, as a provider of valuation studies, I'm the one who might know where there might be some data that might be missing, for example, on population that was surveyed, or ages that had some missing values that they might not be able to discern from the select articles they've looked at. And so it seemed to me that I think most of us would be very willing if our work is going to be used to make sure it's accurate. And so it would seem to be a nice check. I don't think it's going back and asking -- a lot of early discussion was asking for a lot of additional data collection, but I think that would just be a nice check for the researchers themselves.

JW: That sounds like a useful addition to me. I can't say honestly why that hasn't already happened, other than that there could still be a degree of self-selection in it. There's no reason why a researcher finding their study [sounds like "upon"] invaluable perhaps EVRI can't then contact one of the agencies and say, hey, have you considered this aspect? Or I think you should add such and such a component into the record that's on the database. But accepting that there isn't self-selection, then it does sound like a useful aspect, provided the time and resources and so forth are there to actually do it. I think it would be the part of the EVRI people to do it, given that they're jumping upwards at the rate of 300 studies a year.

GM: [inaudible; off mic]

Q: [*Kerry Smith*] I want to change the topic just a little bit. We were stimulated by the discussion of the first two speakers and by Marc's comments at the end. We have a platform problem here. That is, each of these databases is a platform with two sides. There are those generating the results and there are those using the results. So in principle there are four prices. This is something where the French have made huge contributions, and I'm thinking of Turow and Rochet and others' work when they talk about the economics of networks. The question I'm wondering about, and this is probably for the club to think

about, is that there's a pricing structure problem here. This goes back to Coase's old paper on externalities and how we think about, and Jim's comments are what made me think about this, that basically we need to think about the appropriate incentives for the authors to contribute, and for the users to pay, or vice-versa. We've got entry fees and we've got use charges. It might be worth looking at that literature on the economics of networks and so forth, and it's just a wonderful paper by Turow and Rochet summarizing a lot of it, and it would be worth thinking about how the next step, particularly as Jim was suggesting, is this going to go away? And it not only relates to just that but it relates to building new databases and so forth, and having new studies enter. I think that it would really be worth perhaps engaging one of them and talking to you about this.

LL: I think those are really good ideas. My view is, it's the kind of stuff that we should be discussing as part of our EVRI club meeting tomorrow, for example. What are some of the things to explore? We've always recognized that there is economies of scale here, and clearly if you look at the history of EVRI, the Americans made a decision fairly early on not to develop their own tool and instead to try and piggyback with us. But don't underestimate the administration cost; transaction costs are very high. You're talking somebody who's been pushing fairly hard for four or five years to keep the club going, and it is difficult to get each of the countries to commit to steady funding and so on and so forth. And so there are a number of issues. But when it comes to studies, I think we should be thinking in terms of what can we do improve? We kicked around some ideas earlier on, for example, in terms of how could we let researchers input their own studies? And there's a willingness out there among the club members, but there are other caveats. What about quality and what do you do to maintain the quality so that you don't get phony studies or just really bad quality studies in? It's a discussion we're still having and we should continue to do that. But I certainly think that it's a good idea. We need to be thinking in terms of what sort of improvements do we make to this partnership that we have? And I don't know if that answers the question. I think not right now, but at least to signal to you and to the people here that there is a willingness to explore this set of issues, to see how we can move forward.

Q: My name is Andy Stocking, and I was struck by Kerry's comments because in thinking about, in listening to these conversations, there's a model that's been increasingly used on the Internet for decentralizing the control of databases or of networks and going with the distributed work model. And there's a number of examples. One is if you've ever used Craig's List, they have no paid customer support but all their members kind of volunteer to do customer support. A more relevant example is an Internet site called Project Gutenberg, where they're taking millions of pages of pre-copyrighted material. They've scanned it and put it on the Internet, and anybody is allowed to go in and check to make sure the words are active. When they scan it there's a lot of old letters that we don't use today. So I wonder if, with these databases, if there's an opportunity to take the control out of the central agency and distribute it to all of the researchers. It might involve looking at the databases slightly different. Instead of researchers using the database as a way to just extract information, maybe it's a storage receptacle for researchers to go in and put in data that they've used. And then the correlate of that is, when researchers find a paper they like that somebody else has put into the database, they can make comments on that and about how that data was useful for them. In that way, I've heard this described as instead of going from a prisoner's dilemma game to an insurance game. So it's just an idea.

JW: Perhaps we should go further and make it compulsory to launch your papers in database.

Q: John Braden, University of Illinois. Much of the casual conversation as I listen to these presentations from various countries relates to stated preference methods. That is, contingent valuation and so forth. In part because those methods are easily transportable, I think. You're not depending on pre-existing data; you're manufacturing the data, and so you can bring to that technology that crosses boundaries. My question is, are there systematic problems on the revealed preference data side between

countries that reduce our ability to transport using revealed preference data? For example, property transactions data here in the United States, much of it is publicly available. You may have to go jump through some hoops to get it, but you can get it generally. Is that true in other countries? So do we have the same kind of technology available across countries on the revealed preference side that we do on the stated preference side?

JW: I can answer the specific comment in relation to New South Wales, that it's relatively straightforward to get the properly priced data. But it could also be the case that the nature of the property market is quite different, because Australia has something that's known as the two-city effect, where, because most of the really good jobs are in Sydney and Melbourne, the two largest cities there attract a premium regardless. So that doesn't apply to the other cities, so that they become more expensive than their comparable overseas cities. And the property taxation system in all of the Australian states is also set up as a barrier to an owner of property. The data is there, but just off the top of my head I'm not sure if those things would necessarily be obstacles to a hedonic pricing study and the transfer of it. But there might be things that needed to be considered; like you might not be looking at apples with apples. There are issues in terms of capital gains tax, initial purchase duty, vendor sales duty, things which in my home country of New Zealand, those things simply don't exist. There aren't barriers.

ST: As for commerce studies with the hedonic price method, we are in quite a lot of difficulties in obtaining information of set of prices and characteristics of houses. But we may manage to do this in some particular cases. I think that if I'm not mistaken, using values from hedonic price method in benefit transfer is quite difficult for the requirements in the estimation of the [sounds like "demon"] function in the [premise?] studies is quite heavy. So there are relatively few hedonic price method studies that estimate a second stage equation or regression. So that makes it harder to use in benefit transfer, I think.

Q: I'm Randy Kramer, Duke University, and I have a question for David Glover. First of all, I want to commend your organization for promoting this expansion of benefit estimation work and benefit transfer work in Southeast Asia. I think there's far too little work done in the developing world using these approaches. My question for you is, what is driving the research agenda? Is it the research community that's a part of your consortium? Or is there a growing demand in government agencies and other user groups, or is it the donors and development agencies that are active in this part of the world that are promoting expansion of this work?

DG: I think it's a combination. Donors have been quite active in promoting environmental economics in the region, some countries more than others. And in some countries it's caught on to a greater extent than others, but there's affirmative interest in most of the countries now, a familiarity at least with some of the concepts. And in some countries in the Philippines there's economic instruments in place, although perhaps not enforced well. A lot of interest does come from the researchers, though, and we respond to that in our program by having researchers pretty much set the research agenda. They choose the proposals, the topics they're going to work on. And we encourage them to consult their governments about whether this is useful research or not, but we don't insist that governments endorse the proposals or the research itself. I think the research community has an important role in pointing out problems that policy makers haven't thought of yet, haven't recognized as problems.

# 5. State of the Science (Session 3)

## Section Contents

# "A Novel Approach to Temporal Stability Testing of Contingent Valuation Models."

**Roy Brouwer**

***Institute for Environmental Studies (IVM), Vrije Universiteit***
***De Boelelaan 1087, 1081 HV Amsterdam, The Netherlands.***
***roy.brouwer@ivm.vu.nl.***

## Session 3

***Although Roy Brouwer was unable to attend the workshop, his presentation is included in the proceedings.***

## 1. Introduction

This paper addresses the reliability of contingent valuation (CV) estimates of willingness to pay (WTP) for non-market goods through time. Although the NOAA Panel (Arrow *et al*., 1993) raises some concern about the temporal stability of CV estimates, to date test-retest studies have only considered relatively short periods, ranging from two weeks (Kealy *et al*., 1988 and 1990) to two years (Carson *et al*., 1997). These have supported the replicability of findings and stability of values across such modest periods (McConnell et al., 1998).

The present paper examines the temporal stability of incentive compatible dichotomous choice (DC) CV models across a five year period, i.e. a period more than twice as long as the longest considered previously. The issue of temporal stability over extended periods is one of more than academic interest. Benefit-Cost Analyses (BCA) frequently employ values estimated some considerable time prior to those analyses. Temporal stability is therefore implicitly assumed rather than explicitly tested. Yet there is no reason to suppose that values for non-market goods should remain constant over extended periods.

This study addresses the issue of temporal stability through the application of two matching surveys, concerning the same case study area (the Norfolk Broads in the UK), focusing on the same environmental good and valuation scenarios (flood protection and conservation of freshwater wetland habitat and associated recreational amenities), using the same payment vehicle (coercive taxation), the same sampling frame (random in-person interviews) applied to the same sample population (visitors to the area), but sampling at different points in time, namely in the summers of 1991 and 1996. The study's main objective is to test the transferability of resultant models of WTP and the stability of their determinants across this more extended time period. More details are found in Brouwer and Bateman (2005).

## 2. Analytical methods for WTP estimation and testing model transfer

Temporal reliability of DC CV models is tested by examining the statistical equality of unadjusted average WTP values (hypothesis 1) and the DC WTP functions (hypothesis 2). Comprehensive statistical testing procedures were originally proposed by Bergland *et al.,* (1995). Turning to consider tests of model transferability, a novel iterative approach is developed in order to see how much control is needed to produce transferable models of WTP. These models are generated by progressively blending theoretically expected determinants of WTP with additional ad-hoc variables, which may be more transitory in their effect. This approach involves a gradual expansion in the number of explanatory variables added to a model of WTP. At each addition of a variable temporal transferability is assessed by applying the model to both the 1991 and 1996 data and undertaking various tests. This progressive expansion approach allows the identification of the optimal level of control for transferability. This approach is compared to that obtained by estimating a statistical best fit model for a given dataset (see the Annex) and transferring this to the other survey period and vice-versa.

For each model transferability is assessed both forward in time (from 1991 to 1996) and back (from 1996 to 1991) using the Wald test for coefficient stability as per Brouwer and Spaninks (1999). A further test of the transferability of each specification is obtained by pooling the data and assessing transferability through application of the Likelihood Ratio (LR) test as per Downing and Ozuna (1996) and Carson *et al*. (1997). For this latter test data from the two surveys are pooled and a dummy variable included to represent the year in which the study was undertaken. If study year has a significant impact on respondent WTP, this implies that the study results are not transferable. The pooled regression results are the same as the outcomes of the LR test.

**3. Results**

Mean WTP values based on parametric and non-parametric estimation approaches are presented in Table 1. In order to be able to compare the 1991 and 1996 WTP values, the 1996 values are corrected for intervening differences in purchasing power. The standard errors in the Turnbull models are estimated using non-parametric bootstrapping.

| | **Parametric Linear-Logistic** | | **Non-parametric Turnbull** | |
|---|---|---|---|---|
| | **1991** | **1996** | **1991** | **1996** |
| **Mean WTP (£)** | 248.1 | 215.8 | 54.2 | 37.8 |
| **Standard error** | 23.3 | 29.3 | 2.9 | 2.4 |
| **95% CI {1996 – 1991}** | {-34.3 ; -30.3} | | {-16.6 ; -16.2} | |
| **Min-max values** | -∞ - +∞ | -∞ - +∞ | 0-200 | 0-200 |
| ***N*** | 1747 | 1108 | 1747 | 1108 |

**Table 1: Mean real WTP values from the 1991 and 1996 surveys (£ p.a. in 1991 prices) obtained from the parametric logistic model and (lower bound) non-parametric Turnbull model**

The results from the linear-logistic and Turnbull models suggest that visitor valuation of the recreational and amenity benefits provided by the Broads has decreased across the period between the two surveys. In constant prices, mean WTP calculated from the linear-logistic model is 13 percent lower in 1996 than in 1991, and 30 percent in the case of the Turnbull model. The observed difference in income levels between the 1991 and 1996 visitors is one possible explanation for this decrease.

Although the Turnbull model is known to provide a lower bound for mean WTP, the large difference between the Turnbull and linear-logistic model is striking. The parametric estimates are about five times higher than the non-parametric estimates. No big differences exist in terms of the accuracy of the estimates. In relative terms the standard errors of the linear-logistic estimates are only slightly higher than the standard errors of the Turnbull estimates. The differences in mean WTP are statistically significant as can be seen from the 95 percent confidence interval (CI) constructed around their difference based on the standardised normal variable ($z$). The estimated differences indicate that the real value of the recreational amenities in the Broads have decreased by 3 to 6 percent per annum over the study period. This significant decrease in real WTP is in contrast to the non-significant changes noted over shorter periods and may well be a consequence of the longer interval under consideration in this study.

| Transfer | Test | Model specification | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ***Bid*** | ***Bid*** Income | ***Bid*** Income Distance | ***Bid*** Income Local | ***Bid*** Income Distance Scenery | ***Bid*** Income Local Scenery | **Best fit 1991** | **Best fit 1996** |
| Transfer of the estimated 1991 models to 1996 | Wald | 0.93 | 3.71 | 9.70 | 3.51 | 13.20 | 5.88 | 20.50 | 15.03 |
| | $\chi^2_{critical}$ | 5.99 | 7.81 | 9.45 | 9.49 | 11.07 | 11.07 | 14.07 | 12.59 |
| | LR | 0.58 | 2.19 | 6.19 | 2.07 | 7.97 | 3.23 | 11.49 | 10.40 |
| | $\chi^2_{critical}$ | 5.99 | 7.81 | 9.45 | 9.49 | 11.07 | 11.07 | 14.07 | 12.59 |
| | | | | | | | | | |
| Transfer of the estimated 1996 models to 1991 | Wald | 1.64 | 5.31 | 15.98 | 4.98 | 19.92 | 7.45 | 26.35 | 30.61 |
| | $\chi^2_{critical}$ | 5.99 | 7.81 | 9.45 | 9.49 | 11.07 | 11.07 | 14.07 | 12.59 |
| | LR | 0.58 | 2.19 | 6.19 | 2.07 | 7.97 | 3.23 | 11.49 | 10.40 |
| | $\chi^2_{critical}$ | 5.99 | 7.81 | 9.45 | 9.49 | 11.07 | 11.07 | 14.07 | 12.59 |

*Note: Critical values at 5%.*

= *null hypothesis of model equality cannot be rejected (model is transferable)*

**Table 2: Transfer test results from the DC CV models**

Results from our various analyses of model transferability are shown in Table 2. From Table 2 it can be observed that, using the LR test, all models appear transferable. However, adopting the Wald test (which is more stringent) yields a more mixed result, but one from which a clear pattern emerges. Focusing upon these latter tests, both models relying solely upon variables suggested by economic theory (models using the *Bid* variable alone or those supplementing this with the household *Income* variable) are transferable. However, when such models are extended through the addition of more ad-hoc variables, not derived from theory, transferability becomes sporadic. Here, those models using the binary *Local* variable (identifying those respondents who live near to the study site) do transfer, whereas those substituting in the continuous *Distance* variable (the number of miles travelled to reach the site) fail Wald tests of transferability, questioning the usefulness of more sophisticated distance-decay relationships in models of WTP for transfer purposes. Statistical best-fit models (see the Annex) also fail Wald transferability tests. This reflects the differing determinants, which enter each of these models.

## 4. Discussion and conclusions

This study investigated the temporal stability of WTP responses from two large scale CV surveys. The study differs from previous analyses because of the large time span between the two surveys, being more than twice the length of previously considered test-retest periods. While previous studies considering shorter periods have shown no significant difference in real WTP values, the analysis presented here reveals a significant difference across this longer period. However, tests of model transferability indicate that simple models, based solely upon variables derived from economic theory, are transferable across this period. This suggests that underlying relationships for such key determinants are stable even across this longer period. However, expanding models by including theoretically unanticipated factors brings ad-hoc and possibly transitory factors into the models, which consequently prove non-transferable.

Using commonly used testing procedures in the benefits transfer literature, it can be shown that also DC models extended with these ad-hoc factors are transferable, even though the residual variance in these statistically best fit models is significantly different in the two survey years. Contrary to previous findings, this seems to suggest that the unobserved determinants of preference embedded in the stochastic components of utility over time is not stable in this study. The 1996 model explains less of the variability in the dependent variable than the estimated 1991 model. Hence, important determinants of WTP, which have stayed unobserved, may have been overlooked. Additional explanation is given in Brouwer and Bateman (2005).

In conclusion, this study suggests that over extended periods real WTP for public goods such as the flood protection and wetland conservation scheme considered here, can change by statistically significant amounts. However, the analysis suggests that underlying economic-theoretic determinants of WTP remain stable over such periods. Nevertheless, ad-hoc changes in determinants other than those predicted by theory can result in non-transferability of extended (and statistically best-fit) models. This suggests that transfer exercises might usefully focus upon models with firm theoretical underpinnings rather than incorporating more transitory factors.

**References**

Arrow, K., Solow, R., Portney, P.R., Leamer, E.E., Radner, R. and Schuman, H. (1993). Report of the NOAA Panel on Contingent Valuation. *Federal Register*, January 15, 58(10): 4601-4614.

Bergland, O., Magnussen, K. and Navrud, S. (1995). Benefit transfer: testing for accuracy and reliability. *Discussion Paper, #D-03/1995*, Department of Economics and Social Sciences, Agricultural University of Norway.

Brouwer, R. and Spaninks, F.A. (1999). The validity of environmental benefits transfer: further empirical testing. *Environmental and Resource Economics*, 14(1): 95-117.

Brouwer, R. and Bateman, I.J. (2005). Temporal stability and transferability of models of willingness to pay for flood control and wetland conservation. Water Resources Research. In press.

Carson, R.T., Hanemann, W.M., Kopp, R.J., Krosnick, J.A., Mitchell, R.C., Presser, S., Ruud, P.A. and Smith, V.K. with Conaway, M. and Martin, K. (1997). Temporal reliability of estimates from contingent valuation. *Land Economics* 73(2): 151-163.

Downing, M. and Ozuna, T. (1996). Testing the reliability of the benefit function transfer approach. *Journal of Environmental Economics and Management* 30: 316-322.

Kealy, M.J., Dovidio, J.F. and Rockel, M.L. (1988). Accuracy in valuation is a matter of degree. *Land Economics* 64: 158-171.

Kealy, M.J., Montgomery, M. and Dovidio, J.F. (1990). Reliability and predictive validity of contingent values: does the nature of the good matter? *Journal of Environmental Economics and Management*, 19: 244-263.

McConnell, K.E., Strand, I.E. and Valdes, S. (1998). Testing temporal reliability and carry-over effect: the role of correlated responses in test-retest reliability studies. *Environmental and Resource Economics*, 12: 357-374.

**Annex: Best fit multivariate linear-logit models for the 1991 and 1996 surveys**

| Explanatory factors | Value range[1] | 1991<br>Prob ($y_i$ = yes) | Value range[1] | 1996<br>Prob ($y_i$ = yes) |
|---|---|---|---|---|
| Constant | | 0.506<br>(0.400) | | 0.768 *<br>(0.407) |
| *Bid* (the DC bid level presented to respondents) | 1-500 | -0.009 ***<br>(0.0005) | 1-412 [2] | -0.008 ***<br>(0.0008) |
| Income<br>(Annual household income, £) | 2500-62500 | 0.249 * $10^{-4}$ ***<br>(0.564 * $10^{-5}$) | 2060-51500 [2] | 0.193 * $10^{-4}$ **<br>(0.833 * $10^{-5}$) |
| *Size* (number of persons in the household) | 1-9 | -0.143 **<br>(0.056) | 1-12 | -<br>- |
| *Distance* (number of miles travelled to reach the site) | 0-580 | -0.002 ***<br>(0.0007) | 0-650 | 0.002 *<br>(0.001) |
| *Visits*<br>(Number of previous visits p.a.) | 0-305 | 0.009 **<br>(0.004) | 0-356 | -<br>- |
| *Scenic* (appreciation of scenery) | 1-4 | 0.513 ***<br>(0.112) | 1-4 | 0.386 ***<br>(0.108) |
| *Holidaymaker* (respondent was on holiday when interviewed) | 0-1 | -<br>- | 0-1 | -0.757 ***<br>(0.269) |
| Log Likelihood | | -705.9 | | -426.5 |
| Likelihood Ratio Test ($\chi^2$) | | 533.3 ($p<0.01$) | | 145.9 ($p<0.01$) |
| Pseudo R-square (%) | | 32.0 | | 15.7 |
| Predictive power (%) | | 80.8 | | 81.9 |
| N | | 1665 | | 1015 |

[1] Minimum and maximum values.
[2] Corrected for inflation.
* Significant at 0.10
** Significant at 0.05
*** Significant at 0.01
Notes: Standard errors between brackets. The number of observations is lower than in Table 1 because of missing values for some of the explanatory factors.

# "Accounting for Ecosystem Service Values in a Spatially Explicit Format: Value Transfer and Geographic Information Systems."

**Matthew A. Wilson[1*] and Austin Troy[2]**

***University of Vermont***
***USA***

*[1] School of Business Administration and the Gund Institute for Ecological Economics; (802) 656-0511; Wilson@bsad.uvm.edu*
*[2] Rubenstein School of the Environment and Natural Resources*
** Presenting author*

**Presented during Session 3.**

**Keywords:** Ecosystem Services; Value Transfer; Geographic Information Systems.

## Introduction

The goods and services provided by natural ecosystems contribute to human welfare, both directly and indirectly, and therefore represent a significant, yet often uncounted, portion of the total economic value of the landscapes we live in (Wilson *et al* 2004a). While there are many ways that humans can value landscapes - economic, spiritual, and cultural - the ability to estimate the *economic* value of the ecosystem goods and services provided by them is increasingly recognized as a necessary condition for integrated environmental decision-making, sustainable business practice and land-use planning at multiple geographic scales and socio-political levels of analysis - global, national, regional and local (Bingham *et al* 1995; Millennium Assessment 2003; NRC 2005).

Ecosystem services, by definition, are the benefits people obtain either directly or indirectly from ecological systems (Daily 1997; Wilson & Carpenter 1999). They include products such as food, fuel and fiber; regulating services such as climate stabilization and flood control; and nonmaterial assets such as aesthetic views or recreational opportunities. Ecosystem goods and services occur at multiple spatial scales, from climate regulation and carbon sequestration at the global scale, to flood protection, water supply, soil formation, nutrient cycling, waste treatment and pollination at the local and regional scales (de Groot *et al* 2002; Ricketts *et al* 2004). They also span a range of degree of connection to human welfare, with those like carbon sequestration being less directly connected, while food, raw materials, and recreational opportunities are more directly connected (Farber *et al* 2002; Wilson & Carpenter 1999). Because of this connection to human welfare, environmental managers are increasingly being challenged to assess the economic values associated with ecosystem goods and services.

In this paper, we present a conceptual framework for the application of spatially explicit value transfer to assess ecosystem goods and services provided by different landscape types across multiple spatial scales. First, we briefly elucidate a formal system for classifying and valuing ecosystem goods and services associated with natural and semi-natural landscapes. Second we describe a methodology developed for conducting value transfer in a spatial context using economic data, ecological principles and Geographic Information Systems (GIS) technology. Third, we demonstrate the method by showing preliminary results from the EcoValue Project©, a web-based decision support system based at the University of Vermont that uses spatially explicit value-transfer methods. We conclude with observations on the future of spatially explicit ecosystem value transfer and its potential role in the science and management of landscapes.

## Valuing Ecosystem Services

After extensive international peer review, the concept of ecosystem services has recently been adopted by the United Nations' sponsored Millennium Ecosystem Assessment (MA) program (see http://www.millenniumassessment.org). One reason is that ecosystem goods and services form a pivotal link between economic and ecological systems as well as the economists and ecologists who study them. Ecosystem structures and processes are influenced by biophysical drivers (i.e., tectonic pressures, global weather patterns, and solar energy) which in turn create the necessary conditions for providing the ecosystem goods and services that people value. Through laws, market choices and policy decisions, individuals and social groups make tradeoffs between these goods and services to maximize human values. In turn, these decisions directly affect the ecological structures and processes by engineering and construction and/or indirectly by modifying the physical, biological and chemical processes of the landscape.

Although a range of associated goods and services have been referred to in the literature (Costanza *et al* 1997; Daily 1997; de Groot *et al* 2002), the Millennium Ecosystem Assessment (2003) provides a sensible grouping of four primary categories based on functional differences.

**Figure 1: Ecosystem Goods and Services**

| **Provisioning** | **Regulating** | **Cultural** |
|---|---|---|
| Goods produced or provided by ecosystems<br>• food<br>• fresh water<br>• fuel wood<br>• genetic resources | Benefits obtained from regulation of ecosystem processes<br>• climate regulation<br>• disease regulation<br>• flood regulation | Non-material benefits from ecosystems<br>• spiritual<br>• recreational<br>• aesthetic<br>• inspirational<br>• educational |
| **Supporting**<br>Services necessary for production of other ecosystem services<br>• Soil formation<br>• Waste Treatment and Nutrient cycling<br>• Primary production | | |

As this list shows, not all ecosystem goods and services are inherently substitutable with one another. For any given landscape, there are many different services that may be provided, each of which offers a unique contribution to human welfare. For example, a forested landscape may provide fuel wood or food sources, it may help regulate climate through carbon sequestration, it may prevent soil erosion and provide humus for soil formation and it may also provide aesthetic beauty and recreation opportunities. All of these goods and services contribute to the total value provided by the functioning ecological system.

Ecosystem goods and services provided by any given landscape type—forest, wetland, river—can thus potentially yield a range of values to humans. While acknowledging that human values for such ecological systems can extend from the spiritual to the utilitarian (Goulder & Kennedy 1997), the term value as it is employed in this paper has its conceptual foundation in neoclassical economic theory (Freeman 1993; Krutilla 1967). Simply put, economic value is the amount of money a person is willing to give up in order to get an ecosystem good or service (WTP), or the amount of money required to give up that good or service (WTA).

As Figure 1 suggests, ecosystem goods and services may also be divided into two broad categories: (1) the provision of direct *market* goods or services such as food, pollution disposal, and raw materials; and (2) the provision of *non-market* goods or services which include things like climate regulation, habitat for plant and animal life, and the satisfaction people derive from a nice view of a white sand beach or coral reef.

While measuring exchange values simply requires monitoring market data for observable trades, non-market values of goods and services are much more difficult to measure. Indeed, it is these values that have captured the attention of environmental and resource economists who have developed a number of techniques for valuing ecosystem goods and services (Bingham *et al* 1995). When there are no explicit markets for services, more indirect means of assessing economic values must be used. A subset of

economic valuation techniques commonly used to establish WTP when market values do not exist are identified below[3].

**Table 1: Non-Market Valuation Techniques**

- **Avoided Cost** (AC): services allow society to avoid costs that would have been incurred in the absence of those services; flood control (barrier islands) avoids property damages, and waste treatment by wetlands avoids incurred health costs.
- **Marginal Product Estimation** (MP): Service demand is generated in a dynamic modeling environment using production function (i.e., Cobb-Douglas) to estimate value of output in response to corresponding material input.
- **Factor Income** (FI): services provide for the enhancement of incomes; water quality improvements increase commercial fisheries harvest and thus, incomes of fishermen.
- **Travel Cost** (TC): service demand may require travel, whose costs can reflect the implied value of the service; recreation areas attract distant visitors whose value placed on that area must be at least what they were willing to pay to travel to it.
- **Hedonic Pricing** (HP): service demand may be reflected in the prices people will pay for associated goods: For example, housing prices along the shore of pristine freshwater lakes tend to exceed the prices of inland homes.
- **Contingent Valuation** (CV): service demand may be elicited by posing hypothetical scenarios that involve some valuation of alternatives; people would be willing to pay for increased water quality in freshwater lakes and streams.
- **Group Valuation** (GV): This approach is based on principles of deliberative democracy and the assumption that public decision making should result, not from the aggregation of separately measured individual preferences, but from *open public debate.*

As the descriptions in Table 1 suggest, each valuation methodology has its own strengths and limitations, often limiting its use to a select range of ecosystem goods and services within a given landscape. For example, the economic value generated by a naturally functioning ecological system can be estimated using Avoided Cost (AC), can be used to estimate economic value based on the cost of damages due to lost services. Travel Cost (TC) is primarily used for estimating recreation values, while Hedonic Pricing (HP) is used for estimating property values associated with aesthetic qualities of natural ecosystems. On the other hand, Contingent Valuation (CV) surveys are often used to estimate the economic value of less tangible services like critical wildlife habitat or biodiversity. In our research, the full suite of ecosystem valuation techniques is used to account for the economic value of goods and services provided by a natural landscape.

[3] This list of non-market valuation techniques is not intended to be all-inclusive. Rather, it is intended to reveal the breadth of available empirical techniques that have been and are currently being, explored in the field of ecosystem service valuation.

The model of total landscape value used in this paper is based on the ecological-economic idea of functional diversity, linking different ecosystem structures and processes with the output of specific goods and services, which can then be assigned monetary values using the range of valuation techniques described above (Turner 2000). Thus, key linkages can be made between the diverse structures and processes associated with any given land cover type, the landscape and habitat features that created them and the goods and services that result (Wilson *et al* 2005). Once delineated, economic values for these goods and services can then be assessed by measuring the diverse set of human preferences for them. In economic terms, for example, the natural assets of the coastal zone can thus yield direct (fishing) and indirect (nutrient cycling) use values as well as non-use (preservation) values of the coastal system. Once accounted for, these values can then be aggregated to estimate the total value of the system (Anderson & Bishop 1986).

In sum, the concept of ecosystem goods and services is useful for three fundamental reasons. First, it helps to synthesize essential ecological and economic concepts in a dynamic conceptual system. Second, it allows us to make use of the best available ecological and economic tools to reveal meaningful values for critical ecological systems. And finally it can be used by both researchers and decision makers to transparently evaluate tradeoffs between land use change and human well being.

## The Contextual Variability of Value Transfer

The growing sophistication of estimating the non-market value of ecosystem services is matched only by the rising costs of conducting individual empirical assessments for site-specific environmental changes. Unfortunately, however, only rarely can policy analysts and decision makers afford the luxury of funding, designing and implementing an original study for estimating the economic value of particular ecosystem good or services in a specific location. As a result, information from past studies published in the economic literature has been used to provide a meaningful basis for directing environmental policy and management (Desvousges *et al* 1998).

*Value transfer* by definition involves the adaptation of existing valuation information or data to new policy contexts with little or no data[4]. The transfer involves obtaining an estimate for the economic value of non-market goods or services through the analysis of a single study, or group of studies, that have been previously carried out to value similar goods or services. The transfer itself refers to the application of estimated point values, derived utility functions, and other information from the original 'study site' to a 'policy site'(Desvousges *et al* 1998; Loomis 1992). Value transfer has become an increasingly practical way to inform decisions when primary data collection is not feasible due to budget and time constraints, or when expected payoffs are small (EPA 2000; NRC 2005). As such, the transfer method is increasingly seen as an important tool for landscape managers and policy makers since it can be used to reliably estimate the economic values associated with a particular landscape, based on existing research, for considerably less time and expense than a new primary study.

Although the transfer method is increasingly being used to inform policy decisions by public agencies, the academic debate over the validity of the method continues (Downing & Ozuna 1996; Kirchhoff *et al* 1997; Smith 1992). We accept the premise that primary valuation research will always be a "first-best" strategy for gathering information about the value of ecosystem goods and services. In other words, value transfers will always represent a compromise solution. However, when primary research is not possible or plausible, then value transfer, as a "second-best" strategy, is important to consider as a

[4] Following Desvouges et. al. (1998), the term 'value transfer' is used instead of the more commonly used term 'benefit transfer' to reflect the fact that the transfer method is not restricted to economic benefits, but can also be extended to include the analysis of potential economic costs, as well as welfare functions more generally.

source of meaningful baselines for the evaluation of management and policy impacts on ecosystem goods and services. The real-world alternative is to treat the economic values of ecosystem services as zero; a status quo solution that, based on the weight of the empirical evidence, will often be more error prone than value transfer itself.

Thus, it is increasingly clear that with sufficient limitations and recognition of the inherent context sensitivity of value estimates, prior empirical studies can provide a basis for estimating the value of ecosystem goods and services involving sites other than the study site for which the values were originally estimated. Most importantly, as the richness, extent and detail of information about the *context* of value transfer increases, the accuracy of estimated results will likewise improve.

Here is where engagement with the concept of ecosystem goods and services and the use of tools like Geographic Information Systems (GIS) come to the foreground. Although some economists have raised awareness of the need to pay attention to the spatial and ecological characteristics of sites in relation to transfers (Bateman *et al* 2002; Eade & Moran 1996; Lovett *et al* 1997; Ruijgrok 2001), practitioners in the field have not yet effectively standardized the decomposition of transfers into spatially homogeneous units, which are widely recognized as being similar at different locations. Since ecologists have developed such classifications (i.e., land cover types), it is useful to explore whether it is possible to determine the economic values for the ecological goods and services provided by similar ecosystem types and then transfer those values from one location to another using basic ecological principles (de Groot *et al* 2002; Farber *et al* 2002). The challenge is to make value transfer spatially explicit by disaggregating complex landscapes into constituent land cover units and ecosystem service types that can be effectively transferred from one site to another.

## Spatially Explicit Ecosystem Service Value Transfer

Thanks to the increased ease of using Geographic Information Systems (GIS) and the availability of land cover data sets derived from satellite images, ecological and geographic entities can more easily be attributed with ecosystem services and the values they provide to people (Wilson *et al* 2004a). In simplified terms, the technique discussed here involves combining one land cover layer with another layer representing the geography to which ecosystem services are aggregated - i.e. a watershed. While the aggregation units themselves are likely to be in vector format, because vector boundaries are most precise, the land cover layer may be either raster or vector. [5]

Spatial disaggregation increases the contextual specificity of ecosystem value transfer by allowing us to visualize the exact location of ecologically important landscape elements and overlay them with other relevant themes for analysis—biogeophysical or socioeconomic. A common principle in geography is that spatially aggregated measures of geographic phenomena tend to obscure local patterns of heterogeneity (Fotheringham *et al* 2000; Openshaw *et al* 1987). Analogously, aggregate measures of non-market values, while useful, can also obscure the heterogeneous nature of the underlying resources that provide those services and thus provide misleading results. For example, an aggregate measure of ecosystem services at the global level may indicate significant amounts of a land cover type associated with nutrient cycling and waste treatment, such as estuaries (Costanza *et al* 1997). This measure does not tell us, however, whether the estuaries are distributed evenly throughout the world or are all clustered in one region. Obviously, those two possibilities have significantly different ramifications for resource use and landscape management. Not only does a clustered pattern of estuaries imply that some regions have more than

[5] The vector data model represents spatial entities with points, lines and polygons. The raster model uses grid cells to represent quantities or qualities across space.

others, but it also means that the social cost of losing one estuarine system is much higher in the areas of scarcity than in the areas of clustering.

By mapping individual ecosystem types at higher levels of resolution, we can begin to identify areas where there is local scarcity or abundance of a given service-yielding cover type, helping us to prioritize areas of critical concern. The aggregation units used in ecosystem service mapping efforts should be driven by the intended policy or management application, keeping in mind that there are tradeoffs to reducing the aggregation unit resolution too much. For instance, a local conservation program targeted at altering land management for individual large property owners might want to use zoning parcels as aggregation units. However since such mapping would yield far too much information for state-level application, a state agency whose programs affect all lands in the state (e.g. a water resources agency) might use small watersheds as units. When using ecologically based aggregation units, like watersheds, another question is what scale to use. Because watersheds are nested, there is no clear answer as to this question. To use the wetlands example again, we may find that summarizing total area of wetlands by HUC-8[6]watersheds is sufficient for our purposes in that wetlands tends to be evenly distributed throughout them. On the other hand, we may find that in certain environments, wetlands cluster within a watershed; for instance they may tend to form in the lower reaches and less in the upper. Such a pattern could only be picked up by using finer grained watersheds. Understanding such clustering patterns may have important management implications, such as in conservation reserve design.

The first step in geoprocessing involves clipping both input layers to the same spatial extent. In some cases, the aggregation units may be nested within the extent boundary, for example when HUC 12 watersheds are used as aggregation units and the extent boundary is a HUC-6 watershed containing those sub-units. In other cases, they may be overlapping, such as where watersheds are used as aggregation units and a state boundary is used as the extent, in which case clipping of watersheds will occur. It is important to clip both inputs to the same extent, for if, for example, the land cover map stops at a state boundary and the watershed layer includes watersheds that fall partially in the state and partially outside, those watersheds will register as having a low ecosystem service value relative to area.

After clipping, the two inputs are unioned (a geoprocessing tool in which the feature geometry of two layers is combined to the full extent of both inputs) and then areas are calculated for each of the resulting "fragment" polygons. At this point, the feature geometry of the unioned layer can be discarded. All that must be kept is the attribute table of the unioned layer. The record set of this layer is fragment polygons and relevant attributes include area, land cover code and identifier of the watershed to which the fragment belongs. This is enough information to conduct a cross-tabulation of the data that will list watersheds in the rows, land cover types in the columns, and areas in the cells. This table can then be joined back to the original watershed layer. This results in an attribute table for the watershed layer enumerating area of each land cover type by watershed. This methodology involves an additional step if the land cover categorisation in the original input layer is not the same as the intended output categorisation. In the case of ecosystem service valuation, this is often the case because valuation studies often apply to broad categories, such as "forest" rather than to more precise "deciduous forest" or "coniferous forest", which are often coded in land cover maps (Anderson *et al* 1976).

Once basic ecological units (e.g., land cover types) have been enumerated for each watershed, a total ecosystem service value for a given watershed is then calculated by multiplying the value per unit area for that ecosystem service by the area of the given cover type for that watershed. The economic values used to estimate the values associated with each ecosystem good or service are drawn from the existing non-

[6] HUC refers to the nested hydrologic unit classification system (Seaber *et al* 1987). The system ranges from 2 to 16 digits, with HUC-16 watersheds being the smallest.

market valuation literature. As mentioned previously, all ecosystem goods and services associated with a given spatial unit are not inherently substitutable with one another. One particular cover or land use type within a geodatabase layer may have multiple services related to it. A forest may provide fuel wood or food sources, it may help regulate climate through carbon sequestration, it may prevent soil erosion and provide humus for soil formation and it may also provide aesthetic beauty and recreation opportunities. All of these goods and services contribute to the total value provided by each functioning ecological system.

Putting it all together, the total ecosystem service value of a given cover type for a given watershed can thus be determined by adding up the individual, non-substitutable ecosystem service values associated with that cover type. The following formula is used:

$$V(ES_k) = \sum_{i=1}^{n} A(LU_i) \times V(ES_{ki})$$

Where A(LUi) = Area of Land Use (i)
and V(ESki) = Annual value of Ecosystem Services (k) for each Land Use (i).

In this manner, aggregate ecosystem service values for relatively homogonous landscape units can be determined by summing up all the specific ecosystem service values associated with a given unit. The results can then be divided by total landscape area at multiple scales of analysis (i.e., Huc6, Huc8, or Huc12) to give an indication of the prevalence of areas providing high ecosystem service values on the landscape. Using this approach, ecosystem service values can then be mapped and reported in graphic detail, providing decision makers with a more ecologically based view of how economic values are spread across the natural landscape.

## The EcoValue Project©

Here, we briefly demonstrate the applicability of the concepts and methods reviewed above by describing an approach being developed under the auspices of the EcoValue Project currently based at the University of Vermont (Wilson *et al* 2004b). The EcoValue Project (hereafter referred to as EVP) draws from recent developments in ecosystem service valuation, database design, internet technology, and spatial analysis techniques to create a web-accessible, GIS decision support system. The EVP provides *academic* researchers and *non-commercial* stakeholders with the ability to account for and track environmental service values in a customized, spatially explicit format. The system combines GIS and relational database technology in order to: (1) Link together available peer-reviewed economic valuation literature and ecological data in a transparent environment; (2) Allow users to interactively generate maps, graphs and economic statistics for specific parcels of land at multiple scales. The result is a multi-user platform that provides valuation data to researchers, decision-makers, and public stakeholders working in a spatially explicit mapping environment (see http://ecovalue.uvm.edu ).

Currently, the EVP is being used to generate ecosystem service value estimates for the State of Maryland and the Northern Forest region. As discussed previously, the quality of the original studies used in any value transfer will ultimately determine the overall quality and scope of the final value estimates (Brouwer 2000; Desvousges *et al* 1998). Currently only the peer reviewed studies that are focused on ecological systems found in North American temperate regions are included in the EVP. This focus on is due to the consideration of their contextual similarity to the study sites in Maryland and the Northern Forest region. Using data search engines such as ISI Web of Science® and the Environmental Valuation

Resource Inventory (EVRI™), the research team periodically reviews the best available economic literature and selects valuation studies which conform to the following decision rules[7]:

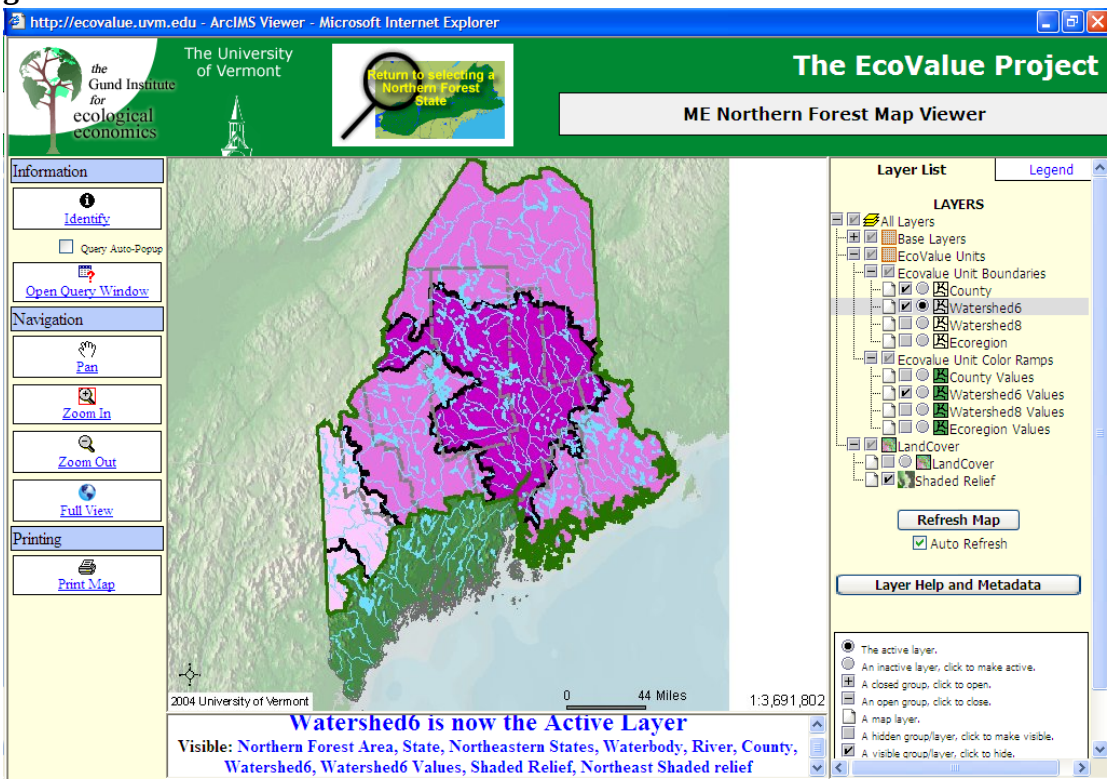
- Published in the peer-reviewed literature
- Limited to results that can readily be translated into spatial equivalencies—(i.e., per ha; per acre)
- Focused on regions in North America and Europe
- Focused primarily on non-consumptive resource uses

For the purpose of aggregation and comparison, all economic values in the EVP are then standardized to USD-2001 ha-1 per year. Conversion to 2001 dollar equivalents is accomplished using the Consumer Price Index (CPI) and conversion to dollar equivalencies is accomplished using available foreign exchange data. When original data is not reported in a spatial equivalent (i.e., per acre or per ha) additional information is sought from the study and augmented with information from secondary sources (i.e., GIS census data or ecological boundary data) to interpolate spatial equivalency (Woodward & Wui 2001). However, many studies in the peer-reviewed economic literature are not amenable to conversion into a unit per area measure. These studies remain in the EVP database, and are available for non-spatial queries.

Currently the EVP uses publicly available land cover/land use (LULC) codes as the primary homogeneous unit of analysis. The National Land Cover Data (NLCD 1992) is a database of satellite imagery that was collected during the early 1990's from Landsat Thematic Mapper satellites. It has been classified into 21 Land Use/ Land Cover types (LULC classes) for the United States. Resolution of this imagery (pixel size) is 30 meters. LULC information provides the fundamental link between economic values and landscape geography. Estimates for the economic value of ecosystem services are assigned to LULC types in a one-to-many relationship. For example, each LULC forest code is assigned a set of ecosystem goods and services (i.e., climate and atmospheric regulation, disturbance prevention, habitat refugium, and recreation) based on ecological functionality documented in the scientific literature (de Groot *et al* 2002). The value for these ecosystem services are then aggregated into an estimated value for each LULC type which are then associated with a particular unit of analysis (i.e., watershed). Thus, by combining the economic value estimates with land cover, the user is able to generate map images that reveal the spatial pattern of ecosystem service values across the landscape.

[7] Current decision rules are iterative and open to change.

**Figure 2: Northern Forest EcoValue Project map viewer with HUC 6 watershed valuation gradient active**




As this screen capture of Huc 6 watershed values from the EVP shows, spatial valuation data can now dynamically be made available to users through internet browser technology. Within the EVP, spatially-explicit boundary data has been linked to the LULC and value-transfer data so that users are able to dynamically query aggregated values for at multiple spatial scales: political (state and county), hydrological (HUC 6, HUC 8, HUC 12) and ecological (Ecoregions). Although there are many types of GIS software available, the software developed by Environmental Systems Research Institute, Inc. (ESRI) is the most widely used by industries and government agencies within the United States. The ESRI software set known as ArcGIS is used extensively in the GIS component of the EVP. Data is stored within geodatabases and ArcIMS, is used as the software for delivering this data through the internet and displaying this information in the form of maps. In this system, the dynamic querying of economic values associated with these maps is made possible by using Active Server Pages (ASP). ASP uses Visual Basic scripting language (VBScript) to give users the ability to execute SQL queries of a web-based geodatabase, residing on a server at the UVM School of Business Administration, and displaying the results in real time within the user's web browser.

## Future Directions

While the conceptual framework and spatial value transfer methodology described in this paper yield important and novel approaches to assessing the economic value of landscapes, such an approach should be viewed as a compliment, not a replacement, for other value transfer approaches (i.e., meta analysis, function transfer). The approach presented here represents only *one step* in what we hope will be a long process of methodological development.

There are several hurdles that must be overcome. One of the most pronounced gaps in the valuation literature is the inability to characterize the spatial and contextual variability of per unit ecosystem-service value multipliers for basic ecological units. This gap is important not just because we need to know where forests or rivers or wetlands are located within the landscape, but also because the marginal economic value of a resource is dependent on its location and the characteristics of its surroundings. Spatial context plays a role in three ways.

First, in some cases the clustering of particular ecosystem goods and services may result in "natural scale economies," such as in economic production, where the clustering together of given land cover types and their associated ecosystem services yield higher net ecosystem benefits than the same cover types or services dispersed over a large area. The analogy here is an area of a rich ore deposits clustered tightly together. Yet, while ore deposits are usually subject to extraction, ecosystem goods or services will typically be targeted for conservation or enhancement. The applicability of this postulate across landscapes will likely vary by ecosystem service, with some services being more amenable to the 'clustering' effect than others (i.e. habitat versus gas regulation).

Second, is the opposite effect. In some cases, the economic value of ecosystem goods or services derives more from scarcity than from scale economies. That is, the marginal ecosystem cost of losing a hectare of wetland in the Los Angeles Basin is likely to be far greater than the marginal cost of losing a hectare of wetland in Alaska, simply because wetlands are abundant in one and scarce in another. Hence, there is value to both spatial agglomeration and spatial dispersion of service-rendering resources. We expect the scarcity effect to be particular salient to recreational and aesthetic values. That is, the marginal social cost of losing one hectare of Central Park is likely to be far greater than that of losing one hectare of green space in a rural area with abundant green space. Currently, the valuation literature does not adequately address how non-market values vary with ecological scarcity and abundance.

Third, ecosystem service values are dependent on location relative to other thematic factors. For instance, even holding the location of a wetland relative to other wetlands, we know that not all wetlands are the same. Some wetlands may be over peaty soils, while others may be over karst-soils, influencing the macro invertebrates that might be found. Some may be surrounded by steep topography, limiting access to certain species, while others may be on flat plains facilitating access to certain species. For many species, one hectare of prime lowland is worth far more than one hectare of steep and rocky terrain. In other words, the value of a service-producing natural asset will vary with numerous other spatially varying factors.

While high resolution spatial data needed for conducting context-based ecosystem service valuation and mapping are increasingly available, a crucial limiting factor remains the availability of economic valuation studies for different ecosystem goods and services measured under different contexts. The current paucity of explicit valuation studies from different social and ecological contexts means that we must make broad generalisations when using value transfer methods to apply ecosystem value multipliers. We cannot begin to address issues of contextual variability or statistical robustness until more studies are conducted of the ecosystem service values of the same cover types in different contexts.

We encourage future researchers in the field of environmental valuation to increase reporting of contextual details about their particular study sites (i.e., spatial coordinates, ecological characteristics, socio-demographic characteristics of the study population, etc.) and to work together with ecologists to employ the evolving standard ecosystem service terminology so that value transfer research can better explain that variability of ecosystem services within and across landscapes. The ultimate goal is to have a critical mass of empirical valuation studies that will allow for comprehensive value transfers to assign value not only on the basis of land cover similarity, but also on the basis of factors like geographic

scarcity or abundance, socio-demographic characteristics of the market, and spatial location of the resource.

## References

Anderson, G. D., Bishop, R. C. 1986. The Valuation Problem. In *Natural resource economics: policy problems and contemporary analysis*, ed. D. W. Bromley,89-137 pp. Liuwer Nijoff Publishing. Boston, MA.

Anderson, J. R., Hardy, E. E., Roach, J. T., Witmer, R. E. 1976. A land use and land cover classification system for use with remote sensor data. U.S. Geological Survey Professional Paper, No. 964. United States Geological Survey. Washington D.C.

Bateman, I. J., Jones, A. P., Lovett, A. A., Lake, I. R., Day, B. H. 2002. Applying Geographical Information Systems (GIS) to environmental and resource economics. Environmental & Resource Economics 22: 219-69.

Bingham, G., Bishop, R. C., Brody, M., Bromley, D., Clark, E., Cooper, W., Costanza, R., Hale, T., Hayden, A., Kellert, S., Norgaard, R., Payne, J., Russell, C., Sute, G. 1995. Issues in Ecosystem Valuation: improving information for decision making. Ecological Economics 14: 73-90.

Brouwer, R. 2000. Environmental value transfer: state of the art and future prospects. Ecological Economics 32: 137-52.

Costanza, R., d'Arge, R., deGroot, R., Farber, S., Grasso, M., Hannon, b., Limburg, K., Naeem, S., O'Neill, R. V., Paruelo, J., Raskin, R. G., Sutton, P., van den Belt, M. 1997. The Value of the World's Ecosystem Services and Natural Capital. Nature 387: 253-60.

Daily, G. C. 1997. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press. Washington D.C.

de Groot, R. S., Wilson, M. A., Boumans, R. M. J. 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics 41: 393-408.

Desvousges, W. H., Johnson, F. R., Spencer Banzhaf, H. S. 1998. Environmental policy analysis with limited information: principles and application of the transfer method. Edward Elgar

Downing, M., Ozuna, T. 1996. Testing the reliability of the benefit function transfer approach. Journal of Environmental Economics and Management 30: 316-22.

Eade, J. D. O., Moran, D. 1996. Spatial economic valuation: Benefits transfer using geographical information systems. Journal of Environmental Management 48: 97-110.

EPA, U. S. 2000. Guidelines for Preparing Economic Anaylses. September, 2000. Washington DC.

Farber, S. C., Costanza, R., Wilson, M. A. 2002. Economic and ecological concepts for valuing ecosystem services. Ecological Economics 41: 375-92.

Fotheringham, A. S., Brunsdon, C., Charlton, M. 2000. Quantitative Geography: Perspectives on Spatial Data Analysis Publication. Sage. London.

Freeman, M. 1993. The Measurement of Environmental and Resource Values. Resources for the Future. Washington D.C.

Goulder, L. H., Kennedy, D. 1997. Valuing Ecosystem Services: Philosophical Bases and Empirical Methods. In *Nature's Services: Societal Dependence on Natural Ecosystems*, ed. G. C. Daily,23-48 pp. Island Press. Washington D.C.

Kirchhoff, S., Colby, B. G., LaFrance, J. T. 1997. Evaluating the performance of benefit transfer: An empirical inquiry. Journal of Environmental Economics and Management 33: 75-93.

Krutilla, J. V. 1967. Conservation Reconsidered. The American Economic Review 57: 777-86.

Loomis, J. B. 1992. The Evolution of a More Rigorous Approach to Benefit Transfer - Benefit Function Transfer. Water Resources Research 28: 701-5.

Lovett, A. A., Brainard, J. S., Bateman, I. J. 1997. Improving benefit transfer demand functions: A GIS approach. Journal of Environmental Management 51: 373-89.

Millennium Assessment. 2003. Ecosystems and Human Well-Being: A Framework for Assessment. Island Press. Washington DC.

NRC. 2005. Valuing Ecosystem Services: Toward Better Environmental Decision Making. The National Academies Press. Washington D.C.

Openshaw, S., Charlton, M. E., Wymer, C., Craft, A. W. 1987. A Mark I Geographical Analysis Machine for the Automated Analysis of Point Data Sets. International Journal of Geographical Information Systems 1: 359-77.

Ricketts, T. H., Daily, G. C., Erlich, P. R., Michener, C. D. 2004. Economic Value of Tropical Forest to Coffee Production. Proceedings of the National Academy of Sciences 101: 12579-82.

Ruijgrok, E. C. M. 2001. Transferring economic values on the basis of an ecological classification of nature. Ecological Economics 39: 399-408.

Seaber, P. R., Kapinos, F. P., Knapp, G. L. 1987. Hydrologic Unit Maps: U. S. Geological Survey Water-Supply Paper 2294. United States Geological Survey. Washington D.C.

Smith, V. K. 1992. On Separating Defensible Benefit Transfers from Smoke and Mirrors. Water Resources Research 28: 685-94.

Turner, R. K. 2000. Integrating natural and socio-economic science in coastal management. Journal of Marines Systems 25: 447-60.

Wilson, M. A., Carpenter, S. R. 1999. Economic Valuation of Freshwater Ecosystem Services in the United States 1971-1997. Ecological Applications 9: 772-83.

Wilson, M. A., Costanza, R., Boumans, R. M. J., Liu, S. 2005. Integrated Assessment and Valuation of Ecosystem Goods and Services Provided by Coastal Systems. In *The Intertidal Ecosystem*, ed. J. G. WIlson,1-28 pp. Royal Irish Academy Press (In Press). Dublin.

Wilson, M. A., Troy, A., Costanza, R. 2004a. The Economic Geography of Ecosystem Goods and Services:Revealing the monetary value of landscapes through transfer methods and Geographic Information Systems. In *Cultural Landscapes and Land Use*, ed. M. Dietrich, V. D. Straaten. Kluwer Academic.

---. 2004b. The EcoValue Project. http://ecovalue.uvm.edu: University of Vermont.

Woodward, R. T., Wui, Y. S. 2001. The economic value of wetland services: a meta-analysis. Ecological Economics 37

# "Publication Measurement Error in Benefit Transfers."

**Randall S. Rosenberger**

***Oregon State University***
***USA***

**Presented during Session 3.**

**Abstract:** Convergent validity tests of benefit transfer accuracy show errors to range from a few percentage points to high degrees of inaccuracy. This paper discusses three potential sources of errors that affect the accuracy of benefit transfers. (1) *Generalization error* occurs when a measure of value is generalized to be applicable to unstudied sites or resources. Generalization error is inversely related to the correspondence between study sites and policy sites. (2) The measurement of values requires many judgments and assumptions on the part of researchers conducting primary studies. *Measurement error* occurs when researchers' decisions affect the transferability of measures of value. And (3) *publication selection bias* occurs when the objectives for publishing research limit benefit transfer applications of research outcomes. Criteria for publishing research results or the primary purpose of undertaking research projects often do not match the needs of benefit transfer practitioners. A means for overcoming these sources of error is offered – an *e-journal* for recording, reporting, and disseminating research with the primary objective of estimating *economic measures of value*. If publications in this e-journal are linked with an active database, then benefit transfer practitioners derive an added bonus of increased access to *values research* outcomes.

**Acknowledgements:** The general content of this paper has benefited from conversations with Tom Stanley, John Loomis, and Tim Phipps.

## INTRODUCTION

There are two primary sources for resource values – primary research and benefit transfers. Benefit transfer is the "application of values and other information from a 'study' site with data to a 'policy' site with little or no data" (Rosenberger and Loomis 2000: 1097). The evolution of benefit transfers began with the transfer of unadjusted individual or aggregate point estimates of value. Loomis (1992) argued that more information, and thus increased validity and reliability of transfers, were available with the transfer of entire demand or benefit functions. The transfer of demand functions enabled the adjustment of value estimates to the specific characteristics of the policy site. More recently, the development of transfer functions has advanced through meta-regression analysis of an entire body of empirical evidence (Rosenberger and Loomis 2001, 2003). Meta-regression analysis has the potential to isolate and measure the basic relationships among empirical estimates of value, moderator variables, and various potentially contaminating influences in the form of a statistical function (Stanley and Jarrell, 1989). This statistical function becomes the link between knowledge derived from applied research and its application to policy settings.

Meta-analysis is the statistical analysis of research outcomes from previous studies; i.e., it is the analysis of analyses (Glass 1976). Meta-analyses can serve three purposes: research synthesis, hypothesis testing, and benefit transfer (Smith and Pattanayak 2002). Meta-analysis has been widely used in the medical and social sciences, but its application to economics is relatively recent. Meta-regression analyses assume that there exists an underlying meta-valuation function that relates the magnitude of empirical estimates of value to characteristics of the study site, market, and research methods (Rosenberger and Phipps 2002, in review; Woodward and Wui 2001). Primary research, within its context, defines relationships between characteristics and values; i.e., part of the underlying meta-valuation function. Meta-regression analysis combines these parts as reported in the literature to construct the entire function. Variability across estimated parameters or values from primary research studies are due to differences in context (i.e., movements along the function) and/or errors in their

estimation (i.e., deviations from the function) (Woodward and Wui 2001). Several meta-regression analyses have been conducted in environmental and natural resource economics (Bateman and Jones 2003), beginning with the evaluation of recreation benefits (Smith and Kaoru 1990a; Walsh et al. 1990) and price elasticities of recreation demand (Smith and Kaoru 1990b), and more recently the evaluation of woodland recreation values (Bateman and Jones 2003) and surface water quality values (Johnston et al. 2003).

Several studies have evaluated the accuracy of benefit transfers, including value and function transfers (Table 1). These measures specify the difference between the known value for a policy site and a transferred value to the policy site. The known ('true' or actual) value for a policy site is derived from an original study designed to estimate a value for this site. Factors that may affect the accuracy of benefit transfers include the quality and robustness of the study site data, the methods used in modeling and interpreting the study site data, analysts' judgments regarding the treatment of study site data and questionnaire development, other errors in the original study, and the physical characteristic, attribute, and market correspondence between the study site and the policy site (Bergland et al. 1995; Boyle and Bergstrom 1992; Brouwer 2000; Desvousges et al. 1992). Protocols for conducting benefit transfers have been suggested as an attempt to minimize the effect of these factors on benefit transfer error (Rosenberger and Loomis 2001, 2003).

This paper will elaborate on three possible sources of errors that affect the accuracy of benefit transfers: (1) generalization error; (2) measurement error; and (3) publication selection bias. Generalization error arises from the benefit transfer application itself. Measurement error is endogenous to primary research and weakly controlled by the benefit transfer analyst. Publication selection bias arises in a body of knowledge (the literature) if selection criteria do not permit publishing of certain results. Publication selection bias limits the stock of knowledge from which benefit transfer analysts draw information. A means for overcoming these sources of errors is offered; namely an e-journal for recording, reporting, and disseminating research with the primary objective of estimating economic measures of value.

## GENERALIZATION ERROR

Generalization errors arise when estimates from study sites are adapted to policy sites. These errors are inversely related to the degree of correspondence between the study site and the policy site. Assume there is an underlying meta-valuation function that links the values of a resource (such as wetlands) or an activity (such as downhill skiing or camping) with characteristics of the markets and sites, across space and over time. Further hypothesize that a primary research project samples from this meta-function. The meta-valuation function may be constructed as an envelope of a set of study site functions that relates site values to characteristics or attributes associated with each site, including market characteristics, physical site characteristics, spatial characteristics, and time (Rosenberger and Phipps 2002, in review). The degree that any of these sets of factors affects benefit transfer accuracy is an empirical question; however, the greater the correspondence (or similarity) of the policy site with the study site, the smaller the expected error (Boyle and Bergstrom 1992; Desvousges et al. 1992).

Several of the studies listed in Table 1 support the hypothesis that the greater the correspondence, or similarity, between the study site and the policy site, the smaller the expected error in benefit transfers. Lower transfer errors resulted from in-state transfers than from across-state transfers (Loomis 1992; VandenBerg et al. 2001). This is potentially due to lower socioeconomic, sociopolitical, and sociocultural differences for transfers within states, or political regions, than across states. In the Loomis et al. (1995) study, their Arkansas and Tennessee multi-site lake recreation models performed better in benefit

transfers between the two regions (percent errors ranging from 1% to 25% with a nonlinear least squares models and 5% to 74% with the Heckman models) than either one when transferred to California (percent errors ranged from 106% to 475% for the nonlinear least squares models and from 1% to 113% for the Heckman models). This suggests that the similarity between the eastern models implicitly accounted for site characteristic effects. VandenBerg et al. (2001) show accuracy gains when they transfer values and functions within communities that have shared experiences of groundwater contamination than transferring across states, within states, or to previously unaffected communities.

Several of the studies in Table 1 also generally support the hypothesis that generalization errors can be reduced by transferring functions instead of point estimates or values. Benefit functions enable the calibration of the function to differences between the study site for which the function was developed and the policy site to which the function is applied (Loomis 1992; Parsons and Kealy 1994; Bergland et al. 1995; Kirchhoff et al. 1997 (for the birdwatching model only); Brouwer and Spaninks 1999; and VandenBerg et al. 2001 (pooled data models)). However, the gains in accuracy may be more a function of the similarity of the sites than the calibration of site characteristics in the function transfers (the function transfers still relatively outperformed the value transfers). This is because most of the functions did not include variables measuring the physical differences between the sites or socio-economic differences between the markets. Many of the physical differences important for calibrating values across sites are unmeasured in the original functions (Rosenberger and Phipps, in review). In part, this is because these characteristics are fixed, or constant, in individual site models, or the researchers assumed these differences are captured in the price coefficient (Downing and Ozuna 1996). Other researchers' decisions regarding model development and recording and reporting of study characteristics may affect the accuracy of benefit transfers.

## MEASUREMENT ERROR

The measurement of values requires many judgments and assumptions on the part of researchers conducting primary studies. The empirical estimation of a theoretical model includes decisions about data and methods including which data are relevant, how data should be adjusted, what estimators are appropriate, and assumptions that are necessary to connect the data to the model (Hanemann 2000). Measurement error occurs when researchers' decisions affect the transferability of measures of value. Most often, methodological moderator effects are statistically significant in meta-regression analyses of value estimates. For example, several methodological factors are statistically significant in a meta-regression analysis of recreation use values, including valuation method, elicitation method, survey design, and units of measurement (Rosenberger and Loomis 2001). Typically these methodological factors are held constant at the mean level of their use in the literature when adapting meta-valuation functions for benefit transfers, but this only hides part of the measurement error issue.

Access to information further complicates the use of meta-analytic techniques in estimating a meta-valuation function for benefit transfer purposes. Florax et al. (2002) argue that although providing incomplete or insufficient information may not be detrimental to the outcome of an original study, it compromises secondary analyses that compare results across different studies. A good database is the foundation for quality meta-analyses in particular and benefit transfers in general. Rosenberger and Loomis (2000) show that empirical valuation studies do a poor job at recording and reporting characteristics of their study sites, including physical characteristics of the sites and characteristics of the sample population. For example, out of the 131 studies included in the Rosenberger and Loomis (2000) recreation use values database, about 3% of the studies reported average income or average age for their samples; less than 1% reported average education level; about 16% reported gender proportions; and only

61% even reported their sample size. In all of the meta-analyses tested in Kirchhoff (1998), Rosenberger and Loomis (2000) and Shrestha and Loomis (2001), none of them included market characteristics of the underlying samples in the original studies. As shown above, both physical differences and market differences between the study sites and policy sites are associated with the accuracy of benefit transfers.

Measurement error and publication selection bias are not mutually exclusive sources of error in benefit transfers. Measurement error may masquerade as publication bias. For example, researchers' choices regarding methodology can be influenced through the peer-review process when the objective is acceptance of a paper, resulting in compromises in modeling choices such as omitted variables, estimation technique and functional form. Statistical issues with a database can also show up as publication bias if they are not properly accounted for in the meta-regression analysis, including issues of heterogeneity, truncated sampling, and non-independence among observations (i.e., multiple estimates from a single study).

## PUBLICATION SELECTION BIAS

Publication selection bias arises when the empirical literature is not an unbiased sample of empirical evidence; i.e., only publishing studies that report statistically significant results or results that conform to expectations; that have a tendency to not report statistically insignificant moderator effects; and/or compiling databases of only easily accessed published research (Florax 2002; Stanley 2004). Publication selection bias may reduce the validity and reliability of meta-regression analyses in a benefit transfer setting; however, these biases are equally problematic to any summary of empirical research (Laird and Mosteller 1988; Sutton et al. 2000; Stanley 2001). Medical researchers and many areas of social science have long recognized the seriousness of publication selection (Sterling 1959; Rosenthal 1979; Begg and Berlin 1988). More recently, Card and Krueger (1995), Ashenfelter et al. (1999), and Gorg and Strobl (2001) have all found publication bias in specific areas of economic research with the help of meta-regression analysis. Card and Kreuger (1995: 239) identify three sources of publication selection in economics: (1) reviewers and editors may be predisposed to accept papers consistent with the conventional view; (2) researchers may use the presence of conventionally expected results as a model selection test; and (3) everyone may possess a predisposition to treat 'statistically significant' results more favorably.

In the area of non-market valuation, research must generally introduce a new method in order to be published in peer-reviewed journals. Most journals in the environmental economics field are not interested in new estimates of benefits for their own sake (Smith and Pattanayak 2002: 273). As such, analyses presented in journal articles may be based, in part, on broad assumptions by the researchers about their data (e.g., an assumed level of cost per mile traveled in a travel cost study). When measurement error and publication selection bias are working in the same direction, an empirical literature can become quite skewed. For example, price elasticities of water demand are exaggerated by nearly four-fold (Stanley 2005).

Several environmental economic meta-regression analyses have investigated the issue of publication selection bias. Smith and Huang (1995) (air quality), Woodward and Wui (2001) (wetland values), Dalhuisen et al. (2003) (residential water demand elasticities), Zelmer (2003) (voluntary contributions for public goods) and van Kooten et al. (2004) (costs of carbon sequestration in forests) included a dummy variable identifying publication source (i.e., journal article or peer-reviewed) as a moderator variable in their meta-regression models. Woodward and Wui (2001) and Zelmer (2003) did not find a significant publication type effect. Smith and Huang (1995) found air quality values derived from hedonic property studies to be larger in published studies. Dalhuisen et al. (2003) found a

significant and positive moderator effect associated with unpublished studies and van Kooten et al. (2004) found a significant and positive effect associated with peer-reviewed studies.

Many peer-reviewed journals and dissertations have an explicit objective to make a methodological contribution, not provide a new estimate of value. When improved methods are the objectives of research, their success will be judged less on the statistical significance or magnitude of their reported estimates of value. For example, Gallett and List (2003) (elasticities of cigarette demand) included a dummy variable identifying publication in the top 36 economics journals. This measure of journal prestige was significant and negative in the price elasticity model and significant and positive in the income elasticity model. Both of these directional effects suggest demand elasticities are larger (more elastic) in the most prestigious economics journals than other outlets for publishing data.

Preliminary indicators of publication selection bias are found in an existing database of recreation use values. A significant and negative effect on use value estimates is found when a dummy variable identifying estimates published in peer-reviewed journals is added to the meta-regression model specification in Rosenberger and Loomis (2001). Split-sample t-tests also show that not only do journal publications have a smaller mean estimate than non-journal publications, but they also have higher standard errors across estimates. The same result holds true for methodological contributions vs. new estimates of value. This is exactly what a concern about publication selection predicts.

## CONCLUSIONS

Evidence of generalization error, measurement error, and publication selection bias supports the current trends and emerging discussions regarding accessibility to the valuation literature. In particular, one means of making primary research more amenable to benefit transfer is to improve reporting of research design and value estimation. Protocols for the recording and reporting of empirical research may be developed using evidence from meta-analyses regarding how moderator variables explain variation in empirical estimates. In addition, discussions should begin regarding the development of an e-journal whose sole purpose is the accurate and complete recording of studies that estimate values, including studies that replicate previous research designs (Sutton et al. 2000). There need be no page limits with an e-journal, so full recording of study details is not only permissible, but desired. Benefit transfer practitioners would be the primary beneficiaries of such a journal, especially if it is linked to an active database. The accumulation of knowledge through empirical research forms the basis for conducting benefit transfers and meta-analyses. Without complete and consistent recording of empirical research outcomes, our body of knowledge may be little more than a biased collection of case studies.

## REFERENCES

Ashenfelter, O., C. Harmon and H. Oosterbeek. 1999. A review of estimates of the schooling/earnings relationship, with tests for publication bias. *Labour Economics* 6:453-470.

Bateman, I.J. and A.P. Jones. 2003. Contrasting conventional with multi-level modeling approaches to meta-analysis: Expectation consistency in U.K. woodland recreation values. *Land Economics* 79(2):235-258.

Begg, C.B. and J.A. Berlin. 1988. Publication bias: A problem in interpreting medical data. *Journal of the Royal Statistical Society (Series A)* 151:419-445.

Bergland, O., K. Magnussen, and S. Navrud. 1995. *Benefit Transfer: Testing for Accuracy and Reliability*. Discussion Paper #D-03/1995. Norway: Department of Economics and Social Sciences. 21p.

Boyle, K.J., and J.C. Bergstrom. 1992. "Benefit Transfer Studies: Myths, Pragmatism, and Idealism." *Water Resources Research* 28(3):657-663.

Brouwer, R. 2000. "Environmental Value Transfer: State of the Art and Future Prospects." *Ecological Economics* 32(1):137-152.

Brouwer, R., and F.A. Spaninks. 1999. "The Validity of Environmental Benefits Transfer: Further Empirical Testing." *Environmental and Resource Economics* 14:95-117.

Card, D. and A.B. Kreuger. 1995. Time-series minimum-wage studies: A meta-analysis. *American Economic Review* 85:238-243.

Dalhuisen, J.M., R.J.G.M. Florax, H.L.F. de Groot and P. Nijkamp. 2003. Price and income elasticities of residential water demand: A meta-analysis. *Land Economics* 79(2):292-308.

Desvousges, W.H., M.C. Naughton, and G.R. Parsons. 1992. "Benefit Transfer: Conceptual Problems in Estimating Water Quality Benefits Using Existing Studies." *Water Resources Research* 28(3):675-683.

Downing, M., and T. Ozuna Jr. 1996. "Testing the Reliability of the Benefit Function Transfer Approach." *Journal of Environmental Economics and Management* 30(3):316-322.

Florax, R.J.G.M. 2002. Methodological pitfalls in meta-analysis: Publication bias. In R.J.G.M. Florax, P. Nijkamp and K.G. Willis (eds.), *Comparative Environmental Economic Assessment*. Northampton, MA: Edward Elgar. Pp. 177-207.

Florax, R.J.G.M., H.L.F. de Groot and R.A. de Mooij. 2002. *Meta-analysis: A tool for upgrading inputs of macroeconomic policy models*. Tinbergen Institute Discussion Paper TI 2002-041/3. Amsterdam-Rotterdam: The Free University.

Gallett, C.A. and J.A. List. 2003. Cigarette demand: A meta-analysis of elasticities. *Health Economics* 12(10):821-835.

Glass, G.V. 1976. Primary, secondary and meta-analysis of research. *Educational Research* 5:3-8.

Gorg, J. and E. Strobl. 2001. Multinational companies and productivity spillovers: A meta-analysis. *Economic Journal* 111:F723-F740.

Hanemann, W.M. 2000. Adaptation and its measurement. *Climatic Change* 45:571-581.

Johnston, R.J., E.Y. Besedin and R.F. Wardwell. 2003. Modeling relationships between use and nonuse values for surface water quality: A meta-analysis. *Water Resources Research* 39(12):1363, doi:10.1029/2003WR002649.

Kirchhoff, S. 1998. *Benefit Function Transfer vs. Meta-Analysis as Policy-Making Tools: A Comparison.* Paper presented at the workshop on Meta-Analysis and Benefit Transfer: State of the Art and Prospects, Tinbergen Institute, Amsterdam, April 6-7, 1998.

Kirchhoff, S., B.G. Colby, and J.T. LaFrance. 1997. "Evaluating the Performance of Benefit Transfer: An Empirical Inquiry." *Journal of Environmental Economics and Management* 33(1):75-93.

Laird, N. and F. Mosteller 1988. Discussion of the paper by Begg and Berlin, *Journal of the Royal Statistical Society (Series A*) *151*: 456.

Loomis, J.B. 1992. The evolution of a more rigorous approach to benefit transfer: Benefit function transfer. *Water Resources Research* 28(3):701-705.

Loomis, J.B., B. Roach, F. Ward, and R. Ready. 1995. "Testing the Transferability of Recreation Demand Models Across Regions: A Study of Corps of Engineers Reservoirs." *Water Resources Research* 31(3):721-730.

Morrison, M., and J. Bennett. 2000. "Choice Modelling, Non-Use Values and Benefit Transfers." *Economic Analysis and Policy* 30(1):13-32.

Parsons, G.R., and M.J. Kealy. 1994. "Benefits Transfer in a Random Utility Model of Recreation." *Water Resources Research* 30(8):2477-2484.

Rosenberger, R.S. and J.B. Loomis. 2000. Using meta-analysis for benefit transfer: In-sample convergent validity tests of an outdoor recreation database. *Water Resources Research* 36(4):1097-1107.

Rosenberger, R.S. and J.B. Loomis. 2001. *Benefit Transfer of Outdoor Recreation Use Values: A Technical Document Supporting the Forest Service Strategic Plan (2000 Revisions)*. General Technical Report RMRS-GTR-72. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 59p. (www.fs.fed.us/rm/pubs/rmrs_gtr72.html).

Rosenberger, R.S. and J.B. Loomis. 2003. Benefit transfer. In: P. Champ, K. Boyle and T. Brown (eds.), *A Primer on Non-Market Valuation*. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Rosenberger, R.S. and T.P. Phipps. 2002. *Site Correspondence Effects in Benefit Transfer: A Meta-Analysis Transfer Function.* Paper presented at the 2nd World Congress of Environmental and Resource Economists, June 22-27, 2002, Monterey, CA.

Rosenberger, R.S. and T.P. Phipps. In review. Correspondence and convergence in benefit transfer accuracy: A meta-analytic review of the literature. In: S. Navrud and R.C. Ready (eds.), *Environmental Value Transfer: Issues and Methods*. Dordrecht, The Netherlands: Kluwer Academic Publishers (in review).

Rosenthal, R. 1979. The 'file drawer problem' and tolerance for null results. *Psychological Bulletin* 86:638-641.

Shrestha, R.K., and J.B. Loomis. 2001. "Testing a Meta-Analysis Model for Benefit Transfer in International Outdoor Recreation." *Ecological Economics* 39(1):67-83.

Smith, V.K. and J. Huang. 1995. Can markets value air quality? A meta-analysis of hedonic property value models. *Journal of Political Economy* 103(1):209-227.

Smith, V.K. and S.K. Pattanayak. 2002. Is meta-analysis a Noah's ark for non-market valuation? *Environmental and Resource Economics* 22:271-296.

Smith, V.K. and Y. Kaoru. 1990a. Signals or noise?: Explaining the variation in recreation benefit estimates. *American Journal of Agricultural Economics* 72(2):419-433.

Smith, V.K. and Y. Kaoru. 1990b. What have we learned since Hotelling's letter?: A meta-analysis. *Economics Letters* 32(3):267-272.

Stanley, T.D. 2001. Wheat from chaff: Meta-analysis as quantitative literature review. *Journal of Economic Perspectives* 15:131-150.

Stanley, T.D. 2004. Meta-regression methods for detecting and estimating empirical effect in the presence of publication selection, Discussion Paper 2004-2, Center for Entrepreneurial Studies, Hendrix College, Conway, AR.

Stanley, T.D. 2005. Beyond publication bias. *Journal of Economic Surveys*, forthcoming.

Stanley, T.D. and S.B. Jarrell. 1989. Meta-regression analysis: A quantitative method of literature surveys. *Journal of Economic Surveys* 3:161-170.

Sterling, T.D. 1959. Publication decisions and their possible effects on inferences drawn from tests of significance. *Journal of the American Statistical Association* 54:30-34.

Sutton, A.J., K.R. Abrams, D.R. Jones, T.A. Sheldon and F.Song. 2000. *Methods for Meta-Analysis in Medical Research*. NY: John Wiley & Sons.

Van Kooten, G.C., A.J. Eagle, J. Manley and T. Smolak. 2004. How costly are carbon offsets? A meta-analysis of carbon forest sinks. *Environmental Science & Policy* 7:239-251.

VandenBerg, T.P., G.L. Poe, and J.R. Powell. 2001. "Assessing the Accuracy of Benefits Transfers: Evidence from a Multi-Site Contingent Valuation Study of Groundwater Quality." In J.C. Bergstrom, K.J. Boyle, and G.L. Poe, eds., *The Economic Value of Water Quality*. Mass: Edward Elgar.

Walsh, R.G., D.M. Johnson and J.R. McKean. 1990. Nonmarket values from two decades of research on recreation demand. In: A. Link and V.K. Smith (eds.), *Advances in Applied Micro-Economics*, Volume 5. Greenwich, CT: JAI Press. Pp. 167-193.

Woodward, R.T. and Y. Wui. 2001. The economic value of wetland services: A meta-analysis. *Ecological Economics* 37(2):257-270.

Zelmer, J. 2003. Linear public goods experiments: A meta-analysis. *Experimental Economics* 6(3):299-310.

**Table 1. Summary of Benefit Transfer Validity Tests.**

| Reference | Resource/Activity | Value Transfer Percent Error[a] | Function Transfer Percent Error[a] |
|---|---|---|---|
| Loomis (1992) | Recreation | 4 – 39 | 1 – 18 |
| Parsons and Kealy (1994) | Water\Recreation | 4 – 34 | 1 – 75 |
| Loomis et al. (1995) | Recreation | | |
| Nonlinear Least Squares Model | | --- | 1 – 475 |
| Heckman Model | | --- | 1 – 113 |
| Bergland et al. (1995) | Water quality | 25 – 45 | 18 – 41 |
| Downing and Ozuna (1996) | Fishing | 0 – 577 | --- |
| Kirchhoff et al. (1997) | Whitewater Rafting | 36 – 56 | 87 – 210 |
| | Birdwatching | 35 – 69 | 2 – 35 |
| Kirchhoff (1998) | Recreation/Habitat | | |
| Benefit Function Transfer | | --- | 2 – 475 |
| Meta-analysis Transfer | | --- | 3 – 7028 |
| Brouwer and Spaninks (1999) | Biodiversity | 27 – 36 | 22 – 40 |
| Morrison and Bennett (2000) | Wetlands | 4 – 191 | --- |
| Rosenberger and Loomis (2000a) | Recreation | --- | 0 – 319 |
| VandenBerg et al. (2001) | Water quality | | |
| Individual Sites | | 1 – 239 | 0 – 298 |
| Pooled Data | | 0 – 105 | 1 – 56 |
| Shrestha and Loomis (2001) | International Recreation | --- | 1 – 81 |

[a]All percent errors are reported as absolute values. Adapted from and expanded on Brouwer (2000).

# "Aquatic Resource Improvements and Benefits Transfer: What Can We Learn From Meta-Analysis?"

**Robert J. Johnston[1*]**

***Various elements of the presented research were co-authored by (in alphabetical order):***

**Elena Y. Besedin[2], Erik C. Helm[3], Richard Iovanna[4], Christopher J. Miller[5], Matthew H. Ranson[2], and Ryan F. Wardwell[2]**

*[1] Department of Agricultural and Resource Economics, University of Connecticut, 1080 Shennecossett Road, Groton, CT, USA 06340-6048*
*[2] Abt Associates Inc.; USA*
*[3] Office of Water, U.S. EPA*
*[4] National Center for Environmental Economics, U.S. EPA*
*[5] Ecosystems Management Services, USDA Forest Service, USA*
** Presenting author*

**Presented during Session 3.**

**Acknowledgements**

This research was partially funded under U.S. EPA Contract No. 68-C-99-239. Opinions belong solely to the principal author and do not necessarily reflect the views or policies of U.S. EPA or imply endorsement by the funding agency.

**Abstract**

Researchers are increasingly considering benefit transfer approaches that allow welfare measures to be adjusted for characteristics of the policy context. The validity and reliability of such adjustments, however, depend on the presence of systematic variation in underlying willingness to pay (WTP). This paper describes two meta-analyses conducted to identify systematic components of WTP for aquatic resource improvements, with a particular emphasis on aquatic living resources. The first analysis models variation in WTP for water quality improvements that benefit aquatic species. The second models variation in WTP for increases in harvest among recreational anglers. Results reveal strong systematic patterns in WTP for aquatic resources, and suggest that observable attributes account for a substantial proportion of WTP variance across studies. The analyses also expose challenges in the interpretation of meta-analysis for benefit transfer and welfare guidance. Specifically, while both models establish the presence of systematic WTP variation associated with resource, context, and user (or nonuser) attributes, they also indicate that WTP is subject to systematic variation associated with study methodology. The appropriate treatment of methodology-related variation is not well informed by economic theory, and may have significant implications for welfare estimation and benefits transfer.

**Introduction**

Despite the mixed performance of benefit transfer in past assessments (Smith et al. 2002), welfare measures estimated using such methods are increasingly incorporated as central components of benefit cost analyses (Bergstrom and De Civita 1999). Given the generally unreliable performance of unadjusted single-site transfers, however, researchers are increasingly considering approaches that allow welfare measures to be adjusted for characteristics of the policy context under consideration. For example, US EPA (2000, p. 87) notes that analysts often "adjust [WTP] point estimates based on judged differences between the study and policy cases."

The validity of willingness to pay (WTP) adjustments and their appropriateness for benefit transfer depends on the presence of systematic, identifiable variation in underlying WTP. If WTP cannot be shown to vary systematically according to attributes distinguishing study and policy sites, the justification for such adjustments—and for benefit transfer in general—becomes more tenuous. The validity of benefit transfer may also be called into question if a large proportion of WTP variation is associated with otherwise unexplained study-level effects, rather than identifiable differences in resource, context and study design attributes. Nonetheless, transfers are often conducted without assessment of whether welfare measures display systematic variation associated with observable resource, context and study design attributes, or whether (in contrast) WTP variation is due largely to unobservable, stochastic, or study-specific elements.

Meta-analysis[8] has been drawing particular attention as a potential means to assess systematic variation in WTP (Brouwer 2002; Johnston et al. 2003). Such methods have been applied extensively in fields such as epidemiology and education, where applications typically involve studies conducted under controlled conditions with standardized experimental designs (Bateman and Jones 2003; Glass et al.

[8] Glass (1976) characterizes meta-analysis as "the statistical analysis of a large collection of results for individual studies for the purposes of integrating the findings. It provides a rigorous alternative to the casual, narrative discussion of research studies which is commonly used to make some sense of the rapidly expanding research literature" (p. 3; cited in Poe et al. (2001), p. 138).

1981). However, because of heterogeneity of research methods in economics and a lack of standard data reporting, meta-analysis is still used sparingly in resource and environmental economics (Button 2002, p. 83-85).

Within a benefit transfer context, meta-analysis may be applied to identify systematic influences of study, economic, and resource attributes on WTP. Such information may allow researchers to more appropriately adjust WTP estimates, providing an improved mechanism for benefit transfer (Rosenberger and Loomis 2003). Based on this potential, US EPA (2000) guidelines characterize meta-analysis as "the most rigorous benefit transfer exercise" (p. 87). Another advantage of meta-analysis is that it "may … provide insights into phenomena for which no current studies exist" (Button 2002, p.78). Nonetheless, review of the literature reveals some controversy with regard to the use of meta-models for applied welfare analysis. For example, while many authors (e.g., Poe et al. 2001) advise caution in direct policy applications of meta-analysis, others recognize its increasing policy use (Bergstrom and De Civita 1999).

This paper describes two meta-analyses conducted to identify systematic components of WTP for aquatic resource improvements, with a particular emphasis on living resources. The first analysis models variation in WTP for water quality improvements that benefit aquatic species. The second models variation in WTP for increases in harvest among recreational anglers. The analyses were initially conducted to explore benefit transfer methods for estimating WTP for fish and related resources affected by US EPA regulations. The broader purpose of the analyses, however, is to assess whether variation in WTP for aquatic resources may be explained sufficiently by systematic variation in policy, context, and other observable attributes to justify benefit transfer, or whether WTP variation is dominated by unexplained or study-level factors. A secondary goal is to assess the potential sensitivity of WTP to specification issues that may not be decided based on theory alone—issues for which researcher judgment is critical in a benefit transfer context.

## Data and Methods

The goals of the presented analyses are to estimate the relative influence of resource, context, and study characteristics on per household WTP for water quality improvements that affect aquatic species, and for increased (per fish) recreational harvest among anglers, respectively. The data and conceptual approach for the two analyses are detailed below.

### *Willingness to Pay for Water Quality Improvements: Data and Conceptual Approach*

The data are drawn from non-market valuation studies that estimate total WTP for water quality changes that affect aquatic life habitats and/or recreational fishing and other recreational uses. From a universe of greater than 300 identified surface water valuation studies addressing such resource types, 34 were found to be suitable for inclusion in the meta-data. Criteria for inclusion were: 1] a requirement that the study estimate total (use and nonuse) per household WTP, 2] a requirement that the water quality change being valued affect aquatic life and or habitat in a water body that provides recreational fishing or other recreational activities, 3] a requirement that the study was conducted in the U.S., 4] a requirement that the study apply methods generally accepted by journal literature, and 5] a requirement that the study provide sufficient information regarding resource, context, and methods to warrant inclusion.

The resulting meta-data comprise 81 observations from 34 unique studies conducted between 1973 and 2001. The studies include eighteen journal articles, ten research reports or academic papers[9], four Ph.D. dissertations, one book, and one Master's thesis. The number of observations exceeds the number of studies because many studies provide more than one estimate of WTP. Multiple WTP estimates from a single study are available due to in-study variations in such factors as the extent of amenity change, elicitation methods applied, water body type and number, recreational activities affected, and species

[9] In some cases, peer-reviewed journal articles failed to provide sufficient information on study attributes, necessitating a review of more detailed technical reports (from which the journal articles were derived). In such cases, the original reports are referenced as the primary data source.

affected. Due to the requirement that each study estimate total (use and nonuse) WTP, the data are limited to studies relying on stated preference methods; these include open-ended contingent valuation, choice-based survey methods, and combined revealed/stated preference techniques. Table 1 summarizes principal study characteristics for those studies included in the meta-data.

Based on theory and findings from the literature, we expect that various attributes may be associated with systematic variations in WTP for water quality improvements (Poe et al. 2001; Johnston et al. 2003). For ease of exposition, these attributes are categorized into those characterizing 1] study and methodology, 2] surveyed populations, 3] geographic region and scale, 4] water body type, and 5] resource condition and change. *Study and methodology* attributes characterize such features as the year in which a study was conducted, payment vehicle and elicitation format, WTP estimation methods and conventions, and survey response rates. *Surveyed populations* attributes characterize such features as the average income of respondents and the representation of users and nonusers within the survey sample. *Geographic region and scale* attributes characterize such features as the number of water bodies affected by the policy and the geographic region in which the study was conducted. *Water body type* attributes characterize hydrological characteristics of the affected water body (e.g., river, lake, salt pond, estuary). Finally, *resource condition and change* attributes characterize baseline conditions, resource uses supported, and the extent of water quality change. Table 2 summarizes the set of independent variables included in the meta-analysis.

Although the definition of most independent variables requires little explanation, there are some variables for which additional detail is warranted. These include variables characterizing surface water quality and its measurement. To allow the partial slope associated with water quality changes to vary systematically as a function of the primary affected species group(s), we include water quality in the model as a set of interactions with binary variables characterizing the primary species affected by water quality change, as noted in the original studies. These interaction variables distinguish the effects of water quality change for fish (*WQ_fish*), shellfish (*WQ_shell*), multiple species (*WQ_many*), and non-specified species (*WQ_non*) (table 2).

Further explanation is also warranted for methods used to reconcile water quality measures across different studies. Many (26) observations in the meta-data characterize quality changes using variants of the Resources for the Future (RFF) water quality ladder (Mitchell and Carson 1989, p. 342).[10] This scale is linked to specific pollutant levels which, in turn, are linked to presence of aquatic species and suitability for particular recreational uses. Other observations in the meta-data, however, rely on ordinal rankings—often paired with verbal descriptions—to measure water quality. To reconcile measurements of water quality change (a prerequisite for this meta-analysis), we map all water quality measures to the RFF water quality ladder.

In most cases, the descriptions of water quality (present in the studies that did not apply the water quality ladder) rendered mapping of water quality measures to the RFF ladder straightforward. For example, studies often defined baseline and subsequent water quality in terms of suitability for recreational activities (e.g. boating, fishing, swimming) or corresponding qualitative water quality measures (e.g. poor, fair, good)—features corresponding to the RFF ladder. For studies in which such information was not provided, we used descriptive information available from studies (e.g. amount/indication of the presence of specific pollutants; historical decline of the quality of the resource) to approximate the baseline level of water quality and the magnitude of the change. However, to account for potential systematic biases involved in mapping those studies that are not based on the RFF water quality ladder, we define the binary variable *wq_ladder*. This variable identifies those studies in which RFF water quality ladder measurements were an original component of the survey instrument.

*Willingness to Pay for Increases in Recreational Harvest: Data and Conceptual Approach*

Because policy analyses often call for welfare estimates denominated in "per-fish" units (e.g., US

[10] Additional details of the ladder are provided by McClelland (1974) and Vaughan (1986).

EPA 2004), the meta-model presented here estimates effects of independent variables on estimated WTP per angler, per fish—an additional departure from prior work (e.g., Markowski et al. 2002). The data are drawn from non-market valuation studies that estimate the marginal value (or WTP) that anglers place on catching an additional fish or allow such a value to be calculated. An in-depth search[11] of the economic literature revealed over 450 journal articles, academic working papers, reports, books, and dissertations that were potentially relevant for this analysis. Of these, 48 studies were considered suitable for inclusion in the meta-data.

Specific criteria for inclusion in the meta-data were: 1] a requirement that the study estimate the marginal value that recreational anglers place on catching an additional fish (WTP) or provide sufficient information to allow such a value to be calculated; 2] a limitation to studies conducted in the U.S. or Canada; 3] a requirement that the study apply primary research methods widely supported by the economics literature; and 4] a requirement that the study provide sufficient information on resource, angler, context, and study attributes to warrant inclusion.

The resulting meta-data comprise 391 observations from 48 unique studies conducted between 1977 and 2001. All included studies apply generally accepted valuation methods such as contingent valuation, travel cost models, or random utility models to assess WTP for increased recreational catch. As noted above, studies were excluded if they were not grounded in recognized concepts of economic theory, or if applied methods did not conform to generally accepted practice. The 48 studies include 24 journal articles, 15 reports, five Ph.D. dissertations, three academic or staff papers, and one book. The number of observations (391) exceeds the number of studies (48) because studies typically provide more than one estimate of WTP. Multiple WTP estimates from a single study are available due to in-study variations in such factors as baseline catch rate, the species being valued, locations where fish are caught, fishing method (e.g., boat versus shore), and valuation methodology applied.

Table 3 summarizes principal study characteristics for those studies included in the meta-data. Two hundred and nine observations are derived from random utility (RUM) or discrete choice models, 59 observations are derived from individual or multiple-site travel cost models, and 122 observations are derived from stated preference methods. Response rates from individual studies range from 38% to 99%, with sample sizes from 72 to 36,802. Marginal WTP per fish was provided by the authors for 298 of the 391 observations; for the remaining 93 observations WTP per fish was calculated based on data provided by the original study. All per fish WTP values were converted to June 2003 dollars. Resulting real WTP per fish over the sample ranged from \$0.048 to \$612.79, with a mean of \$16.82.[12]

Independent variables included in the meta-analysis are derived from a list of attributes with potential influence on WTP per fish, based on theory and prior findings in the empirical literature. These variables are divided into two general categories. These include: 1] resource, context, and angler attributes and 2] study methodology attributes. Table 4 characterizes the full set of independent variables included in one or more estimated models.

Although the interpretation and calculation of most variables is relatively straightforward, the specification of a small number of variables warrants additional explanation. These include the dependent variable, which characterizes marginal WTP per fish, per trip. The majority of studies provide estimates of marginal WTP per fish. However, approximately one-quarter of the observations (93) do not provide this information directly. In these cases, WTP per fish was calculated using one of two approaches. Where possible, regression coefficients provided in the original studies were used to directly

[11] Sources reviewed included: a] US EPA research and bibliographies dealing with the recreational fishing benefits; b] resource and environmental economics journals; c] online reference and abstract databases; d] academic search engines; e] homepages of authors known to have published valuation studies of recreational fishing; f] web sites of agricultural and resource economics departments at several colleges and universities; and g] web sites of organizations and agencies known to publish environmental and resource economics valuation research.

[12] If two outlier observations corresponding to Morey et al. (1993) are excluded, WTP for catching an additional fish ranged from \$0.048 to \$327.29, with a mean of \$14.33.

calculate marginal WTP per fish.[13] In 52 cases where WTP per fish could not be calculated from regression coefficients, either because the regression equation was non-linear or because the study estimated WTP for a specified percentage change in catch rates, linear extrapolation was used to approximate marginal WTP.[14]

Another set of variables that warrant further explanation are those characterizing targeted fish species. Original studies in the meta-data address a substantial variety of species, many of which are similar (e.g., different species of pacific salmon). To reduce the number of occasions in which a species-specific dummy variable distinguishes only a single study, species were assigned to an aggregate species groups. These assignments were based on the angling, biological, and regional characteristics of each species. The assigned groups include four saltwater species groups (big game, small game, flatfish, and other saltwater fish), two anadromous species groups (salmon and steelhead trout), and five freshwater species groups (panfish, bass, walleye/pike, muskellunge, and trout). The other saltwater group includes bottomfish species, species caught by anglers not targeting any particular species, and species that did not clearly fit in one of the other groups. The panfish group includes freshwater species such as yellow perch, catfish, sunfish, and other warm-water species. Species groups that could be harvested in a variety of geographic areas were further subdivided on the basis of regional differences, using multiplicative interactions between species group and region. Table 5 shows the species assigned to each aggregate species group.

A final set of variables that may require additional explanation includes those characterizing average baseline catch rates. Studies in the meta-data expressed catch rates using four different measurement conventions: fish/hour, fish/day, fish/trip, and fish/year. Rather than include four distinct catch rate variables, we combine per hour, per day, and per trip catch rates into a normalized variable denoted *cr_nonyear*, which transforms catch rates to per day units.[15] Per year catch rates were specified as a separate variable, *cr_year*, with an additional dummy variable identifying those studies in which catch rates were so specified (*catch_year*).

**Empirical Methods**

Past meta-analyses have incorporated a range of statistical methods, with none universally accepted as superior (e.g., Poole and Greenland 1999; Bateman and Jones 2003; Poe et al. 2001; Johnston et al. 2003). Indeed, the literature provides mixed guidance on several specification and estimation issues, leaving researchers to make sometimes *ad hoc* judgments regarding the most appropriate specification of meta-models. Despite the variation in statistical approaches to meta-analysis, the literature has reached consensus on many fundamental issues. For example, there is general consensus that meta-models must somehow address potential correlation among observations provided by like authors or studies and the related potential for heteroskedasticity (Bateman and Jones 2003; Rosenberger and Loomis 2000b).

Here, we follow Bateman and Jones (2003) and apply a multilevel models to the meta-data, to

[13] For example, in studies applying random utility models (RUM), angler WTP for catching an additional fish may be calculated as a ratio of the first derivative of the estimated utility function with respect to the travel cost and the first derivative with respect to catch rate. This is interpreted as the change in travel cost that is just sufficient to return a representative angler to a baseline level of utility, subsequent to a one-fish increase in catch rate that causes an increase in utility above the baseline.

[14] In most cases, this involved calculating average WTP per fish for a specified increase in catch rates. For example, if a study reported that the average angler is willing to pay $10 per trip to catch an additional two fish per trip, then we calculated average marginal WTP per fish as $10 divided by two fish, or $5 per fish.

[15] For example, per hour catch rates were converted to per day catch rates by multiplying by the number of hours fished per day, as provided in the study. In cases where the study did not provide information on fishing day length, we assumed a four hour fishing day.

address potential correlation among observations gathered from single studies.[16] Following Poe et al. (2001) and Smith and Osborne (1996, p. 293), we also apply Huber-White robust variance estimation; this "approach treats each study as the equivalent of a sample cluster with the potential for heteroskedasticity…across clusters."

*Willingness to Pay for Water Quality Improvements: Empirical Methods*

In all cases, the dependent variable in is the natural log of estimated household WTP for water quality improvements in aquatic habitat. For model one, all right-hand-side variables are linear, resulting in a semi-log functional form common in meta-analysis (e.g., Smith and Osborne 1996; Johnston et al. 2003). While linear forms are also common (Bateman and Jones 2003, Poe et al. 2001, Rosenberger and Loomis 2000a,b), the semi-log form was chosen based on its statistical performance, ability to capture curvature in the valuation function, and because it allows independent variables to influence WTP in a multiplicative rather than additive manner.

For comparison, two alternative specifications are illustrated. Model two is a trans-log model, identical to the semi-log specification save for the inclusion of water quality measures as natural logarithms. This form shares many advantages of the semi-log functional form, but also incorporates the desirable quality that WTP is constrained to zero when quality change is also equal to zero. For both models one and two, weighting of observations is avoided following Bateman and Jones (2003). Model three is identical to the semi-log specification, save that observations are weighted following Poe et al. (2001). Weights are defined such that weights on multiple observations within each study sum to one. Although weighting methods prevent studies providing multiple observations from unduly influencing model estimation, they also imply that such studies are no more informative, overall, than others (Bateman and Jones 2003).

*Willingness to Pay for Increases in Recreational Harvest: Empirical Methods*

Trials with various common functional forms led to the selection of a semi-log functional form, in which the natural log of WTP per fish is regressed against a set of linear explanatory variables. As above, the selection of the semi-log functional form was based on statistical performance, intuitiveness of model results, and the common use of this model in the meta-analysis literature. Given the controversy in the literature over the use of weighted models, the unrestricted model is estimated using both weighted and unweighted models.

**Meta-Analysis Results—WTP for Water Quality Improvement in Aquatic Habitat**

Regression results reveal numerous statistically significant and intuitive patterns that influence WTP for water quality improvements in aquatic habitats (table 5). In general, the statistical fit of the three estimated equations is good; model results suggest a considerable systematic component of WTP variation. Likelihood ratio tests (table 6) show that model variables are jointly significant at $p<0.01$ in all cases. In all models, the majority of independent variables are statistically significant at $p<0.10$, with most statistically significant at $p<0.01$. Signs of significant parameter estimates generally correspond with intuition, where prior expectations exist. Considering these factors, the statistical performance of all models compare favorably to prior meta-analyses in the valuation literature.

While all models provide evidence of systematic WTP variation associated with resource, context, and study attributes, random-effects associated with systematic study-level variance ($\sigma_u^2$) are not statistically significant in any of the estimated models. Indeed, $\sigma_u^2$ approximates (or is equal to) zero in all cases. This finding is similar to those of Bateman and Jones (2003) and Johnston et al. (2003), and

[16] Some individually-published studies included in the recreational fishing meta-data rely on common valuation surveys (i.e., primary data). Where this occurs, the level-two effect is specified at the level of the valuation survey. For example, both Hicks et al. (1999) and U.S. EPA (2004) used data from the 1994 Marine Recreational Fisheries Statistics Survey for the Atlantic coast.

suggests that once one accounts for variation in observable resource, context, and study attributes, no additional systematic variation in WTP may be ascribed to study-level effects. This is a significant finding, as it suggests that systematic variation in WTP is not driven by unobservable attributes unique to particular studies or sets of study authors.

*Contrasting Model Specifications*

Despite differences in the three presented model specifications, statistical results are similar. In most all cases, coefficient magnitudes and standard errors vary to only a small degree. Measures of equation fit are similar, and all models are significant at $p<0.01$. Moreover, additional preliminary models—suppressed from table 5 for the sake of brevity—reveal that the signs and magnitudes of statistically significant parameter estimates are generally robust with regard to modest changes in model variables. Such results mirror those of Johnston et al. (2003), whose meta-analysis of use and nonuse WTP for water quality improvements finds a high degree of robustness to changes in model specification. For purposes of initial discussion, we emphasize results of the semi-log model (model one). Despite emphasizing results of a single model, we emphasize that—with a few exceptions to be discussed later—policy implications of the three model specifications are nearly identical.

*Systematic Components of WTP: Resource Attributes*

The variables *WQ_fish*, *WQ_shell*, *WQ_many*, and *WQ_non* indicate the effects of water quality improvements associated with gains in fish, shellfish, multiple species, and unspecified habitat, respectively (table 2). All signs are as expected. The associated coefficients are positive and statistically significant ($p<0.02$ or better), indicating that higher WTP is associated with larger gains in water quality, as measured on the RFF ladder (table 6). This is a noteworthy result, as it indicates that WTP—compared systematically across studies—is sensitive to the scope of water quality improvements (cf. Smith and Osborne 1996; Johnston et al. 2003).

Results also suggest that WTP for water quality improvement declines as baseline water quality increases. The variable *baseline* represents the baseline water quality from which water quality change would occur. The associated parameter estimate is significant ($p<0.01$) and of the expected negative sign, revealing diminishing returns to scale for water quality improvements. This finding suggests that WTP across studies is not only systematically sensitive to scope at a broad level (i.e., larger water quality improvements generate larger WTP), but at a more subtle, if no less important, level associated with diminishing marginal returns to scale.

*Systematic Components of WTP: Geographical and Water Body Type Attributes*

Ten binary variables characterize geographic region and scale and water body type; eight are statistically significant at $p<0.10$. The default category from which these variables allow systematic variations in WTP is an estuarine water body in the northeast United States. Compared to this baseline, lower WTP is associated with rivers (*single_river*, *multiple_river*), while higher WTP is associated with water quality gains in salt ponds (*salt_pond*). *Single_lake* and *regional_fresh* both have positive values, but neither is statistically significant.

Results further suggest that WTP is sensitive to the number of water bodies under consideration. Of the water body categories distinguished above, both rivers and salt ponds include variation in numbers of affected water bodies explicitly described by the survey. This variation is captured by the variable *num_riv_pond* (table 2). The associated parameter estimate is statistically significant ($p<0.01$) and indicates that WTP increases with the number of water bodies considered (table 6). This result, combined with the statistical significance of the water quality change variables noted above, suggests that WTP values in the meta-data are strongly sensitive to scope—both in terms of the number of water bodies and the magnitude of quality change. Such multidimensional scope sensitivity extends findings such as those of Smith and Osborne (1996), which address sensitivity to scope in more limited dimensions.

Finally, the regional indicator variables *southeast*, *pacif_mount*, *plains*, and *mult_reg* are statistically significant at $p<0.05$ (most at $p<0.01$), suggesting that there are significant differences among

WTP estimates from surveys in different geographical regions of the United States. While such effects may be related to systematic differences in preferences or resource characteristics across regions, they may also be related to otherwise unexplained characteristics of authors, methodology, or other factors that may be correlated with geographical region.

*Systematic Components of WTP: Population Attributes*

WTP studies often differ with regard to the presence and type of variables that characterize sampled populations. Given disparity in the treatment of such factors, meta-analyses in the valuation literature typically include few variables characterizing such attributes. Here, only two variables, *nonusers* and *income*, are used to characterize surveyed populations. The variable *nonusers* is of particular relevance. The negative and significant ($p<0.01$) parameter estimate indicates that surveys of nonusers only—where nonusers by definition have only nonuse values for the resource improvements in question (Freeman 2003, p. 142)—generate lower WTP values than surveys that include users, who may have both use and nonuse values. Caution must be taken in using such estimates to provide guidance regarding general population nonuse values, however, as nonuser values may underestimate nonuse values of the general population, if nonuse values of users exceed those of nonusers (Whitehead and Blomquist 1991).

*Systematic Components of WTP: Study Attributes*

A variety of study and methodology effects influence WTP for water quality improvements. While not surprising, this does indicate that methodological approach influences WTP, as indicated by prior meta-analyses (e.g. Johnston et al. 2003; Brouwer 2002; Rosenberger and Loomis 2000a; Smith and Osborne 1996). Of twelve variables characterizing study and methodological effects, ten are significant at $p<0.10$. Among these is the year in which a study was conducted (*year_indx*), with later studies associated with lower WTP. This is an expected result, as the focus of stated preference survey design over time has often been on the reduction of biases that would otherwise result in an overstatement of WTP (Arrow et al. 1993).

Model results reveal that voluntary (*voluntary*) payment vehicles are associated with reduced WTP estimates. This result counters common intuition that voluntary payment vehicles may be associated with overstatements of true WTP, but may indicate an unwillingness among respondents to proffer large voluntary payments, given the fear that others will free-ride.

Smaller WTP estimates are associated with studies that eliminate or trim outlier bids when estimating WTP (*outlier_bids*; $p<0.01$). Conversely, increased WTP estimates are associated with studies that seek to eliminate protest bids (*protest_bids*; $p<0.01$), suggesting a preponderance of zero protest bids. Especially when eliciting values that relate to ecological resources, such as fish species, such bids may be provided by respondents that have preferences structures at variance with consumer choice axioms; they may be essentially unwilling to equate an ecological change with *any* dollar amount (Spash 2000).

Studies with high response rates (*hi_response*; $p<0.01$) are associated with lower WTP estimates, an expected result associated with limiting avidity bias. In addition, lower WTP is associated with the use of the RFF water quality ladder in the original survey (*wq_ladder*; $p<0.10$). As is the case with a variety of study design variables, there is no necessary expectation with respect to the direction of this effect. Survey format variables also have an effect on WTP, as might be expected. *Interview* and *mail* both have positive and statistically significant coefficients ($p<0.01$), compared to the default of telephone surveys.

WTP values for the majority of studies included in the analysis consist of annual payments over an indefinite duration. However, a small number of studies estimate WTP for payments over a short horizon—typically three to five years. The variable *lump_sum* identifies studies in which payments were to occur on something other than an indefinite annual basis (table 2). The positive and statistically significant parameter for *lump_sum* indicates sensitivity to the payment schedule (Stevens et al. 1997). Studies that ask respondents to report an annual payment (as opposed to a shorter *lump_sum* payment) have lower nominal WTP estimates ($p<0.01$).

**Meta-Analysis Results—Per Fish WTP for Increases in Recreational Catch**

Statistical results for three unweighted and one weighted multilevel model specifications are illustrated in table 7. Model one is an unrestricted model, including the full set of variables listed in table 7. Model two is a restricted model, distinguished from model one by omission of all variables characterizing resource, context, and angler attributes (i.e., only methodological variables remain). Model three is a restricted model, from which all variables characterizing study methodology have been omitted. Model four is an unrestricted weighted model.

Likelihood ratio tests indicate that models one, three, and four (unrestricted and methodology-omitted models) are statistically significant at better than $p<0.01$ ($\chi^2$=236.5, 188.2, and 341.4 with df = 45, 33, and 45, respectively). However, model two, including only methodological variables, may be shown to be significant only at $p=0.1097$ ($\chi^2$=18.2; df=12). Based only on these results, one might conclude that methodological variables have no statistically significant influence on WTP at $p<0.10$, across the 391 observations.

Such a preliminary conclusion, however, is refuted by statistical comparisons across the three unweighted models. Specifically, likelihood ratio tests of restrictions incorporated in models two and three reject the null hypothesis of zero joint influence (of omitted variables) in both cases. For model two, the restrictions are statistically significant at better than $p<0.01$ ($\chi^2$=218.3; df=33), indicating that the omission of resource, context, and angler characteristics has a statistically significant impact on the model. For model three, the restrictions are also statistically significant at better than $p<0.01$ ($\chi^2$=48.3; df=12), indicating that the omission of methodological variables has a statistically significant impact on the model. Hence, once one has incorporated variables characterizing resource, context, and angler characteristics, variables characterizing study methodology become highly significant.

Aside from significant effects associated with methodological variables, all models find significant variation associated with study-level random effects, indicating that WTP is influenced by otherwise unobservable attributes of individual studies or valuation surveys. While this may indicate the presence of valid differences in WTP across studies related to unobservable attributes (or attributes otherwise unincorporated in the meta-analysis), it may also indicate the presence of systematic biases associated with particular studies or authors. These results further suggest that systematic variation in WTP per fish is not limited to desirable variation associated with easily observable resource, context, and angler characteristics.

Given results of likelihood ratio tests noted above, we base subsequent discussions on the unrestricted models (models one and four). Contrasting these models, we find generally similar results, notwithstanding a small number of variables that change sign and/or significance. For example, angler income may be shown to be statistically significant in the weighted model; it is not statistically significant in the unweighted model. The statistical significance of a small number of species/region coefficients also changes between the two models. Given the generally similar results of the two models, however, we follow Bateman and Jones (2003) and Johnston et al. (2003), and base subsequent discussions largely on unweighted model results.[17]

*Impact of Methodological Variables*

While likelihood ratio tests indicate a statistically significant impact of methodological variables on WTP per fish, they also indicate that the joint explanatory power of these variables is lower that that of variables characterizing resource, context, and angler attributes. This somewhat positive sign notwithstanding, study methodology clearly influences WTP per fish, suggesting the presence of that which Markowski et al. (2002) denote "experimentally-induced biases" in source-study WTP estimates.

The statistical significance of methodological effects only emerges, however, once one appropriately accounts for WTP variation associated with resource, context, and angler characteristics. (Recall, the model incorporating only methodological variables cannot be shown to be statistically

[17] Markowski et al. (2002) discusses the potential role of weighting in meta-models in greater detail.

significant at $p<0.10$.) This finding suggests that simple comparisons of mean or median WTP values across studies—without addressing systematic differences in resources, contexts, or populations—may result in misleading conclusions regarding the influence of methodological approaches on WTP.

Coefficient signs and magnitudes also provide insight into the effects that may be associated with particular approaches to estimating WTP per fish. For example, model results suggest that lower WTP estimates are associated with the use of stated preference methodologies, compared to revealed preference methodologies. Holding all else constant, this finding holds for all variants of stated and revealed preference approaches, as revealed by coefficient estimates for *SP_conjoint*, *SP_dichot*, *TC_individual*, *TC_zonal*, *RUM_nest*, and *RUM_nonnest*. While perhaps counter to common intuition, this finding is consistent with past findings of Cameron (1992), Carson et al. (1996) and others.

This finding must be qualified, however, given the potentially confounding effects of other variables characterizing the implementation of stated preference methods. For example, positive coefficient estimates associated with *SP_phone*, *SP_mail*, and *SP_year* suggest that larger WTP estimates are associated with telephone and mail survey instruments and with more recent surveys. Thus, for studies based on recent telephone or mail surveys, stated preference WTP estimates might be expected to exceed those from some revealed preference methods. The positive influence of *SP_year* on WTP per fish is of particular note, given that the focus of survey design over time has often been on the reduction of survey biases that would otherwise result in an overstatement of WTP (Johnston et al. 2003). Hence, the finding that more recent studies are associated with increased WTP might be considered somewhat counterintuitive.

Other methodological variables show generally expected influences on WTP per fish. For example, as noted above, in-person interview methods (the default) are associated with reduced WTP, compared to telephone or mail implementation (*SP_mail*; *SP_phone*), although the coefficient associated with *SP_mail* is not statistically significant at $p<0.10$. The model does not find a statistically significant difference between WTP per fish associated with open-ended surveys (including payment cards and iterative bidding) and that associated with dichotomous choice instruments (*SP_dichot*). However, a statistically significant reduction in WTP is associated with choice experiment or conjoint surveys (*SP_conjoint*). Hence, while some prior research has shown that discrete choice methods may be associated with higher WTP estimates (Boyle et al. 1996; Ready, Buzby, and Hu 1996), results here do not support such conclusions.

Although parameter estimates associated with the various revealed preference methods are all statistically significant at $p<0.01$, their magnitudes are similar (i.e., ranging from 3.23 to 3.91). This finding indicates that within our meta-data, little difference in WTP may be associated with the use of different variants of revealed preference methodology (e.g., random utility models, individual travel cost models, zonal travel cost models). However, model results do suggest that studies with higher response rates (for both stated and revealed methods) are associated with reduced estimates of WTP per fish.

*Impact of Resource, Context, and Angler Characteristics*

Eight variables characterize angler demographic and economic attributes. Four of these are statistically significant at $p<0.01$, and associated parameter estimates have expected signs (where prior expectations exist). Although the coefficient estimate associated with angler household income (*inc_thou*) is not statistically significant in the unweighted model, it is of the expected positive sign. The parameter estimate on gender is negative and significant, indicating that women are willing to pay more to catch an additional fish per trip. Finally, the parameter estimate for *nonlocal* is positive and significant, indicating that anglers who travel out-of-state to fish are willing to pay more to catch additional fish than those who fish in local areas.

The model includes 20 binary variables that characterize the target species and region in which the species was targeted, contrasted to the default of panfish harvested nationwide (tables 2, 4). Fifteen of these variables are significant at $p<0.05$. In general, results suggest that higher WTP estimates are associated with anadromous species (i.e., salmon and steelhead) in all regions, big game fish (particularly in the South Atlantic and Pacific), and muskellunge. Generally lower WTP estimates are associated with

species groups such as panfish, trout (non-steelhead), and "other" saltwater species (*other_sw*).

The systematic and largely intuitive patterns in WTP per fish associated with species/region variables are one of the more promising results of the meta-analysis. Despite the fact that WTP estimates are drawn from 48 distinct studies (391 observations), results suggest substantial homogeneity associated with the WTP for similar fish species. For example, figure 1 illustrates parameter estimates (indicating marginal effects on WTP per fish) for freshwater trout fishing in different geographic regions, compared to those for anadromous species (i.e., salmon and steelhead). Figure 1 shows that WTP for catching an additional salmon or steelhead is remarkably stable across regions, with parameter estimates ranging from 2.25 to 2.46. The sole exception is the parameter estimate for *salmon_Atlantic* (5.34). This estimate, however, should be interpreted with caution, as all observations for Atlantic salmon are obtained from two studies sharing the same primary author (Morey, Shaw, and Rowe 1991; Morey, Rowe, and Watson 1993). Somewhat larger variations in parameter estimates are evident within the trout group. Specifically, larger WTP per fish is associated with Great Lakes trout compared to trout caught in inland streams and lakes. Nonetheless, the meta-analysis reveals a clear pattern in which WTP per fish for anadromous species exceeds that for freshwater trout species, *ceteris paribus*.[18]

Holding all else constant, WTP results are also similar across regions for flatfish (*flatfish_atl*, *flatfish_pac*), small game (*small_game_atl*, *small_game_pac*), and big game (*big_game_natl*, *big_game_satl*, *big_game_pac*). This again suggests that similar species tend to generate similar per fish WTP estimates. More broadly, such results illustrate patterns in which WTP per fish—across the different studies in the meta-analysis—is systematically related to the type of species targeted. Moreover, relative WTP appears to be consistent with intuition regarding the highest versus lowest valued recreational fish.

A third set of variables characterizes other attributes of fishing, including the catch rate. The negative parameter estimates for both *cr_nonyear* and *cr_year* indicate that anglers' WTP per fish decreases as the baseline catch rate increases. This result is consistent with both economic theory and expectations. However, of these variables, only *cr_year* is statistically significant ($p<0.01$); although of the expected sign, *cr_nonyear* is not statistically significant.

**Implications for WTP Estimation and Benefit transfer**

Findings from both meta-analyses suggest a wide range of robust, systematic and intuitive patterns influencing WTP for aquatic resource improvements. Results suggest that while WTP is sensitive to survey and elicitation methods, it is also systematically influenced by scope in various dimensions, the type of habitat or species under consideration, the type of population sample (i.e., user versus nonuser), and other attributes of the resource(s) and region(s) in question. Based on such results, one might argue that meta-analyses can provide useful guidance regarding the general magnitudes of welfare effects within a benefit transfer context—at least with regard to potential WTP adjustments associated with policy, resource, or context effects.

The statistical performance of these particular meta-analyses notwithstanding, however, there are a variety of issues that must be addressed if one seeks to use such results for benefit transfer or welfare guidance. Many of these issues may not be appropriately resolved based solely on theoretical or empirical considerations, and involve such features as implications of functional form, the assignment of levels for study design attributes, and methods used to reconcile environmental quality measures. Such issues remain relevant, even in instances where WTP variation is largely systematic and robust to changes in model specification. Two examples are illustrated—one from each meta-model—to illustrate potential issues and questions faced by researchers seeking to use meta-analysis for benefits transfer or welfare

[18] Note that anadromous steelhead and freshwater rainbow trout are the same species (Oncorhynchus mykiss). Therefore, rainbow trout caught in the Great Lakes region was classified as steelhead. Meta-analysis results clearly indicate that WTP for steelhead/rainbow trout fishing more closely approximates that for other anadromous species, rather than that for other trout species.

assessment.

*Example One: Sensitivity of WTP (for Water Quality Improvements) to Study Methodology and Functional Form*

The literature provides little guidance with regard to the choice of functional forms for meta-models used in welfare analysis. Econometric functional forms are most appropriately interpreted as approximations of actual functional relationships. Nonetheless, there may be constraints or patterns imposed by specific functional forms that researchers may find desirable or undesirable in certain contexts. For example, while many meta-analyses of WTP apply linear or semi-log functional forms, appropriately specified double log or trans-log models have the desirable quality that WTP may be constrained to zero when quality change is also equal to zero. Semi-log and linear specifications do not impose this exogenous—but theoretically attractive—restriction. In addition, constraints imposed on the second-derivatives of estimated WTP by semi-log or linear functions may be undesirable under certain circumstances. Such issues may be of particular relevance in cases where WTP is highly sensitive to functional form, or in which investigators are faced with a choice of one form that may offer superior empirical performance while an alternative form provides desirable theoretical properties.

The literature also provides little guidance with regard to the specification of variables characterizing study methodology, including those characterizing such factors as survey implementation, question formats, payment vehicles, and analytic methods. Here, WTP is sensitive to a wide array of such variables (table 6). While this does not negatively affect the statistical properties of meta-models—and in fact may be expected—it does lead to questions regarding the most appropriate treatment of these variables for benefit transfers.

To illustrate potential implications of issues such as functional form and variable level assignment in the present case, we use model results (table 6) to estimate nonuser WTP associated with increasing levels of *WQ_fish*. Nonuser WTP estimates are calculated for both the semi-log and trans-log models. For purposes of illustration, levels for policy and context variables are fixed at levels consistent with what might be expected from a regulation promulgated under the US Clean Water Act. To illustrate the potential significance of level assignments for study methodology variables within this context, we calculate nonuser WTP given two different sets of level assignments for these variables. For simplicity, we show potential WTP variation associated with changes in only one set of methodology variables—those characterizing survey administration method (e.g., mail, phone, or in-person). Other methodological variables are set with the goal of providing conservative WTP estimates, subject to consistency with methodological guidance in the literature.[19]

Table 8 shows the four scenarios under which nonuser WTP is illustrated. These include 1] semi-log specification, mail survey; 2] trans-log specification, mail survey; 3] semi-log specification, telephone survey; 4] trans-log specification, telephone survey. For each scenario, table 8 illustrates estimated mean nonuser WTP for three different levels of *WQ_fish* (increases of 0.5, 1.0 and 2.0 units). To further clarify WTP differences, figure 2 illustrates estimated nonuser WTP for each scenario, as a continuous function of *WQ_fish*. As baseline water quality for WTP illustration is set at 7 on the RFF ladder, the maximum possible gain in *WQ_fish* is 3.

In general, illustrated patterns in WTP (figure 2) show little sensitivity to functional form; over most of the data range WTP forecasts are similar. While the choice between semi- and trans-log forms may have little practical consequence for policies involving moderate water quality change (between 0.5 and 2.5), implications are more evident at the extremes of the data—particularly for very small changes in water quality. While more striking WTP differences occur in a data range for which there are no in-

[19] For example, in correspondence with typical guidance (e.g., Arrow et al. 1993) we assume a non-voluntary payment mechanism (*voluntary* = 0), a discrete choice instrument (*discrete_ch* = 1), high response rate (*hi_response*=1), and elimination of protest and outlier bids (*protest_bids* = 1; *outlier_bids* = 1).

sample observations (the smallest water quality change present in the meta-data is 0.5 units), they nonetheless exemplify the need to carefully consider choices affecting the development and application of meta-analysis for benefit transfer.

Central to such choices here is a tradeoff between congruence to accepted theory and model fit. To wit, the trans-log model offers desirable theoretical properties, as noted above. These include the properties that WTP approaches zero as quality change approaches zero, and the negative second-derivative of the WTP function with regard to water quality change. In contrast, the semi-log model offers a somewhat improved fit to the data. The meta-analysis literature offers little to assist researchers in choosing among such contrasting specifications.

Unlike sensitivity associated with functional form, WTP variation associated with the survey administration method applies over the full range of policy outcomes, with often substantial implications for WTP. Figure 2 illustrates substantial shifts in estimated nonuser WTP associated with changes in the method of survey administration, with mail surveys associated with as much as a 76% increase in predicted WTP, compared to the default of a telephone survey.

Researchers may address such sensitivity in a variety of ways. Where possible, one might choose variable levels based on guidance from prior work regarding the appropriateness of particular methodologies within stated preference research (Arrow et al. 1993). Where such guidance is lacking, variables might be specified at mean values. A potential advantage of the mean-value approach includes reduced sensitivity to researcher judgment, as variable level assignments are determined by the data. However, while the use of mean values for methodological variables represents an alternative, perhaps compelling strategy for variable-level assignments, it does not ameliorate the sensitivity of WTP to such variables.

An alternative approach to the sensitivity of WTP to methodological variables would be to omit such variables from the model(s). That is, variables characterizing study methodology–assuming negligible correlation to other model variables–might be dropped, their influence instead subsumed under random-effects in the multilevel model. Statistical tests (e.g., Hausman; likelihood ratio) would be essential in such cases. Here, likelihood ratio ($\chi^2$=51.17; df=11; p=0.0001) and Hausman ($\chi^2$=36.73; df=19; p=0.009) tests performed on preliminary models indicate that such omissions are both statistically significant, and lead to systematic changes in remaining model parameters, respectively.[20] Hence, in the present case, the omission of methodological variables appears unjustified from a statistical perspective.

The appropriateness and policy implications of such solutions may vary across datasets and policy contexts. Such variation notwithstanding, the potential sensitivity of WTP to variables characterizing study methodology remains a challenge to those seeking to apply meta-analysis for welfare estimation. However, at least in the present case, issues related to functional form appear to have only modest implications for WTP estimates derived from the meta-model. Similar examples may be used to illustrate that the choices of weighted versus unweighted models have only modest implications for WTP in the present case; this finding is not surprising given the similarity of parameter estimates in table 6.

*Example Two: Sensitivity of Per-Fish WTP (among Recreational Anglers) to Study Methodology*

To illustrate the potential magnitude of methodological effects on WTP within the second meta-analysis (e.g., per fish WTP among recreational anglers), we forecast marginal WTP for four species groups (Pacific salmon, South Atlantic big game, freshwater panfish, and Atlantic flatfish), under varying assumptions regarding study methodology. For purposes of illustration, WTP is forecast assuming that angler characteristics are set equal to mean values. We also assume a situation in which information

[20] The Hausman test compares an unrestricted semi-log, unweighted model to an analogous model from which the eleven methodological variables (noted in table 5) have been omitted. Full results of the restricted model are suppressed for brevity. The unrestricted model is identical to that shown in table 3, save that Huber-White adjustment is not applied to the covariance matrix.

regarding age, gender, trips, and catch rates is provided by the source study (i.e., *spec_age*, *spec_gender*, and *spec_cr* are equal to one). Catch rates are assumed to be specified per day, at the mean sample value of 2.10 for *cr_nonyear*.

For each of the four species noted above, WTP is forecast under three methodological scenarios: 1] conjoint methodology with an in-person survey instrument; 2] a nested random utility (RUM) model; and 3] an individual travel cost model. For all cases, we assume response rates below 50%. Because there is some correlation between study methodology and the year in which studies were conducted, we set *SP_year*, *TC_year*, and *RUM_year* equal to their mean for each valuation methodology.[21] Figure 3 illustrates resulting WTP forecasts.[22]

As shown by figure 3, study methodology may have substantial effects on WTP. Across the four species groups—and given other specification assumptions noted above—model results predict a 89% increase in WTP associated with the use of individual travel cost methods and a 59% increase in WTP associated with the use of nested RUM models, compared to in-person conjoint methods. RUM model WTP forecasts exceed individual travel cost forecasts by 19%. In terms of raw magnitudes, WTP differences are similarly large, but vary according to species group. For example, WTP for an additional Pacific salmon is $51.05 assuming travel cost methods, but is only $26.98 assuming conjoint methods—a difference of $24.07 (figure 3). The analogous WTP difference shrinks to $2.48 for panfish: still a substantial increase in relative terms, compared to the baseline WTP forecast of $2.79 from the in-person conjoint model.

This variation in cardinal WTP magnitude may also affect the ordinal ranking of species WTP. For example, species/region coefficients alone suggest that WTP per Pacific salmon exceeds that for an additional Atlantic flatfish, holding all else equal (table 7). However, the illustrated forecast of WTP per fish for Pacific Salmon assuming conjoint methodology ($26.98) is *lower* than the forecast for an additional Atlantic flatfish assuming individual travel cost methodology ($45.73) (figure 3). While the ordinal ranking of WTP associated with other species groups is more robust[23], such results nonetheless suggest that pair-wise or small-sample comparisons of WTP estimates across studies using different methodological approaches may in some instances result in misleading inferences regarding relative WTP per fish, and suggests that researchers treat such comparisons with caution.

Further complicating WTP effects associated with study methodology is the potential confounding impact of variables characterizing other aspects of research design and implementation. These include, for example, survey administration method, study year, and response rate. As an example of such effects, figure 4 reprises the WTP illustration shown in figure two, but with the study year variables (*SP_year*, *TC_year*, and *RUM_year*) set to 2000 instead of their mean values.

---

[21] All observations taken from studies that used a conjoint methodology were based on surveys conducted between 1986 and 2000, with a mean survey year of 1994.8. For the illustration, SP_year is set to this value. Similarly, RUM_year is set to 1993.7 and TC_year is set to 1981.7, based on the mean survey year for observations from studies using nested random utility models and individual travel cost models, respectively.

[22] Following Bockstael and Strand (1987), $\hat{\sigma}_u^2 / 2$ is incorporated into the sum of variable effects when estimating WTP, to account for regression error in WTP estimates.

[23] For example, WTP per additional Pacific salmon based on the three sets of methodological assumptions described above ($51.05, $43.01, $26.98; figure 2) universally exceeds that for Atlantic flatfish ($15.98, $13.47, $8.45; figure 2), regardless of assumed methodology. Indeed, in most cases when the coefficients of two species variables are statistically distinguishable, WTP predictions for those two species based on different methodological assumptions are also distinguishable (i.e., the range of predictions based on different methodologies for one species do not overlap with the range of predictions for the other species). Such results suggest that despite significant variation associated with different valuation methodologies and survey techniques, comparisons of WTP estimates across studies using different methodological approaches may still result in correct inferences regarding the ordinal ranking of per fish WTP across difference species.

Results again show divergence in WTP across methodologies. Compared to WTP estimates based on in-person conjoint analysis methods, predicted WTP is 51% smaller assuming a nested RUM model and 75% smaller assuming an individual travel costs model (figure 4). The magnitude of WTP effects aside, these results are of particular note given that the original illustration of figure 3 (assuming mean study years for each methodology) forecasts an *opposite* ordering of WTP, with regard to study methodology. For example, figure 4 indicates that WTP associated with conjoint studies *exceeds* that associated with the other two methodological options, assuming a study year of 2000 in all cases. In contrast, figure 3 indicates that WTP associated with conjoint studies *is lower than* that associated with the other two options.

Such results suggest that careful consideration be given to the assumptions used in applying the estimated model to forecast WTP. Perhaps more significantly, results also point to the potential difficulty in establishing invariant patterns in WTP associated with particular types of survey methodology (e.g., conjoint, RUM). Here, such conclusions vary markedly depending on the assumed values of other study attributes. Hence, while model results establish the presence of (desirable) systematic WTP variation associated with resource, context, and angler attributes, they also indicate that WTP is subject to systematic variation associated with study methodology, and that these latter effects do not follow universal, easily-identifiable patterns.

**Are Methodological Effects Consistent Across Meta-Models?**

Compounding potential challenges associated with the treatment of methodological effects in meta-analysis used for welfare evaluation is the fact that such effects may not be consistent across resource types. For example, in-person interview methods are associated with statistically significant *increases* in estimated WTP within studies addressing stated preferences for water quality improvements (compared to mail and phone surveys), yet are also associated with statistically significant *decreases* in estimated WTP within studies addressing increased recreational catch. Similarly, the effect of survey year does not appear consistent—with later surveys associated with reduced stated WTP for water quality improvements (*year_indx*), and increased stated WTP for fish catch (*SP_year*). In other instances, however, methodological effects are consistent across meta-models. For example, high response rates are associated with a statistically significant decrease in WTP in both illustrated meta-analyses.

The consistency of methodological impacts across different meta-analyses—addressing WTP for different resource types—is an area of research that has yet to be explored in the literature. However, findings of such assessments may shed considerable light on both the reliability of meta-analysis and/or the consistency of methodological effects (on WTP) across different types of resources. Both issues may have critical implications for the use of meta-analysis for welfare evaluation and benefit transfer.

**Conclusion**

This paper presents two meta-analyses conducted to estimate systematic components of WTP for aquatic resource improvements. Model results are promising with regard to the ability of meta-analysis to identify systematic components of WTP and reveal patterns unapparent from valuation models considered in isolation. We find intuitive and statistically significant relationships between a range of independent variables and WTP, including findings that indicate strong sensitivity to scope in various dimensions. WTP for both water quality improvements and increases in recreational catch is shown to be sensitive to such factors as geographical region, sample characteristics, water body type, habitat type, and a variety of study design attributes.

While illustrating that meta-analysis can successfully explain a substantial proportion of the variance in WTP estimates, model results also expose challenges faced in the estimation and interpretation of meta-models for policy analysis. These challenges involve methodological choices faced by researchers, and remain salient even in cases where the statistical performance of meta-models may be exemplary. Researchers commonly face choices involving such factors as functional form, the use of weights in statistical models, and metrics used to reconcile resource quality across studies (Smith et al. 2002; Engel 2002). In addition, application of meta-models to policy analysis typically requires

professional judgment regarding selection of independent variable values, particularly for variables characterizing study methodology.

Currently, the literature provides minimal guidance regarding such issues. However, as meta-analysis and similar methods become more commonly used as central components of benefit cost analyses, the need for research and guidance on such issues will almost certainly increase. Even given strong systematic variation in WTP, the ability of researchers to agree on standard guidance for policy applications of meta-analysis and benefit transfer may have significant implications for the future role of such methods in applied welfare analysis.

**References**

Agnello, R. 1989. The Economic Value of Fishing Success: An Application of Socioeconomic Survey Data. *Fishery Bulletin* 87(1):223-232.

Aiken, R.A. 1985. Public Benefits of Environmental Protection in Colorado. Masters thesis. Colorado State University.

Alexander, S.J. 1995. "Applying Random Utility Modeling to Recreational Fishing in Oregon: Effects of Forest Management Alternatives on Steelhead Production in the Elk River Watershed." Oregon State University. 0172 [DAI, 56, no. 04A, (1995): 1461]

Anderson, G.D. and S.F. Edwards. 1986. Protecting Rhode Island's Coastal Salt Ponds: An Economic Assessment of Downzoning. *Coastal Zone Management* 14( ½): 67-91.

Arrow, K. , R. Solow, E. Leamer, P. Portney, R. Rander, and H. Schuman. 1993. Report of the NOAA Panel on Contingent Valuation. *Federal Register* 58 (10): 4602-4614.

Azevedo, C., J.A. Herriges, and C.L. Kling. 2001. Valuing Preservation and Improvements of Water Quality in Clear Lake. Center for Agricultural and Rural Development (CARD), Iowa State University, Staff Report 01-SR 94.

Bateman, I.J. and A.P. Jones. 2003. Contrasting conventional with multi-level modeling approaches to meta-analysis: Expectation consistency in U.K. woodland recreation values. *Land Economics* 79(2):235-258.

Bergstrom, J.C. and P. De Civita. 1999. Status of benefits transfer in the United States and Canada: A Review. *Canadian Journal of Agricultural Economics* 47(1):79-87.

Berrens, R.P., O. Bergland, and R.M. Adams. 1993. Valuation Issues in an Urban Recreational Fishery: Spring Chinook Salmon in Portland, Oregon. *Journal of Leisure Research* 25: 70-83.

Besedin, E., M. Mazzotta, D. Cacela and L. Tudor. 2004. "Combining Ecological and Economic Analysis: An Application to Valuation of Power Plant Impacts on Great Lakes Recreational Fishing." Paper Presented at American Fisheries Society meeting Symposium: Socio-economics and Extension: Empowering People in Fisheries Conservation, Madison, WI.

Bockstael, N. and I. Strand. 1987. The Effect of Common Sources of Regression Error on Benefit Estimates. *Land Economics* 63(1):11-20.

Bockstael, N.E., K.E. McConnell and I.E. Strand. 1989. Measuring the Benefits of Improvements in Water Quality: The Chesapeake Bay. *Marine Resource Economics* 6(1): 1-18.

Boyle, K.J., B. Roach, and D.G. Waddington. 1998. 1996 Net Economic Values for Bass, Trout and Walleye Fishing, Deer, Elk and Moose Hunting, and Wildlife Watching: Addendum to the 1996 National Survey of Fishing, Hunting and Wildlife-Associated Recreation. Report 96-2. U.S. Fish and Wildlife Service, August.

Boyle, K.J., F.R. Johnson, D.W. McCollum, W.H. Desvousges, R.H. Dunford, and S.P. Hudson. 1996. Valuing Public Goods: Discrete versus Continuous Contingent-Valuation Responses. *Land Economics* 72(3):381-396.

Boyle, K.J., G.L. Poe and J. Bergstrom. 1994. What Do We Know About Groundwater Values?

Preliminary Implications form a Meta-Analysis of Contingent Valuation Studies. *American Journal of Agricultural Economics* 76(5):1055-1061.

Breffle, W., E.R. Morey, R.D. Rowe, D.M. Waldman, S.M. Wytinck. 1999. Recreational Fishing Damages From Fish Consumption Advisories in the Waters of Green Bay. Prepared by Stratus Consulting Inc., Boulder, CO, for U.S. Fish and Wildlife Service, U.S. Department of Justice, U.S. Department of Interior. November 1.

Brouwer, R. 2002. Environmental Value Transfer: State of the Art and Future Prospects. In *Comparative Environmental Economic Assessment*, P. Nijkamp, R. Florax, and P. Willis eds., Cheltenham, UK: Edward Elgar Publishers.

Brouwer, R., I.H. Langford, I.J. Bateman, and R.K. Turner. 1999. A Meta-Analysis of Wetland Contingent Valuation Studies. *Regional Environmental Change* 1(1):47-57.

Button, K. 2002. An Evaluation of the Potential of Meta-Analysis, in *Comparative Environmental Economic Assessment*, P. Nijkamp, R. Florax, and P. Willis eds., Cheltenham, UK: Edward Elgar Publishers.

Cameron, T.A. 1992. Combining Contingent Valuation and Travel Cost Data for the Valuation of Non-Market Goods. *Land Economics* 68(3):302-307.

Cameron, T.A. and D.D. Huppert. 1989. OLS versus ML Estimation of Non-market Resource Values with Payment Card Interval Data. *Journal of Environmental Economics and Management* 17(3): 230-246.

Cameron, T.A. and M.D. James. 1987a. Efficient Estimation Methods for 'Closed-Ended' Contingent Valuation Surveys. *The Review of Economics and Statistics* 69(2):269-76.

Cameron, T.A. and M.D. James. 1987b. Estimating Willingness to Pay From Survey Data: An Alternative Pre-Test-Market Evaluation Procedure. *Journal of Marketing Research* 24(4):389-395.

Carson, R. C., N. E. Flores, K. M. Martin, and J. L. Wright. 1996. Contingent Valuation and Revealed Preference Methodologies: Comparing the Estimates for Quasi-Public Goods, *Land Economics* 72(1):80-99.

Carson, R.; M. Hanemann; and D. Steinberg. 1990. A Discrete Choice Contingent Valuation Estimate of the Values of Kenai King Salmon. *Journal of Behavioral Economics* 19(1):53-68:

Carson, R.T., W.M. Hanemann, R.J. Kopp, J.A. Krosnick, R.C. Mitchell, S. Presser, P.A. Ruud, and V.K. Smith. 1994. Prospective Interim Lost Use Value due to DDT and PCB Contamination in the Southern California Bight. Volume 2. Report to the National Oceanic and Atmospheric Administration, Produced by Natural Resources Damage Assessment Inc., LA Jolla, CA.

Clonts, H.A., and J.W. Malone. 1990. Preservation Attitudes and Consumer Surplus in Free Flowing Rivers. In *Social Science and Natural Resource Recreation Management*, Joanne Vining, ed., Boulder, CO: Westview Press.

Croke, K., R.G. Fabian and G. Brenniman. 1987. Estimating the Value of Improved Water Quality in an Urban River System. *Journal of Environmental Systems* 16(1): 13-24.

Cronin, F.J. 1982. Valuing Nonmarket Goods Through Contingent Markets. Richland, WA: Pacific Northwest Laboratory, PNL-4255,

Dalton, R.S., C.T. Bastian, and J.J. Jacobs. 1998. Estimating the Economic Value of Improved Trout Fishing on Wyoming Streams. *North American Journal of Fisheries Management* 18(4):786-797.

De Zoysa, A.D.N. 1995. A Benefit Evaluation of Programs to Enhance Groundwater Quality, Surface Water Quality and Wetland Habitat in Northwest Ohio. Dissertation, Ohio State University.

Desvousges, W.H., F.R. Johnson, and H.S. Banzhaf. 1998. *Environmental Policy Analysis with Limited Information: Principles and Applications of the Transfer Method*. Edward Elgar Publishers, Northampton, MA.

Desvousges, W.H., V.K. Smith and M.P. McGivney. 1983. A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvements. Washington, D.C.: U.S. Environmental Protection Agency, Economic Analysis Division.

Engel, S. 2002. Benefit Function Transfer Versus Meta-Analysis as Policy Making Tools: A Comparison. In *Comparative Environmental Economic Assessment*, P. Nijkamp, R. Florax, and P. Willis eds., Cheltenham, UK: Edward Elgar Publishers.

Farber, S., and B. Griner. 2000. Valuing Watershed Quality Improvements Using Conjoint Analysis. *Ecological Economics* 34(1): 63-76.

Freeman, A.M. III. 2003. *The Measurement of Environmental and Resource Values: Theory and Methods*. Washington, DC: Resources for the Future.

Gautam, A. and S. Steinback. 1998. "Valuation of recreational fisheries in the north-east U.S. Striped Bass: A Case Study." *Recreational Fisheries: Social, Economic and Management Aspects*. Ch 23. Ed. Phil Hickley and Helena Tompkins, Fishing News Books, Oxford.

Glass, G.V. 1976. Primary, Secondary, and Meta-Analysis of Research. *Educational Researcher* 5(10): 3-8.

Glass, G.V., B. Shaw, and M.L. Smith. 1981. *Meta-Analysis in Social Research*. Beverly Hills, CA: Sage Publications.

Hayes, K.M., T.J. Tyrrell and G. Anderson. 1992. Estimating the Benefits of Water Quality Improvements in the Upper Narragansett Bay. *Marine Resource Economics* 7: 75-85.

Herriges, J.A., and J.F. Shogren. 1996. Starting Point Bias in Dichotomous Choice Valuation with Follow-Up Questioning. *Journal of Environmental Economics and Management* 30(1): 112-131.

Hicks, R. 2002. Stated Preference Methods for Environmental Management: Recreational Summer Flounder Angling in the Northeastern United States. Final report prepared for Fisheries Statistics and Economics Division, Office of Science and Technology, National Marine Fisheries Service. Requisition Request # NFFKS-18. March.

Hicks, R., S. Steinback, A. Gautam, and E. Thunberg. 1999. Volume II: The Economic Value of New England and Mid-Atlantic Sportfishing in 1994. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. NOAA Technical Memorandum NMFS-F/SPO-38.

Huang, J.C., T.C. Haab and J.C. Whitehead. 1997. Willingness to Pay for Quality Improvements: Should Revealed and Stated Preference Data Be Combined? *Journal of Environmental Economics and Management* 34(3): 240-255.

Huppert, D.D. 1989. Measuring the Value of Fish to Anglers: Application to Central California Anadromous Species. *Marine Resource Economics* 6(2):89-107.

Hushak, L.J.; J. M. Winslow, and N. Dutta. 1988. Economic Value of Great Lakes Sportfishing: the Case of Private-boat Fishing in Ohio's Lake Erie. *Transactions of the American Fisheries Society* 117(4):363-373.

Johnson, D. M. 1989. Economic Benefits of Alternative Fishery Management Programs. Colorado State University, Dissertation.

Johnson, D.M., R.J. Behnke, D.A. Harpman, and R.G. Walsh. 1995. Economic benefits and costs of stocking catchable rainbow trout: a synthesis of economic analysis in Colorado. *North American Journal of Fisheries Management* 15(1):26–32.

Johnson, N.S. and R.M. Adams. 1989. "On the Marginal Value of a Fish: Some Evidence from the Steelhead Fishery." *Marine Resource Economics* 6(1):43-55.

Johnston, R.J., E.Y. Besedin and R.F. Wardwell. 2003. Modeling Relationships Between Use and Nonuse Values for Surface Water Quality: A Meta-Analysis. *Water Resources Research* 39(12): 1363-1372.

Johnston, R.J., E.Y. Besedin, R. Iovanna, C. Miller, R. Wardwell, and M. Ranson. 2004. Estimating Nonuse Values for Aquatic Resource Improvements: An Application of Meta-Analysis. *Annual Meeting of the Northeastern Agricultural and Resource Economics Association*. Halifax, NS, June 20-23.

Johnston, R.J., J.J. Opaluch, T.A. Grigalunas, and M.J. Mazzotta. 2001. Estimating Amenity Benefits of Coastal Farmland. *Growth and Change* 32(summer):305-325.

Jones and Stokes Associates, Inc. 1987. Juneau Area Sport Fishing Economic Study. Jones & Stokes

Associates, Inc., Robert D. Niehaus, Inc. Prepared for Alaska Department of Fish and Game, Sport Fish Division. Anchorage. Study Report AK 99518-1599. October.

Kaoru, Y. 1993. Differentiating Use and Nonuse Values for Coastal Pond Water Quality Improvements. *Environmental and Resource Economics* 3: 487-494.

Kirkley, J.E., N.E. Bockstael, K.E. McConnell, and I.E. Strand. 1999. The Economic Value of Saltwater Angling in Virginia. Virginia Marine Resource Report No. 99-2, VSG-99-02, January.

Krinsky, I. and A.L. Robb. 1986. Approximating the statistical properties of Elasticities. *Review of Economics and Statistics* 68(4):715-719.

Lant, C.L., and R. S. Roberts. 1990. Greenbelts in the Cornbelt: Riparian Wetlands, Intrinsic Values, and Market Failure. *Environment and Planning A* 22(10): 1375-1388.

Lee, S.T. 1996. The Economics of Recreational Fishing. Dissertation, University of Washington.

Loomis, J.B. 1988. The Bioeconomic Effects of Timber Harvesting on Recreational and Commercial Salmon and Steelhead Fishing: A Case Study of the Siuslaw National Forest. *Marine Resource Economics* 5(1):43-60.

Loomis, J.B. 1996. How Large is the Extent of the Market for Public Goods: Evidence from a Nation Wide Contingent Valuation Survey. *Applied Economics* 28(7): 779-782.

Lupi, F. and J.P. Hoehn. 1998. A Partial Benefit-Cost Analysis of Sea Lamprey Treatment on the St. Marys River. Research Report, Michigan State University.

Lupi, F., J.P. Hoehn, H. Chen, and T. Tomasi. 1997. The Michigan Recreational Angling Demand Model. Michigan State University and the Michigan Department of Natural Resources and Department of Environmental Quality.

Lyke, A.J. 1993. Discrete Choice Models to Value Changes in Environmental Quality: A Great Lakes Case Study. Dissertation, University of Wisconsin-Madison.

Magat, W.A., J. Huber, K.W. Viscusi and J. Bell. 2000. An Iterative Choice Approach to Valuing Clean Lakes, Rivers, and Streams. *Journal of Risk and Uncertainty* 21(1): 7-43.

MaineToday.com. 2003. 2003 Saltwater Fishing Regulations. http://outdoors.mainetoday.com/fishing/bruce/bassreg.shtml.

Marine Recreational Fisheries Statistics (Southeast, Northeast, Pacific West). http://www.st.nmfs.gov/recreational/the_mrfss.html.

Markowski, M.A., K.J. Boyle, R.C. Bishop, D.M. Larson, and R.W. Patterson. 2002. A Cautionary Note on Interpreting Meta-Analyses. Unpublished paper, Industrial Economics, Inc.

Matthews, L.G., F.R. Homans, and K.W. Easter. 1999. Reducing Phosphorous Pollution in the Minnesota River: How Much is it Worth? Staff Paper. Department of Applied Economics, University of Minnesota.

McClelland, N.I. 1974. Water Quality Index Application in the Kansas River Basin. Report to US EPA Region VII. Kansas City, MO.

McConnell, K. E. and I.E. Strand, 1994. Volume 2: The Economic Value of Mid and South Atlantic Sportfishing. University of Maryland, Report to the USEPA and NOAA. [CR-811043-01-0].

MDNR. 2002. Data from the 2001 Recreational Angler Survey. Charlevoix Fisheries Research Station. Michigan Department of Natural Resources. Received from David Clapp, Charlevoix Great Lakes Research Station, Charlevoix, MI.

Milliman, S.R., B.L. Johnson, R.C. Bishop, and K.J. Boyle. 1992. The Bioeconomics of Resource Rehabilitation: A Commercial-Sport Analysis for a Great Lakes Fishery. *Land Economics* 68(2):191-210.

Mitchell, R.C. and R.T. Carson. 1981. An Experiment in Determining Willingness to Pay for National Water Quality Improvements. Preliminary Draft of a Report to the U.S. Environmental Protection Agency. Washington, D.C.: Resources for the Future.

Mitchell, R.C. and R.T. Carson. 1989. *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Washington, D.C.: Resources for the Future.

Morey, E.R., W.D. Shaw and R.D. Rowe. 1991. A Discrete-Choice Model of Recreational Participation, Site Choice, and Activity Valuation When Complete Trip Data Are Not Available.

*Journal of Environmental Economics and Management* 20(2):181-201.

Morey, E.R., R.D. Rowe, and M. Watson. 1993. A Repeated Nested-Logit Model of Atlantic Salmon Fishing. *American Journal of Agricultural Economics* 75(3):578-592.

Morey, E.R., W.S. Breffle, R.D. Rowe, and D.M. Waldman. 2002. Estimating Recreational Trout Fishing Damages in Montana's Clark Fork River basin: Summary of a Natural Resource Damage Assessment. *Journal of Environmental Management* 66(2):159-170.

Mrozek, J.R. and L.O. Taylor. 2002. What Determines the Value of Life? A Meta-Analysis. *Journal of Policy Analysis and Management.* 21(2):253-270.

Murdock, J. 2001. Valuing Recreational Fishing Opportunities While Catching Unobserved Characteristics. Research Report, Yale University.

Norton, V., T. Smith, and I.E. Strand. 1983. Stripers: The Economic Value of the Atlantic Coast Commercial and Recreational Striped Bass Fisheries. Maryland Sea Grant Publication No. 12. UN-SG-TS-83-12.

Olsen, D., J. Richards, and R.D. Scott. 1991. Existence and Sport Values for Doubling the Size of Columbia River Basin Salmon and Steelhead Runs. *Rivers* 2(1):44-56.

Pendleton, L. H. and R. Mendelsohn. 1998. Estimating the Economic Impact of Climate Change on the Freshwater Sportsfisheries of the Northeastern U.S. *Land Economics* 74(4):483-96.

Poe, G.L., K.J. Boyle, and J.C. Bergstrom. 2001. A Preliminary Meta Analysis of Contingent Values for Ground Water Quality Revisited, in J.C. Bergstrom, K.J. Boyle and G.L. Poe, eds. The Economic Value of Water Quality. Northampton, MA: Edward Elgar Publishers.

Poole, C. and S. Greenland. 1999. Random-Effects Meta-Analyses Are Not Always Conservative. *American Journal of Epidemiology* 150(5):469-474.

Ready, R.C., J.C. Buzby and D. Hu. 1996. Differences Between Continuous and Discrete Contingent Valuation Estimates. *Land Economics* 72(3):397-411.

Roberts, L.A., and J.A. Leitch. 1997. Economic Valuation of Some Wetland Outputs of Mud Lake. Agricultural Economics Report No. 381, Department of Agricultural Economics, North Dakota Agricultural Experiment Station, North Dakota State University.

Rosenberger, R.S. and J.B. Loomis. 2000a. Panel Stratification in Meta-Analysis of Economic Studies: An Investigation of Its Effects in the Recreation Valuation Literature. *Journal of Agricultural and Applied Economics* 32(3): 459-470.

Rosenberger, R.S. and J.B. Loomis. 2000b. Using Meta-Analysis for Benefit Transfer: In-Sample Convergent Validity Tests of an Outdoor Recreation Database. *Water Resources Research* 36(4):1097-1107.

Rosenberger, R.S. and J.B. Loomis. 2003. Benefit Transfer. In *A Primer on Non-Market Valuation* edited by P.A. Champ, K.J. Boyle and T.C. Brown. Dordrecht, The Netherlands: Kluwer Academic Publishers (pp. 445-482).

Rowe, R.D., E.R. Morey, A.D. Ross, and W.D. Shaw. 1985. Valuing Marine Recreational Fishing on the Pacific Coast. Energy and Resource Consultants Inc. Report prepared for the National Marine Fisheries Service, National Oceanic and Atmospheric Administration. Report LJ-85-18C. March.

Rowe, R.D., W.D. Schulze, B. Hurd and D. Orr. 1985. *Economic Assessment of Damage Related to the Eagle Mine Facility*. Boulder, CO: Energy and Resource Consultants.

Samples, K. and R. Bishop. 1985. Estimating the Value of Variations in Anglers' Successs Rates: An Application of the Multiple-Site Travel Cost Method. *Marine Resource Economics* 2(1):55-74.

Sanders, L. B., R.G. Walsh, and J.B. Loomis. 1990. Toward Empirical Estimation of the Total Value of Protecting Rivers. *Water Resources Research* 26(7): 1345-1357.

Santos, J.M.L. 1998. *The Economic Valuation of Landscape Change*. Edward Elgar, Cheltenham, UK.

Schuhmann, P.W. 1996. A Welfare Analysis of Commercial Fishery Harvest Restrictions: A Bioeconomic Model of Red Drum Stock Dynamics and Recreation Demand. Dissertation, North Carolina State University.

Schuhmann, P.W. 1998. Deriving Species-Specific Benefits Measures for Expected Catch

Improvements in a Random Utility Framework. *Marine Resource Economics* 13(1):1-21.

Schulze, W.D., R.D. Rowe, W.S. Breffle, R.R. Boyce, and G.H. McClelland. 1995. *Contingent Valuation of Natural Resource Damages Due to Injuries to the Upper Clark Fork River Basin*, State of Montana, Natural Resource Damage Litigation Program. Boulder, CO: RCG/Hagler Bailly.

Shafer, E.L., R. Carline, R.W. Guldin, and H.K. Cordell. 1993. Economic Amenity Values of Wildlife: Six Case Studies of Pennsylvania. *Environmental Management* 17(2):669-682.

Shrestha, R.K. and J.B. Loomis. 2003. Meta-Analytic Benefit Transfer of Outdoor Recreation Economic Values: Testing Out-of-Sample Convergent Validity. *Environmental and Resource Economics* 25:79–100.

Smith, V.K. and L. Osborne. 1996. Do Contingent Valuation Estimates Pass the Scope Test? A Meta Analysis. *Journal of Environmental Economics and Management* 31(3):287-301.

Smith, V.K. and Y. Kaoru. 1990. Signals or Noise? Explaining the Variation in Recreational Benefit Estimates. *American Journal of Agricultural Economics* 72:419-433.

Smith, V.K., G. Van Houtven, and S.K. Pattanayak. 2002. Benefit Transfer via Preference Calibration: 'Prudential Algebra' for Policy. *Land Economics* 78(1):132-152.

Spash, C.L. 2000. Ecosystems, Contingent Valuation and Ethics: The Case of Wetland Re-Creation. *Ecological Economics* 34(2): 195-215.

StataCorp. 2001. *Stata Reference Manual, Release 7.* College Station, TX: Stata Press.

Stevens, T., N. De Coteau, and C. Willis. 1997. Sensitivity of Contingent Valuation to Alternative Payment Schedules. *Land Economics* 73(1): 140-148.

Stumborg, B.E., K.A. Baerenklau, and R.C. Bishop. 2001. Nonpoint Source Pollution and Present Values: A Contingent Valuation of Lake Mendota. *Review of Agricultural Economics*. 23(1): 120-132.

Sturtevant, L.A., F.R. Johnson, and W.H. Desvousges. 1998. A Meta-analysis of Recreational Fishing. Unpublished paper. Triangle Economic Research, Durham, NC.

Sutherland, R. J., and R.G. Walsh. 1985. Effect of Distance on the Preservation Value of Water Quality. *Land Economics* 61(3): 282-291.

U.S. EPA. 2000. Guidelines for Preparing Economic Analyses. (EPA 240-R-00-003). Washington, DC: U.S. EPA, Office of the Administrator.

U.S. EPA. 2000. Economic and Environmental Impact Assessment of Proposed Effluent Limitations Guidelines and Standards for the Coal Mining Industry: Remining and Western Alkaline Subcategories. U.S. EPA, Office of Water, Washington, DC

U.S. EPA. 2003. Economic and Environmental Benefits Analysis Document for the Final Effluent Limitations Guidelines and Standards for the Metal Products and Machinery Point Source Category (EPA-821-B-03-002). U.S. EPA, Office of Water, Washington, DC.

U.S. EPA. 2004. Economic and Benefits Analysis for the Final Section 316(b) Phase II Existing Facilities Rule (EPA-821-R-04-005). U.S. EPA, Office of Water, Washington, DC, February 2004.

U.S. FWS and U.S. Census Bureau. 2002. 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

Vaughan, W. J.; and C.S. Russell. 1982. Valuing a Fishing Day: An Application of a Systematic Varying Parameter Model. *Land Economics* 58(4):450-463.

Vaughan, W.J. 1986. The RFF Water Quality Ladder, Appendix B in R.C. Mitchell and R.T. Carson, *The Use of Contingent Valuation Data for Benefit/Cost Analysis in Water Pollution Control, Final Report*. Washington: Resources for the Future.

Walsh, R.G., D.M. Johnson and J.R. McKean. 1992. Benefit Transfer of Outdoor Recreation Demand Studies, 1968-1988. *Water Resources Research* 28(3):707-713.

Welle, P.G. 1986. Potential Economic Impacts of Acid Deposition: A Contingent Valuation Study of Minnesota. Dissertation, University of Wisconsin-Madison.

Wey, K.A. 1990. Social Welfare Analysis of Congestion and Water Quality of Great Salt Pond, Block Island, Rhode Island. Dissertation, University of Rhode Island.

Whitehead, J.C. & T.C. Haab, 1999. Southeast Marine Recreational Fishery Statistical Survey: Distance and Catch Based Choice Sets. *Marine Resource Economics* 14(4):283-298.

Whitehead, J.C., and G.C. Blomquist. 1991. A Link Between Behavior, Information, and Existence Value. *Leisure Sciences* 13(2):97 -109.

Whitehead, J.C., and P.A. Groothuis. 1992. Economic Benefits of Improved Water Quality: a case study of North Carolina's Tar-Pamlico River. *Rivers* 3: 170-178.

Whitehead, J.C., and R. Aiken. 2000. An Analysis of Trends in Net Economic Values for Bass Fishing from the National Survey of Fishing, Hunting, and Wildlife-associated Recreation. East Carolina University, Department of Economics.

Whitehead, J.C., G.C. Blomquist, T.J. Hoban and W.B. Clifford. 1995. Assessing the Validity and Reliability of Contingent Values: A Comparison of On-Site Users, Off-Site Users, and Non-users. *Journal of Environmental Economics and Management* 29(2): 238-251.

Whittington, D., G. Cassidy, D. Amaral, E. McClelland, H. Wang and C. Poulos. 1994. The Economic Value of Improving the Environmental Quality of Galveston Bay. Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill. GBNEP-38, 6/94.

Williams, J.S. and P.W. Bettoli. 2003. Net Value of Trout Fishing Opportunities in Tennessee Tailwaters. Fisheries Report 03-21. Final Report Submitted to the Tennessee Wildlife Resource Agency.

Woodward, R.T., and Y.S. Wui. 2001. The Economic Value of Wetland Services: a Meta-Analysis. *Ecological Economics* 37(2):257-270.

**Table 1. Characteristics of Surface Water Valuation Studies Included in Meta-Analysis**

| Citation for Study | Number of Observations in Meta-Data | State | Water Body Type | Species Affected | Methodology | Adjusted Raw WTP Values[a] |
|---|---|---|---|---|---|---|
| Aiken (1985) | 1 | CO | all freshwater | game fish | contingent valuation (CVM)—multiple methods[b] | $167.98 |
| Anderson & Edwards (1986) | 1 | RI | salt pond/marshes | unspecified | contingent valuation (CVM)—open ended | $157.14 |
| Azevedo et al. (2001) | 5 | IA | lake | game fish | CVM—discrete choice | $17.76 - $118.68 |
| Bockstael et al. (1989) | 2 | MD | estuary | unspecified | CVM—discrete choice | $65.80 - $209.51 |
| Cameron & Huppert (1989) | 1 | CA | river/stream | game fish | CVM—discrete choice | $43.07 |
| Carson et al. (1994) | 2 | CA | estuary | game fish; multiple categories | CVM—discrete choice | $35.83 - $67.47 |
| Clonts & Malone (1990) | 3 | AL | river/stream | unspecified | CVM—iterative bidding | $68.10 - $110.85 |
| Croke et al. (1987) | 9 | IL | river/stream | all recreational fish; none | CVM—iterative bidding | $53.31 - $81.46 |
| Cronin (1982) | 4 | DC | river/stream | all recreational fish | CVM—open ended | $61.85 - $212.73 |
| Desvousges et al. (1983) | 2 | PA | river/stream | unspecified | CVM—discrete choice | $111.41 - $220.24 |
| De Zoysa (1995) | 2 | OH | lake; river and lake | multiple categories | CVM—discrete choice | $35.88 - $61.02 |
| Farber & Griner (2000) | 3 | PA | river/stream | all recreational fish | CVM—discrete choice | $44.22 - $105.58 |
| Hayes et al. (1992) | 2 | RI | estuary | shellfish; none | CVM—discrete choice | $339.72 - $351.47 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Herriges and Shogren (1996) | 2 | IA | lake | all recreational fish | CVM—discrete choice | $53.66 - $180.35 |
| Huang et al. (1997) | 2 | NC | estuary | multiple categories | CVM—discrete choice / revealed and stated preference | $221.75 - $228.07 |
| Kaoru (1993) | 1 | MA | salt pond/marshes | shellfish | CVM—open ended | $190.10 |
| Lant & Roberts (1990) | 3 | IA/IL | river/stream | game fish; all recreational fish | CVM—discrete choice | $107.86 - $134.18 |
| Loomis (1996) | 1 | WA | river/stream | game fish | CVM—discrete choice | $80.93 |
| Lyke (1993) | 2 | WI | lake | game fish | CVM—discrete choice | $51.96 - $84.99 |
| Magat et al. (2000) | 2 | CO/NC | all freshwater | all aquatic species | CVM—iterative bidding | $114.49 - $376.61 |
| Matthews et al. (1999) | 2 | MN | river/stream | all aquatic species | CVM—discrete choice | $15.77 - $22.01 |
| Mitchell & Carson (1981) | 1 | National | all freshwater | all aquatic species | CVM—discrete choice | $242.34 |
| Olsen et al. (1991) | 3 | Pacific NW | river/stream | game fish | CVM—open ended | $34.48 - $107.59 |
| Roberts & Leitch (1997) | 1 | MN/SD | lake | multiple categories | CVM—discrete choice | $7.26 |
| Rowe et al. (1985) | 1 | CO | river/stream | game fish | CVM—open ended | $117.04 |
| Sanders et al. (1990) | 4 | CO | river/stream | unspecified | CVM—open ended | $70.44 - $171.59 |
| Schulze et al. (1995) | 2 | MT | river and lake | multiple categories | CVM—discrete choice | $15.08 - $21.16 |
| Stumborg et al. (2001) | 2 | WI | lake | multiple categories | CVM—discrete choice | $57.90 - $88.38 |
| Sutherland & Walsh (1985) | 1 | MT | river and lake | unspecified | CVM—open ended | $126.98 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Welle (1986) | 6 | MN | all freshwater | multiple categories; game fish | multiple methods | $95.30 - $207.32 |
| Wey (1990) | 2 | RI | salt pond/marshes | shellfish | multiple methods | $55.61 - $200.50 |
| Whitehead & Groothuis (1992) | 3 | NC | river/stream | all recreational fish | CVM—open ended | $27.74 - $46.23 |
| Whitehead et al. (1995) | 2 | NC | estuary | multiple categories | CVM—iterative bidding | $68.08 - $97.91 |
| Whittington et al. (1994) | 1 | TX | estuary | all aquatic species | CVM—discrete choice | $169.32 |

[a] As noted in the text, reported WTP values apply to different levels of water quality change. All WTP estimates are converted to 2002 dollars and rounded to the nearest cent, and hence may not match exactly the raw WTP estimates reported in source studies. Where multiple WTP estimates are available from a given study, the range of values is presented.

[b] The author averaged WTP estimates derived from both open-ended and iterative bidding methods to obtain a single reported WTP estimate.

**Table 2. Meta-Analysis Variables and Descriptive Statistics: Water Quality Meta-Analysis**

| Variable | Description | Units and Measurement | Mean (Std. Dev.) |
|---|---|---|---|
| *ln_WTP* | Natural log of willingness-to-pay for specified resource improvements. WTP for all studies was converted to 2002 dollars using the U.S. Bureau of Labor Statistics non-seasonally adjusted average CPI for all urban consumers. | Natural log of dollars (Range: 1.98 to 5.93) | 4.43 (0.77) |
| *year_indx* | Year in which the study was conducted, converted to an index by subtracting 1970. | Year Index (Range: 3 to 31) | 18.79 (6.57) |
| *discrete_ch* | Binary variable indicating that WTP was estimated using a discrete choice survey instrument. | Binary (Range: 0 or 1) | 0.35 (0.37) |
| *voluntary* | Binary variable indicating that WTP was estimated using a payment vehicle described as voluntary. | Binary (Range: 0 or 1) | 0.07 (0.26) |
| *interview* | Binary variable indicating that the survey conducted through in-person interviews. | Binary (Range: 0 or 1) | 0.19 (0.39) |
| *mail* | Binary variable indicating that the survey was conducted through the mail. | Binary (Range: 0 or 1) | 0.56 (0.50) |
| *lump_sum* | Binary variable indicating that payments were to occur on something other than a long-term annual basis (e.g., a single lump sum payment). | Binary (Range: 0 or 1) | 0.21 (0.41) |
| *nonparam* | Binary variable indicating that WTP was estimated using nonparametric methods. | Binary (Range: 0 or 1) | 0.46 (0.50) |
| *wq_change* | Change in mean water quality, specified on the RFF water quality ladder. Defined as the difference between baseline and post-improvement quality. Where the original study (survey) did not use the RFF water quality ladder, we mapped water quality descriptions to analogous levels on the RFF ladder to derive water quality change (see text). Note that this variable was only included in the model as part of an interaction term (*WQ_fish*, *WQ_shell*, *WQ_many*, *WQ_non*). | Water quality ladder units (Range: 0.5 to 5.75) | 2.42 (1.07) |
| *lnwq_change* | The natural log of *wq_change* (see above). | Range: -0.69 to 1.75 | 0.77 (0.52) |
| *wq_ladder* | Binary variable indicating that the original survey reported resource changes using a standard Resources for the Future water quality ladder. | Binary (Range: 0 or 1) | 0.32 (0.47) |
| *protest_bids* | Binary variable indicating that protest bids were excluded when estimating WTP. | Binary (Range: 0 or 1) | 0.46 (0.50) |
| *outlier_bids* | Binary variable indicating that outlier bids were excluded when estimating WTP. | Binary (Range: 0 or 1) | 0.22 (0.42) |
| *median_WTP* | Binary variable indicating that the study reported median, not mean, WTP. | Binary (Range: 0 or 1) | 0.06 (0.24) |
| *hi_response* | Binary variable indicating that the survey response rate exceeds 74% (i.e., 75% or above). | Binary (Range: 0 or 1) | 0.31 (0.47) |
| *income* | Mean income of survey respondents, either as reported by the original survey or calculated based on US Census averages for the original surveyed region. | Dollars (Range: 30396 to 137693) | 34470 (12788.72) |

| | | | |
|---|---|---|---|
| *nonusers* | Binary variable indicating that the survey is implemented over a population of nonusers (default category for this dummy is a survey of any population that includes users). | Binary (Range: 0 or 1) | 0.19 (0.39) |
| *single_river* | Binary variable indicating that resource change explicitly takes place over a single river (default is a change in an estuary). | Binary (Range: 0 or 1) | 0.24 (0.43) |
| *single_lake* | Binary variable indicating that resource change explicitly takes place over a single lake. | Binary (Range: 0 or 1) | 0.12 (0.33) |
| *multiple_river* | Binary variable indicating that resource change explicitly takes place over multiple rivers. | Binary (Range: 0 or 1) | 0.09 (0.28) |
| *salt_pond* | Binary variable indicating that resource change explicitly takes place over multiple salt ponds. | Binary (Range: 0 or 1) | 0.05 (0.22) |
| *num_riv_pond* | Number of rivers or salt ponds affected by policy when *multiple_river* or *salt_pond*=1 (Only studies addressing rivers and salt ponds specified multiple water bodies.). Specified as the sum of the multiplicative interactions between *multiple_river* and the number of water bodies and that of *salt_pond* and the number of water bodies. | Number of specified rivers or ponds (Range: 0 to 15) | 1.40 (3.56) |
| *regional_fresh* | Binary variable indicating that resource change explicitly takes place in a fresh waterbody . | Binary (Range: 0 or 1) | 0.16 (0.37) |
| *southeast* | Binary variable indicating that survey was conducted in the USDA southeast region (default is northeast region). | Binary (Range: 0 or 1) | 0.12 (0.33) |
| *pacif_mount* | Binary variable indicating that survey was conducted in the USDA pacific / mountain region. | Binary (Range: 0 or 1) | 0.18 (0.40) |
| *plains* | Binary variable indicating that survey was conducted in the USDA northern or southern plains region. | Binary (Range: 0 or 1) | 0.02 (0.15) |
| *mult_reg* | Binary variable indicating that survey included respondents from more than one of the regions. | Binary (Range: 0 or 1) | 0.04 (0.19) |
| *WQ_fish* | Interaction variable: *wq_change* multiplied by a binary variable identifying studies in which water quality improvements are stated to benefit only fin fish. Default is zero (i.e. water quality change did not affect fish). | Water quality ladder units (Range: 0.5 to 5.75) | 1.15 (1.53) |
| *WQ_shell* | Interaction variable: *wq_change* multiplied by a binary variable identifying studies in which water quality improvements are stated to benefit only shellfish. Default is zero (i.e. water quality change did not affect shellfish). | Water quality ladder units (Range: 0.5 to 4.00) | 0.12 (0.64) |
| *WQ_many* | Interaction variable: *wq_change* multiplied by a binary variable identifying studies in which water quality improvements are stated to benefit multiple species types. Default is zero (i.e. water quality change did not affect multiple species). | Water quality ladder units (Range: 0.5 to 4.00) | 0.63 (1.20) |
| *WQ_non* | Interaction variable: *wq_change* multiplied by a binary variable identifying studies in which species benefitting from water quality improvements remain unspecified. Default is zero (i.e. water quality change did not unspecified species). | Water quality ladder units (Range: 0.5 to 2.5) | 0.52 (0.93) |
| *lnWQ_fish* | Interaction variable: *lnwq_change* multiplied by a binary variable identifying studies in which water quality improvements are stated to benefit only fin fish. Default is zero (i.e. water quality change did not affect | Range: -0.69 to 1.75 | 0.37 (0.54) |

| | | | |
|---|---|---|---|
| | fish). | | |
| *lnWQ_shell* | Interaction variable: *lnwq_change* multiplied by a binary variable identifying studies in which water quality improvements are stated to benefit only shellfish. Default is zero (i.e. water quality change did not affect shellfish). | Range: 0 to 1.39 | 0.03 (0.22) |
| *lnWQ_many* | Interaction variable: *lnwq_change* multiplied by a binary variable identifying studies in which water quality improvements are stated to benefit multiple species types. Default is zero (i.e. water quality change did not affect multiple species). | Range: -0.69 to 1.39 | 0.19 (0.46) |
| *lnWQ_non* | Interaction variable: *lnwq_change* multiplied by a binary variable identifying studies in which species benefitting from water quality improvements remain unspecified. Default is zero (i.e. water quality change did not unspecified species). | Range: 0 to 0.92 | 0.18 (0.33) |
| *nonfish_uses* | Binary variable identifying studies in which changes in uses other than fishing are specifically noted in the survey. | Binary (Range: 0 or 1) | 0.73 (0.45) |
| *fishplus* | Binary variable identifying studies in which a fish population or harvest change of 50% or greater is reported in the survey. | Binary (Range: 0 or 1) | 0.12 (0.33) |
| *baseline* | Baseline water quality, specified on the RFF water quality ladder. | Water quality ladder units (Range: 0 to 7) | 4.60 (2.47) |

**Table 3**. **Recreational Angling Valuation Studies Included in the Meta-Analysis**

| Author and Year | Obs. in Analysis[a] | State(s) | Study Methodology / Elicitation Format | Marginal Value per Fish[b] |
|---|---|---|---|---|
| Agnello (1989) | 30 | FL - NY | travel cost | bluefish ($0.70 - $9.23)<br>flounder ($3.33 - $28.67)<br>weakfish ($0.05 - $9.69)<br>all three species ($1.16 - $15.80) |
| Alexander (1995) | 8 | OR | nested RUM | steelhead trout ($3.59 - $23.17) |
| Berrens, Bergland, and Adams (1993) | 1 | OR | CV (payment card) | Chinook salmon ($3.99) |
| Besedin et al. (2004) | 12 | MI | non-nested RUM | bass ($13.14 - $17.12)<br>perch ($1.79 - $2.95)<br>walleye/pike ($10.17 - $21.34)<br>salmon/trout ($20.56 - $23.36)<br>general/no target ($1.58 - $3.34) |
| Bockstael, McConnell, and Strand (1989) | 1 | MD | travel cost | *striped bass* ($2.23) |
| Boyle, Roach, and Waddington (1998) | 4 | FWS Mountain Trout, Western Trout, Northeast Trout, and Northern Bass Regions | CV (dichotomous choice) | trout ($0.91 - $3.96)<br>bass ($4.22) |
| Breffle et al. (1999) | 8 | WI | CV (conjoint analysis) | *yellow perch* ($0.79 - $1.57)<br>*trout/salmon* ($20.99 - $42.10)<br>*walleye* ($4.13 - $8.34)<br>*smallmouth bass* ($13.70 - $27.48) |
| Cameron and Huppert (1989) | 2 | CA | CV (payment card) | *salmon* ($5.82 - $16.76) |
| Cameron and James (1987a) | 1 | British Columbia, Canada | CV (dichotomous choice) | salmon ($2.51) |
| Cameron and James (1987b) | 1 | British Columbia, Canada | CV (dichotomous choice) | salmon ($19.78) |
| Carson et al. (1990) | 3 | AK | CV (payment card, conjoint analysis) | Chinook salmon ($15.80 - $45.92) |
| Dalton et al. (1998) | 2 | WY | CV (dichotomous choice) | *trout* ($28.13 - $51.41) |

| | | | | |
|---|---|---|---|---|
| Gautam and Steinbeck (1998) | 3 | ME, NH, MA, RI, CT | travel cost, non-nested RUM | striped bass ($4.18 - $7.02) |
| Hicks et al. (1999) | 44 | ME, NH, MA, RI, CT, NY, NJ, DE, MD, VA | nested RUM | big game ($5.67 - $8.19)<br>bottomfish ($2.02 - $3.25)<br>small game ($3.01 - $4.64)<br>flatfish ($3.84 - $7.13) |
| Hicks (2002) | 3 | NH - VA | CV (conjoint analysis), non-nested RUM | summer flounder ($2.59 - $4.65) |
| Huppert (1989) | 3 | CA | CV (payment card), travel cost | *Chinook salmon and striped bass* ($7.74 - $58.44) |
| Hushak, Winslow, and Dutta (1988) | 3 | OH | travel cost | *walleye* ($2.34 - $3.13) |
| Johnson et al. (1995) | 19 | CO | CV (iterative bidding, dichotomous choice) | trout ($0.54 - $2.94) |
| Johnson (1989) | 5 | CO | CV (iterative bidding) | brown and rainbow trout ($0.87 - $1.61)<br>rainbow trout ($2.58) |
| Johnson and Adams (1989) | 1 | OR | CV (multiple methods) | steelhead trout ($11.15) |
| Jones and Stokes Associates, Inc (1987) | 4 | AK | non-nested RUM | *halibut* ($153.91)<br>*Chinook salmon* ($327.29)<br>*coho salmon* ($178.65)<br>*dolly varden* ($23.25) |
| Kirkley et al. (1999) | 10 | VA | CV (open-ended) | bottomfish and croaker ($3.05 - $12.88)<br>summer flounder ($4.69 - $19.91)<br>gamefish ($16.40 - $65.59)<br>no target ($1.93 - $8.20) |
| Lee (1996) | 5 | WA | CV (conjoint analysis) | trout ($1.13 - $3.83) |
| Loomis (1988) | 13 | OR, WA | travel cost | steelhead trout ($40.69 - $182.23)<br>salmon ($13.23 - $114.21) |
| Lupi and Hoehn (1998) | 3 | MI | nested RUM | lake trout ($10.12 - $13.90) |
| Lupi et al. (1997) | 10 | MI | nested RUM | *bass* ($8.54)<br>*carp* ($1.40)<br>*coho salmon* ($18.33)<br>*northern pike* ($2.34)<br>*rainbow trout* ($10.12 - $15.77)<br>*Chinook salmon* ($4.04 - $13.25)<br>*lake trout* ($6.61)<br>*walleye* ($3.66) |
| McConnell and Strand (1994) | 36 | FL - NY | CV (dichotomous choice) | *big game* ($0.65 - $54.56)<br>*small game* ($11.59 - $30.91)<br>*flatfish* ($0.37 - $10.50)<br>*bottomfish* ($0.25 - $4.51) |

| | | | | |
|---|---|---|---|---|
| Milliman et al. (1992) | 1 | MI | CV (dichotomous choice) | yellow perch ($0.33) |
| Morey, Rowe, and Watson (1993) | 2 | ME | nested RUM | *Atlantic salmon* ($386.63 - $612.79) |
| Morey et al. (2002) | 2 | MT | nested RUM | *trout* ($11.62 - $198.03) |
| Morey, Shaw, and Rowe (1991) | 3 | OR | non-nested RUM | *salmon* ($5.66)<br>*ocean perch* ($13.74)<br>*smelt and grunion* ($32.39) |
| Murdock (2001) | 7 | WI | nested RUM | *panfish* ($9.77)<br>*walleye* ($22.63)<br>*smallmouth bass* ($19.47)<br>*temperate bass* ($4.23)<br>*northern pike* ($15.68)<br>*trout* ($32.68)<br>*salmon* ($51.61) |
| Norton, Smith, and Strand (1983) | 4 | ME - NC | travel cost | striped bass ($3.39 - $31.98) |
| Olsen, Richards, and Scott (1991) | 6 | WA, OR | CV (open-ended) | salmon ($21.95 - $37.44)<br>steelhead trout ($37.00 - $81.29) |
| Pendleton and Mendelsohn (1998) | 3 | ME, NH, VT, NY | non-nested RUM | rainbow trout ($23.37)<br>other trout ($4.32 - $26.44) |
| Rowe et al. (1985) | 24 | CA, OR, WA | non-nested RUM | coastal pelagics ($3.82 - $4.45)<br>flatfish ($3.31 - $14.33)<br>rockfish and bottomfish ($2.63 - $6.79)<br>salmon ($7.21 - $31.24)<br>smelt and grunion ($0.30 - $7.40) |
| Samples and Bishop (1985) | 1 | MI | travel cost | salmon and trout ($19.01) |
| Schuhmann (1996) | 7 | NC | non-nested RUM | *big game* ($33.78 - $133.11)<br>*bottomfish* ($14.53)<br>*drum* ($1.65 - $11.57)<br>*surface fish* ($12.67 - $25.96) |
| Schuhmann (1998) | 8 | MD, NC | non-nested RUM | *billfish* ($33.72)<br>*bottomfish* ($14.51)<br>*drum* ($11.55)<br>*surface fish* ($12.66) |
| Shafer et al. (1993) | 1 | PA | travel cost | *trout* ($1.35) |

| | | | | |
|---|---|---|---|---|
| U.S. EPA (2004; Chapter B4) | 31 | CA | non-nested RUM | big game ($2.15 - $6.47)<br>bottomfish ($1.38 - $2.76)<br>flatfish ($3.19 - $11.06)<br>jacks ($29.15)<br>salmon ($8.46 - $15.56)<br>sea bass ($0.36 - $0.73)<br>small game ($2.26 - $3.09)<br>striped bass ($4.31 - $8.41)<br>sturgeon ($61.43)<br>no target/other ($0.46 - $6.68) |
| U.S. EPA (2004; Chapter D4) | 15 | NY - VA | nested RUM | big game ($20.97)<br>bluefish ($6.32 - $6.42)<br>bottomfish ($4.70 - $4.76)<br>flatfish ($8.55 - $8.75)<br>other small game ($4.68 - $6.64)<br>striped bass ($15.52 - $15.56)<br>weakfish ($14.31 - $14.99)<br>no target ($5.70 - $5.83) |
| U.S. EPA (2004; Chapter E4) | 10 | FL, NC, SC, GA | non-nested RUM | big game ($37.89)<br>bottomfish ($4.91 - $9.39)<br>flatfish ($27.63 - $31.18)<br>small game ($10.31 - $13.72)<br>snapper and grouper ($5.41)<br>no target ($7.41 - $19.73) |
| U.S. EPA (2004; Chapter F4) | 13 | FL, AL, MS, LA | non-nested RUM | big game ($30.48)<br>bottomfish ($2.21 - $7.23)<br>flatfish ($9.41 - $16.62)<br>seatrout ($10.14 - $13.85)<br>small game ($12.85 - $15.64)<br>snapper and grouper ($11.27 - $11.47)<br>no target ($5.35 - $6.36) |
| Vaughan and Russell (1982) | 2 | USA | travel cost | trout ($1.14)<br>catfish ($0.78) |
| Whitehead and Haab (1999) | 1 | NC, SC, GA, FL, AL, MI, LA | non-nested RUM | small game ($4.32) |
| Whitehead and Aiken (2000) | 6 | USA | CV (dichotomous choice) | bass ($4.60 - $10.37) |
| Williams and Bettoli (2003) | 8 | TN | CV (dichotomous choice) | trout ($0.62 - $9.43) |

[a] Where multiple observations are available from a given study, state, study methodology/elicitation format, and species may take on different values for different observations from that study.

[b] The marginal values per fish presented here represent the highest and lowest values from the study for the specified species or group of species. Italicized values in this column indicate that marginal WTP per fish was not directly provided, but was calculated from information in the study. All values are presented in June 2003 dollars.

**Table 4. Meta-Analysis Variables and Descriptive Statistics: WTP for Recreational Harvest**

| Variable[a] | Description | Units (Range) | Mean (Std. Dev.) |
|---|---|---|---|
| *log_WTP* | Natural log of the marginal value per fish. | Natural log of dollars (-3.0260 to 6.4180) | 1.8419 (1.3165) |
| *SP_conjoint* | Binary (dummy) variable indicating that the study used conjoint or choice-experiment stated preference methodology. | Binary variable (0 to 1) | 0.0435 (0.2042) |
| *SP_dichot* | Binary (dummy) variable indicating that the study used a stated preference methodology with a dichotomous choice elicitation format. | Binary variable (0 to 1) | 0.1739 (0.3795) |
| *TC_individual* | Binary (dummy) variable indicating that the study used a travel cost model based on data on the number of trips taken by individual respondents to different recreational sites. | Binary variable (0 to 1) | 0.1074 (0.3100) |
| *TC_zonal* | Binary (dummy) variable indicating that the study used a zonal travel cost model based on data on the aggregate number of trips taken to one or several recreational sites by visitors who live within specified distance ranges of the site. | Binary variable (0 to 1) | 0.0409 (0.1984) |
| *RUM_nest* | Binary (dummy) variable indicating that the study used a nested random utility model. | Binary variable (0 to 1) | 0.2353 (0.4247) |
| *RUM_nonnest* | Binary (dummy) variable indicating that the study used a non-nested random utility model. | Binary variable (0 to 1) | 0.3043 (0.4607) |
| *SP_year* | If the study uses a stated preference methodology, this variable represents the year in which the study was conducted, converted to an index by subtracting 1976; otherwise, this variable is set to zero. | Year index (0 to 25) | 4.6036 (7.3592) |
| *TC_year* | If the study uses a travel cost methodology, this variable represents the year in which the study was conducted, converted to an index by subtracting 1976; otherwise, this variable is set to zero. | Year index (0 to 18) | 0.7315 (2.1914) |
| *RUM_year* | If the study uses a RUM methodology, this variable represents the year in which the study was conducted, converted to an index by subtracting 1976; otherwise, this variable is set to zero. | Year index (0 to 25) | 9.3734 (9.7162) |
| *sp_mail* | Binary (dummy) variable indicating that the study was a stated preference study that was administered by mail. | Binary variable (0 to 1) | 0.0512 (0.2206) |
| *sp_phone* | Binary (dummy) variable indicating that the study was a stated preference study that was administered by phone. | Binary variable (0 to 1) | 0.1304 (0.3372) |
| *high_resp_rate* | Binary (dummy) variable indicating that the sample response rate was greater than 50%. | Binary variable (0 to 1) | 0.3581 (0.4800) |
| *inc_thou* | Household income of survey respondents in 1,000's of dollars. If the study does not list income values, *inc_thou* was imputed from Census data. | 1,000s of June 2003 dollars (21.990 to 70.610) | 46.7008 (10.2017) |
| *gender* | The percentage of sample respondents that were male. | Percentage (0 to 98) | 89.1138[b] (6.0485) |

| | | | |
|---|---|---|---|
| *spec_gender* | Binary (dummy) variable indicating that the study presented information on the percentage of sample respondents that were male. | Binary variable (0 to 1) | 0.3887 (0.4881) |
| *age* | The mean age of sample respondents. | Years (0 to 51) | 43.5075[b] (2.1844) |
| *spec_age* | Binary (dummy) variable indicating that the study provided information on the mean age of sample respondents. | Binary variable (0 to 1) | 0.3683 (0.4830) |
| *trips* | The mean number of fishing trips taken each year by sample respondents. | Fishing trips (0 to 56.4) | 29.5637[b] (12.2168) |
| *spec_trips* | Binary (dummy) variable indicating that the study provided information on the mean number of fishing trips taken each year by sample respondents. | Binary variable (0 to 1) | 0.4450 (0.4976) |
| *nonlocal* | Binary (dummy) variable indicating that no respondents in the sample were local residents. | Binary variable (0 to 1) | 0.0051 (0.0714) |
| *big_game_natl* | Binary (dummy) variable indicating that the target species was big game in the North Atlantic or Mid-Atlantic regions. | Binary variable (0 to 1) | 0.0486 (0.2153) |
| *big_game_satl* | Binary (dummy) variable indicating that the target species was big game in the South Atlantic or Gulf of Mexico regions. | Binary variable (0 to 1) | 0.0205 (0.1418) |
| *big_game_pac* | Binary (dummy) variable indicating that the target species was big game in the California or Pacific Northwest regions. | Binary variable (0 to 1) | 0.0077 (0.0874) |
| *small_game_atl* | Binary (dummy) variable indicating that the target species was small game in the North Atlantic, Mid-Atlantic, South Atlantic, or Gulf of Mexico regions. | Binary variable (0 to 1) | 0.1611 (0.3681) |
| *small_game_pac* | Binary (dummy) variable indicating that the target species was small game in the California or Pacific Northwest regions. | Binary variable (0 to 1) | 0.0281 (0.1656) |
| *flatfish_atl* | Binary (dummy) variable indicating that the target species was flatfish in the North Atlantic, Mid-Atlantic, South Atlantic, or Gulf of Mexico regions. | Binary variable (0 to 1) | 0.0997 (0.3000) |
| *flatfish_pac* | Binary (dummy) variable indicating that the target species was flatfish in the California or Pacific Northwest regions. | Binary variable (0 to 1) | 0.0179 (0.1328) |
| *other_sw* | Binary (dummy) variable indicating that the target species was bottomfish or other saltwater species. | Binary variable (0 to 1) | 0.2276 (0.4198) |
| *musky* | Binary (dummy) variable indicating that the target species was muskellunge. | Binary variable (0 to 1) | 0.0026 (0.0506) |
| *pike_walleye* | Binary (dummy) variable indicating that the target species was northern pike or walleye. | Binary variable (0 to 1) | 0.0307 (0.1727) |
| *bass_fw* | Binary (dummy) variable indicating that the target species was largemouth bass or smallmouth bass. | Binary variable (0 to 1) | 0.0358 (0.1860) |
| *trout_east* | Binary (dummy) variable indicating that the target species was trout in states on the eastern side of the U.S. | Binary variable (0 to 1) | 0.0332 (0.1795) |
| *trout_GL* | Binary (dummy) variable indicating that the target species was trout in the Great Lakes region. | Binary variable (0 to 1) | 0.0128 (0.1125) |
| *trout_west* | Binary (dummy) variable indicating that the target species was trout in states on the western side of the U.S. | Binary variable (0 to 1) | 0.0895 (0.2859) |

| | | | |
|---|---|---|---|
| *trout_other* | Binary (dummy) variable indicating that the target species was trout in fee-fishing establishments across the U.S. | Binary variable (0 to 1) | 0.0026 (0.0506) |
| *salmon_atlantic* | Binary (dummy) variable indicating that the target species was salmon on the Atlantic coast. | Binary variable (0 to 1) | 0.0051 (0.0714) |
| *salmon_GL* | Binary (dummy) variable indicating that the target species was salmon in the Great Lakes. | Binary variable (0 to 1) | 0.0230 (0.1502) |
| *salmon_pacific* | Binary (dummy) variable indicating that the target species was salmon on the Pacific coast. | Binary variable (0 to 1) | 0.0844 (0.2783) |
| *steelhead_GL* | Binary (dummy) variable indicating that the target species was steelhead in the Great Lakes. | Binary variable (0 to 1) | 0.0051 (0.0714) |
| *steelhead_pac* | Binary (dummy) variable indicating that the target species was steelhead on the Pacific coast. | Binary variable (0 to 1) | 0.0358 (0.1860) |
| *catch_year* | Binary (dummy) variable indicating that the study expressed catch rates on a per year basis. | Binary variables (0 to 1) | 0.0716 (0.2582) |
| *cr_nonyear* | For studies that present catch rate on a per hour, per day, or per trip basis, this variable represents the baseline catch rate for the target species, expressed in fish per day or fish per trip; otherwise this variable is set to zero. | Fish per day (0 to 14.0000) | 2.1038[b] (2.0403) |
| *cr_year* | For studies that present catch rate on a per year basis, this variable represents the baseline catch rate for the target species, expressed in fish per year; otherwise this variable is set to zero. | Fish per year (0 to 67.3800) | 41.2277[b] (24.7833) |
| *spec_cr* | Binary (dummy) variable indicating that the study presents information on the baseline catch rate. | Binary variable (0 to 1) | 0.8440 (0.3633) |
| *shore* | Binary (dummy) variable indicating that all respondents in the sample fished from shore. | Binary variable (0 to 1) | 0.1458 (0.3633) |

[a] The default variable values are:

- A zero value for all of the study methodology variables (*SP_conjoint*, *SP_dichot*, *TC_individual*, *TC_zonal*, *RUM_nested*, and *RUM_nonnested*) indicates that the study used a stated preference methodology with an open-ended, iterative bidding, or payment card elicitation format.
- A zero value for *sp_mail* and *sp_phone* indicates that a stated preference survey was administered by phone or in person.
- A zero value for *nonlocal* indicates that the survey included local anglers or a mix of local and nonlocal anglers.
- A zero value for all of the species/region variables indicates that the target species was panfish caught nationwide.
- A zero value for *shore* indicates that survey respondents fished from boats or from both the shore and from boats.

[b] These values represent mean values and standard deviations *only* for those observations in which the variable value was specified (i.e., zero values are suppressed for the purposes of calculating the mean and standard deviation only).

**Table 5. Aggregate Species Groups in the Meta-Analysis**

| Group Name | Number of Observations | Species Included[a,b] |
|---|---|---|
| Big Game | 30 | billfish family, dogfish, rays, sharks, skates, sturgeon, swordfish, tarpon family, tuna, other big game |
| Small Game | 74 | barracuda, bluefish, bonito, cobia, dolly varden, dolphinfish, jacks, mackerel, red drum, seatrout, striped bass, weakfish, other small game |
| Flatfish | 46 | halibut, sanddab, summer flounder, winter flounder, other flatfish |
| Other Saltwater | 89 | banded drum, black drum, chubbyu, cod family, cow cod, croaker, grouper, grunion, grunt, high-hat, kingfish, lingcod, other drum, perch, porgy, rockfish, sablefish, sand drum, sculpin, sea bass, smelt, snapper, spot, spotted drum, star drum, white sea bass, wreckfish, other bottom species, other coastal pelagics, "no target" saltwater species |
| Salmon | 44 | Atlantic salmon, Chinook salmon, coho salmon, other salmon |
| Steelhead | 16 | steelhead trout, rainbow trout |
| Muskellunge | 1 | muskellunge |
| Walleye/Pike | 12 | northern pike, walleye |
| Bass | 14 | largemouth bass, smallmouth bass |
| Panfish | 11 | catfish, carp, yellow perch, other panfish, "general" and "no target" freshwater species |
| Trout | 54 | brown trout, lake trout, rainbow trout, other trout |

[a] Some studies evaluated WTP for groups of species that did not fit cleanly into one of the aggregate species groups. In those cases, the groups of species from the study were assigned to the aggregate species group with which they shared the most species.

[b] Rainbow trout in the Great Lakes were classified as steelhead trout because they share similar physical characteristics and life cycles with true anadromous steelhead. Although they have different common names, rainbow trout and steelhead both belong to the species *Oncorhynchus mykiss*.

**Table 6. Results for Multilevel Models: WTP for Aquatic Habitat Improvements**

| Variable | Parameter Estimate (Std. Error) | | |
|---|---|---|---|
| | **Model One Semi-Log Unweighted** | **Model Two Trans-log Unweighted** | **Model Two Semi-Log Weighted** |
| *intercept* | 6.0043*** | 6.0782*** | 6.0232*** |
| | (0.6078) | (0.6813) | (0.4633) |
| *year_indx* | -0.1058*** | -0.1220*** | -0.1201*** |
| | (0.0185) | (0.0152) | (0.0201) |
| *discrete_ch* | 0.3713 | 0.7057** | 0.4020 |
| | (0.3306) | (0.2726) | (0.2800) |
| *voluntary* | -1.6422*** | -1.5980*** | -1.7320*** |
| | (0.2255) | (0.2410) | (0.1461) |
| *interview* | 1.3030*** | 1.3401*** | 1.2615*** |
| | (0.1700) | (0.1880) | (0.1449) |
| *mail* | 0.5627*** | 0.6353*** | 0.6809*** |
| | (0.1753) | (0.1944) | (0.1906) |
| *lump_sum* | 0.6180*** | 0.4826*** | 0.6878*** |
| | (0.1710) | (0.1606) | (0.1224) |
| *nonparam* | -0.4650** | -0.2593* | -0.4057** |
| | (0.1756) | (0.1365) | (0.1612) |
| *wq_ladder* | -0.3617* | -0.2148 | -0.2333* |
| | (0.1795) | (0.1984) | (0.1321) |
| *protest_bids* | 0.9390*** | 1.0556*** | 0.9464*** |
| | (0.1325) | (0.1255) | (0.1092) |
| *outlier_bids* | -0.8814*** | -0.8335*** | -0.8729*** |
| | (0.1103) | (0.1165) | (0.1041) |
| *median_WTP* | 0.2193 | 0.1641 | 0.1339 |
| | (0.1625) | (0.1609) | (0.1922) |
| *hi_response* | -0.8020*** | -0.8654*** | -0.8246*** |
| | (0.1190) | (0.1280) | (0.0698) |
| *income* | 3.83E-07 | 5.04E-06 | 4.59E-06 |
| | (4.88E-06) | (4.63E-06) | (4.84E-06) |
| *nonusers* | -0.5019*** | -0.5169*** | -0.6215*** |
| | (0.1176) | (0.1245) | (0.1149) |
| *single_river* | -0.3236* | -0.3250 | -0.3738** |
| | (0.1791) | (0.2157) | (0.1703) |
| *single_lake* | 0.2950 | 0.5420** | 0.4062 |
| | (0.2621) | (0.2523) | (0.2648) |
| *multiple_river* | -1.6155*** | -1.3804*** | -1.7595*** |
| | (0.2951) | (0.3036) | (0.2085) |
| *salt_pond* | 0.7613** | 0.5510 | 0.5252 |
| | (0.3366) | (0.3452) | (0.3231) |
| *num_rivers_ponds* | 0.0791*** | 0.0789*** | 0.0821*** |
| | (0.0094) | (0.0115) | (0.0145) |
| *regional_fresh* | -0.0069 | 0.0901 | 0.0143 |
| | (0.1642) | (0.1967) | (0.1490) |
| *southeast* | 1.1396*** | 1.3434*** | 1.2807*** |
| | (0.2174) | (0.2379) | (0.1974) |

| | | | |
|---|---|---|---|
| *pacif_mount* | -0.3080** | -0.3143* | -0.3168*** |
| | (0.1298) | (0.1610) | (0.1047) |
| *plains* | -0.7958** | -0.8544*** | -0.9292*** |
| | (0.2831) | (0.3058) | (0.2641) |
| *mult_reg* | 0.6074** | 0.5682* | 0.7514*** |
| | (0.2490) | (0.3040) | (0.2331) |
| *WQ_fish* (*lnWQ_fish* for translog) | 0.2095** | 0.2274* | 0.1726* |
| | (0.0809) | (0.1210) | (0.0998) |
| *WQ_shell* (*lnWQ_shell* for translog) | 0.2610** | 0.4567** | 0.2127* |
| | (0.0984) | (0.2152) | (0.1109) |
| *WQ_many* (*lnWQ_many* for translog) | 0.2400** | 0.3093 | 0.2199* |
| | (0.0977) | (0.1893) | (0.1150) |
| *WQ_non* (*lnWQ_non* for translog) | 0.4808** | 0.6827* | 0.4765** |
| | (0.1947) | (0.3396) | (0.1854) |
| *nonfish_uses* | -0.1541 | -0.1375 | -0.2072* |
| | (0.1225) | (0.1405) | (0.1111) |
| *fishplus* | 0.7964*** | 0.8104*** | 0.9222*** |
| | (0.1719) | (0.1845) | (0.1649) |
| *baseline* | -0.1240*** | -0.1290*** | -0.1168*** |
| | (0.0407) | (0.0441) | (0.0289) |
| **-2 Log Likelihood** | | | |
| Full model | 65.8 | 70.7 | 63.2 |
| Intercept and random effects only | 167.6 | 167.6 | 176.6 |
| -2 Log Likelihood $\chi^2$ | 101.8*** | 96.9*** | 113.4*** |
| **Covariance Factors** | | | |
| Study Level ($\sigma_u^2$) | $7.71 \times 10^{-18}$ | 0.0 | $1.18 \times 10^{-19}$ |
| Residual ($\sigma_e^2$) | 0.1320 | 0.1402 | 0.0421 |
| **$R^2$** (see note) | 0.77 | 0.76 | 0.85 |
| **Observations (N)** | 81 | 81 | 81 |

Note: Because $\sigma_u^2$ approximates (or is equal to) zero in all cases, unadjusted $R^2$ estimates here are identical to those obtained from OLS. However, in the general case, $R^2$ obtained from multilevel or random-effects models is not equivalent to standard OLS $R^2$, and should not be interpreted equivalently (Statacorp 2001, p. 439).

* p<0.10
** p<0.05
*** p<0.01

**Table 7. Results for Multilevel Models: Per Fish WTP for Recreational Harvest**

| Variable | Parameter[a] (Std. Err.) | | | |
|---|---|---|---|---|
| | **Model One (Unrestricted)** | **Model Two (Methodology Only)** | **Model Three (Methodology Omitted)** | **Model Four (Weighted)** |
| *Intercept* | -3.2870** | 1.6123** | 0.03352 | -4.4923*** |
| | (1.2194) | (0.7745) | (0.9692) | (1.0348) |
| *SP_conjoint* | -1.1987** | -0.03493 | | -1.2906*** |
| | (0.4780) | (0.7230) | | (0.4878) |
| *SP_dichot* | -0.2906 | -0.7178 | | 0.5247 |
| | (0.3659) | (0.5409) | | (0.3399) |
| *TC_individual* | 3.2337*** | 0.5990 | | 4.3417*** |
| | (0.7708) | (0.9212) | | (0.6961) |
| *TC_zonal* | 3.5602*** | 1.3114 | | 3.7764*** |
| | (0.6072) | (1.2634) | | (0.6350) |
| *RUM_nest* | 3.3841*** | 2.2313** | | 4.7759*** |
| | (0.9285) | (0.9910) | | (0.7618) |
| *RUM_nonnest* | 3.9126*** | 1.4738 | | 5.3050*** |
| | (0.8427) | (0.9341) | | (0.6194) |
| *SP_year* | 0.1842*** | 0.04569 | | 0.2455*** |
| | (0.03831) | (0.03960) | | (0.03317) |
| *TC_year* | -0.05780** | 0.02859 | | -0.02351 |
| | (0.02586) | (0.04118) | | (0.04440) |
| *RUM_year* | -0.03678* | -0.04726 | | -0.06487*** |
| | (0.02056) | (0.03479) | | (0.02340) |
| *SP_mail* | 0.6506 | 0.1023 | | 0.4240 |
| | (0.4023) | (0.5822) | | (0.3006) |
| *SP_phone* | 1.0502** | 0.2064 | | 0.7610 |
| | (0.5039) | (0.6195) | | (0.5485) |
| *high_resp_rate* | -0.8155*** | -0.5569*** | | -0.7396*** |
| | (0.2762) | (0.1663) | | (0.2735) |
| *inc_thou* | 0.01457 | | 0.003093 | 0.02646*** |
| | (0.01171) | | (0.01891) | (0.01208) |
| *gender* | -0.08068*** | | -0.07219*** | -0.09235*** |
| | (0.01718) | | (0.01764) | (0.01962) |
| *spec_gender* | 6.7972*** | | 6.3488*** | 7.7103*** |
| | (1.4694) | | (1.7246) | (1.7320) |
| *age* | -0.07264 | | -0.07387 | -0.1354* |
| | (0.06656) | | (0.05750) | (0.07398) |
| *spec_age* | 3.8017 | | 3.3646 | 5.9947** |
| | (2.8192) | | (2.3379) | (3.0149) |
| *trips* | -0.01890 | | -0.01525 | -0.00306 |
| | (0.01343) | | (0.01773) | (0.01602) |
| *spec_trips* | 0.8438*** | | 0.6996 | 1.1520*** |
| | (0.3189) | | (0.4743) | (0.4435) |
| *nonlocal* | 3.5950*** | | 3.6071*** | 3.2170*** |
| | (0.3596) | | (0.3291) | (0.2761) |
| *big_game_natl* | 1.2285** | | 1.9614*** | 0.5850 |
| | (0.5032) | | (0.5192) | (0.4467) |
| *big_game_satl* | 2.1601*** | | 2.8527*** | 1.7286*** |
| | (0.5926) | | (0.5319) | (0.5121) |
| *big_game_pac* | 2.0546*** | | 3.0093*** | 1.4329*** |
| | (0.4799) | | (0.4506) | (0.4369) |

| | | | | |
|---|---|---|---|---|
| *small_game_atl* | 1.0587 | | 1.8266*** | 0.6213 |
| | (0.7399) | | (0.6021) | (0.5706) |
| *small_game_pac* | 1.4371*** | | 2.2362*** | 0.5575 |
| | (0.4330) | | (0.3558) | (0.4438) |
| *flatfish_atl* | 1.1088*** | | 1.8085*** | 0.5384 |
| | (0.3709) | | (0.3878) | (0.3620) |
| *flatfish_pac* | 1.6171*** | | 2.4994*** | 1.2922** |
| | (0.5258) | | (0.5030) | (0.5062) |
| *other_sw* | 0.4498 | | 1.2516*** | -0.1725 |
| | (0.4339) | | (0.3775) | (0.4011) |
| *musky* | 3.5631*** | | 3.5904*** | 3.4712*** |
| | (0.3281) | | (0.3874) | (0.2850) |
| *pike_walleye* | 1.2546*** | | 1.3170*** | 1.1445*** |
| | (0.3209) | | (0.3351) | (0.2666) |
| *bass_fw* | 1.7142*** | | 1.6225*** | 1.5982*** |
| | (0.4805) | | (0.4844) | (0.5027) |
| *trout_east* | 0.7173* | | 1.6090*** | -0.04427 |
| | (0.3862) | | (0.4673) | (0.3874) |
| *trout_GL* | 1.7802*** | | 2.0177*** | 1.6633*** |
| | (0.3524) | | (0.3765) | (0.2551) |
| *trout_west* | 0.6358 | | 0.6777 | 0.2349 |
| | (0.3918) | | (0.4294) | (0.4559) |
| *trout_other* | -0.7200 | | 0.2921 | 0.2882*** |
| | (0.4633) | | (0.1872) | (0.07209) |
| *salmon_atlantic* | 5.3450*** | | 5.5396*** | 4.0623*** |
| | (0.4700) | | (0.5239) | (0.5496) |
| *salmon_GL* | 2.2583*** | | 2.2988*** | 2.2134*** |
| | (0.2957) | | (0.3375) | (0.2528) |
| *salmon_pacific* | 2.3844*** | | 3.3227*** | 2.4011*** |
| | (0.7000) | | (0.5448) | (0.5867) |
| *steelhead_GL* | 2.2701*** | | 2.9424*** | 1.8736*** |
| | (0.5331) | | (0.4551) | (0.5074) |
| *steelhead_pac* | 2.4655*** | | 2.3529*** | 2.3207*** |
| | (0.2526) | | (0.2888) | (0.2185) |
| *catch_year* | 1.3246*** | | 0.1869 | 1.7082*** |
| | (0.4778) | | (0.3255) | (0.4538) |
| *cr_nonyear* | -0.08238 | | -0.05934 | -0.1048** |
| | (0.07108) | | (0.07743) | (0.04803) |
| *cr_year* | -0.06682*** | | -0.02310** | -0.09966*** |
| | (0.01827) | | (0.01005) | (0.01849) |
| *spec_cr* | 0.6799*** | | 0.009221 | 0.8014*** |
| | (0.2275) | | (0.1802) | (0.2546) |
| *shore* | -0.2451 | | -0.1239 | -0.4168* |
| | (0.1808) | | (0.2301) | (0.2522) |
| *-2 LnL $\chi^2$ (df)* | 236.5*** | 18.2 | 188.2*** | 341.4*** |
| | (45) | (12) | (33) | (45) |
| *-2 LnL $\chi^2$ for restrictions (df)* | -- | 218.3*** | 48.3*** | -- |
| | | (33) | (12) | |
| *LR $\chi^2$ for test of random effects* | 3.58* | 101.42*** | 40.77*** | 104.15*** |
| *N* | 391 | 391 | 391 | 391 |

*Note:*
*** denotes significance at p<0.01.
** denotes significance at p<0.05.
* denotes significance at p<0.10.

**Table 8. Specification of Attribute Levels and Nonuser WTP Forecasts**

| Variable | Specification 1<br><br>Semi-Log; Telephone Survey | Specification 2<br><br>Trans-Log; Telephone Survey | Specification 3<br><br>Semi-Log; Mail Survey | Specification 4<br><br>Trans-Log; Mail Survey |
|---|---|---|---|---|
| *intercept* | 1 | 1 | 1 | 1 |
| *year_indx* | 31 | 31 | 31 | 31 |
| *discrete_ch* | 1 | 1 | 1 | 1 |
| *voluntary* | 0 | 0 | 0 | 0 |
| *interview* | 0 | 0 | 0 | 0 |
| ***mail*** | **0** | **0** | **1** | **1** |
| *lump_sum* | 0 | 0 | 0 | 0 |
| *nonparam* | 0 | 0 | 0 | 0 |
| *wq_ladder* | 0 | 0 | 0 | 0 |
| *protest_bids* | 1 | 1 | 1 | 1 |
| *outlier_bids* | 1 | 1 | 1 | 1 |
| *median_WTP* | 0 | 0 | 0 | 0 |
| *hi_response* | 1 | 1 | 1 | 1 |
| *income* | 53840 | 53840 | 53840 | 53840 |
| *nonusers* | 1 | 1 | 1 | 1 |
| *single_river* | 0 | 0 | 0 | 0 |
| *single_lake* | 0 | 0 | 0 | 0 |
| *multiple_river* | 0 | 0 | 0 | 0 |
| *salt_pond* | 0 | 0 | 0 | 0 |
| *num_rivers_ponds* | 0 | 0 | 0 | 0 |
| *regional_fresh* | 0 | 0 | 0 | 0 |
| *southeast* | 0 | 0 | 0 | 0 |
| *pacif_mount* | 0 | 0 | 0 | 0 |
| *plains* | 0 | 0 | 0 | 0 |
| *mult_reg* | 0 | 0 | 0 | 0 |
| *WQ_fish* | 0-3 | 0-3 | 0-3 | 0-3 |
| *nonfish_uses* | 0 | 0 | 0 | 0 |
| *fishplus* | 0 | 0 | 0 | 0 |
| *baseline* | 7 | 7 | 7 | 7 |
| **Nonuser WTP Forecasts (2002 dollars)** | | | | |
| *WTP for WQ_fish=0.5* | 3.24 | 3.07 | 5.70 | 5.80 |
| *WTP for WQ_fish=1.0* | 3.60 | 3.60 | 6.32 | 6.79 |
| *WTP for WQ_fish=2.0* | 4.44 | 4.21 | 7.80 | 7.95 |

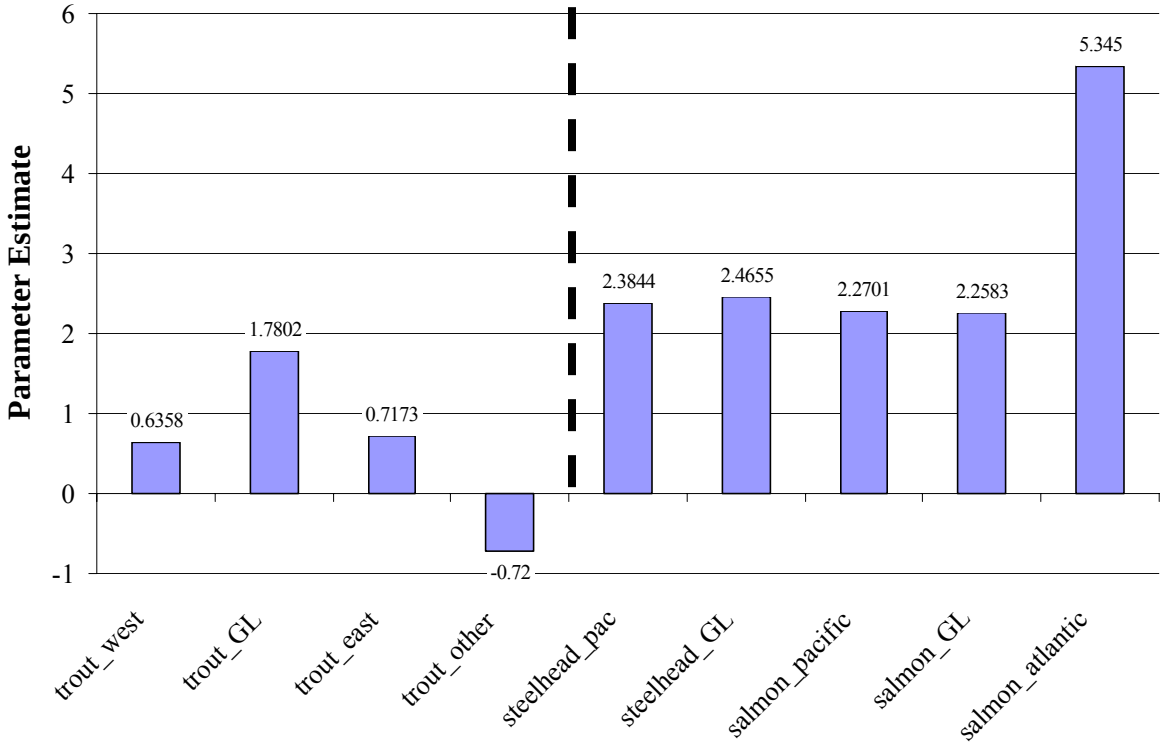



**Figure 1. Parameter Estimates: Trout and Salmon Species/Region Groups**

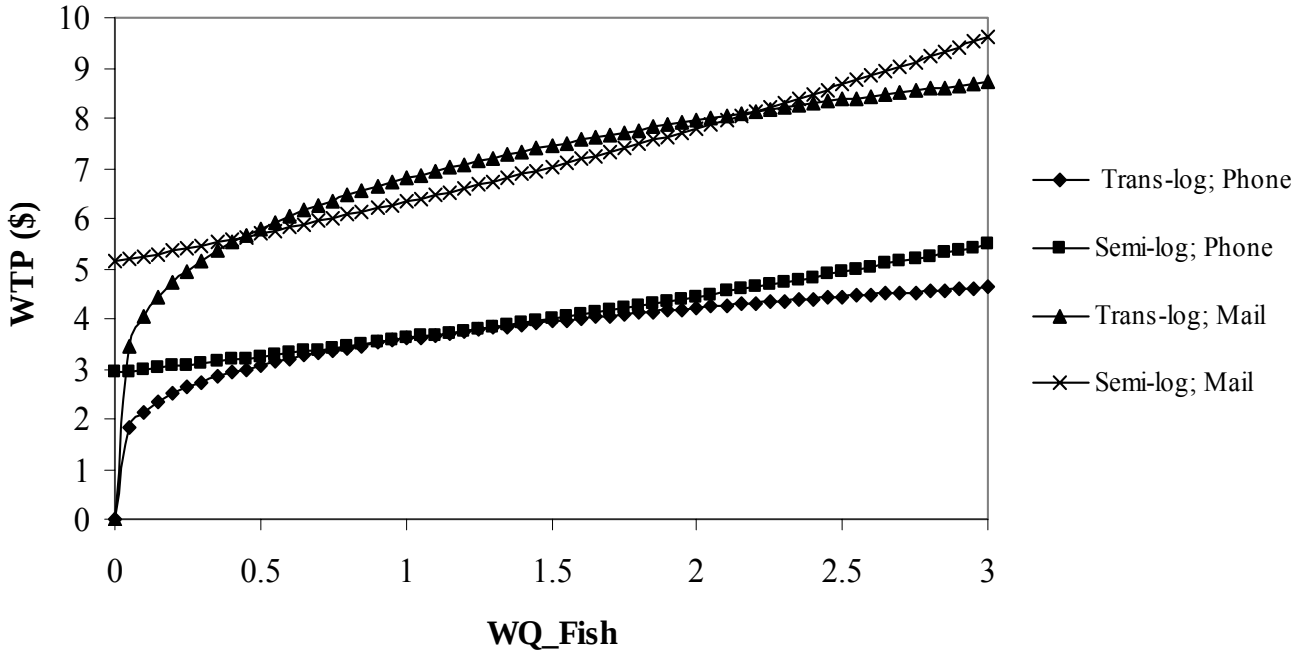



**Figure 2. Estimated Willingness to Pay for Improvements in Water Quality for Fish Habitat (*WQ_Fish*): Four Specifications**

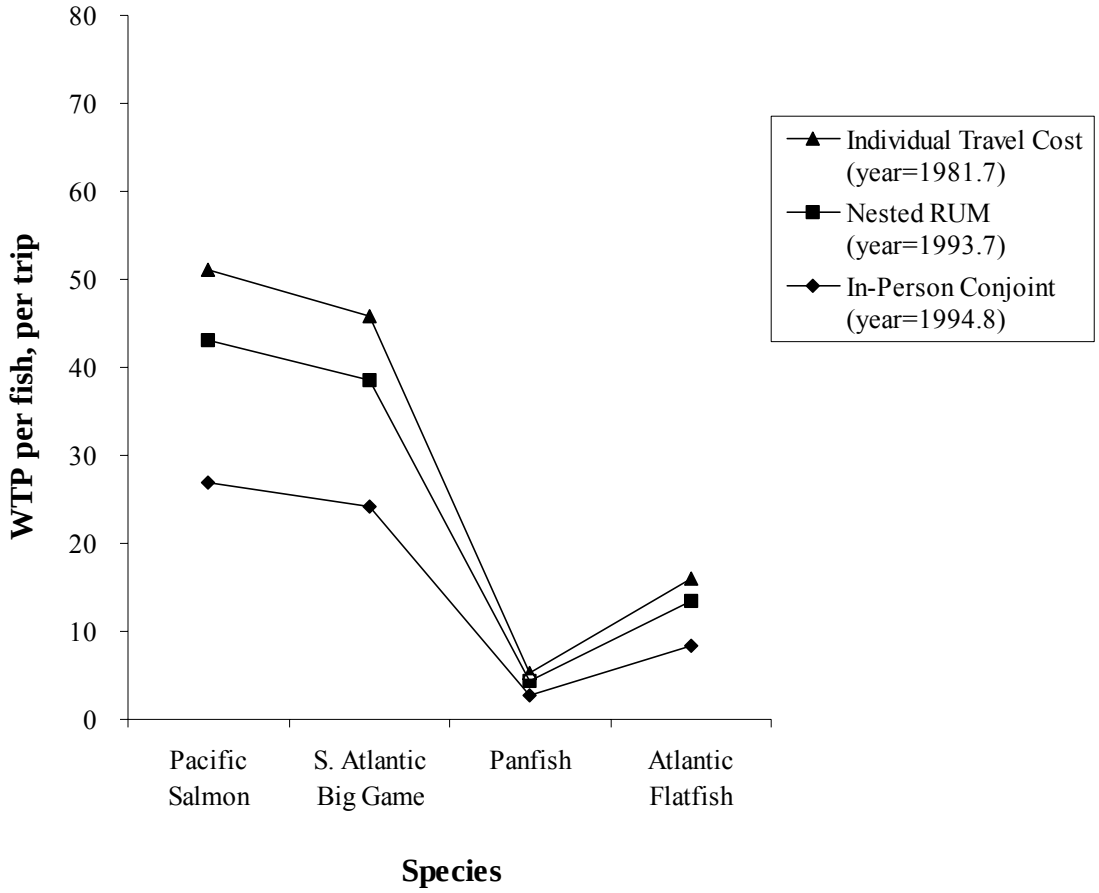



**Figure 3. Per Fish WTP as a Function of Research Methodology: An Illustration Assuming Mean Year for Included Study Methodologies.**

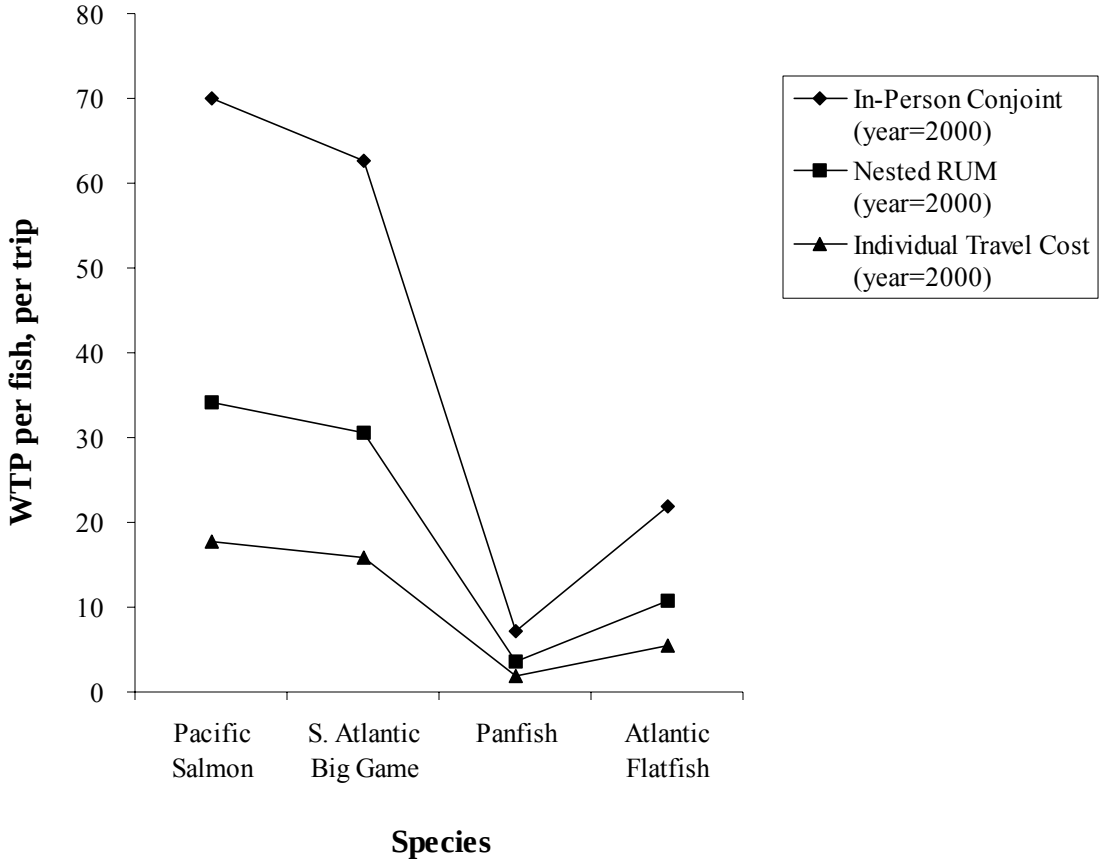



**Figure 4. Per Fish WTP as a Function of Research Methodology: An Illustration Assuming Equivalent Study Years (2000).**

# "International Benefits Transfer: Methods and Validity Tests"

**Richard Ready**

***Department of Agricultural Economics and Rural Sociology, 112-A Armsby Building***
***Pennsylvania State University, University Park, PA 16802, USA***
***e-mail: rready@psu.edu***

**Presented during Session 3.**

## I. Why International Benefits Transfer?

Intuitively, when conducting benefit transfer, it is preferable to find a study site located close to the policy site of interest. The closer the study site is to the policy site, the more likely that both the good being valued and the user population affected will be similar. Rosenberger (2001) has found some evidence that transfers conducted within a region perform better than transfers conducted between regions.

Still, there are good reasons to explore the feasibility of benefit transfers conducted across national boundaries. First, while the bulk of valuation studies have been conducted in the United States and Western Europe, nonmarket values are increasingly demanded for policy analyses in less developed and transitioning countries. Second, multi-national bodies (for example the European Union and the North American Commission for Environmental Cooperation) need to be able to conduct policy analyses for coordinated environmental actions. If benefit transfer is feasible across national boundaries, then it is attractive both because of the potential cost savings and because of the ability to use consistent values in analyses of actions that impact more than one country.

In these comments I highlight some of the unique issues that must be addressed when conducting international benefit transfer, and review some empirical tests of the validity of international benefit transfer. Many of the issues are illustrated using results from a study valuing health improvements conducted in five European countries (Ready et al. 2004).

## II. Currency Conversion

The first issue that must be addressed when conducting international benefit transfer is the conversion to a common currency. As will be shown, even in situations where the same currency is used in more than one country (for example the euro and the U.S. dollar), there is still an issue related to currency conversion.

Consider two individuals living in two different countries with the same preference structure over consumption of market goods, x, and the level of public goods available, Q. Under what circumstances would we expect these two individuals to have the same WTP for a change in the level of the public good? The individual in Country A has willingness to pay for a change from $Q_0$ to $Q_1$ defined by

$$V(I_A, p_A, Q_0) = V(I_A\text{-}WTP_A, p_A, Q_1)$$

where $I_A$ is income in Country A and $p_A$ is the price of market goods in Country A. If the exchange rate between the currency in Country A and the Currency in Country B is given by $\beta$, what do we know about $WTP_B$ relative to $WTP_A$?

Because indirect utility functions are homogeneous of degree 0, we know that

$$V(\beta*I_A, \beta*p_A, Q_0) = V(\beta*I_A - \beta*WTP_A, \beta*p_A, Q_1).$$

Therefore, the individual in Country B will have willingness to pay $WTP_B = \beta*WTP_A$ only if he has income $IB = \beta*I_A$ and faces prices $p_B = \beta*p_A$. This last point is critical. Identical individuals using

different currencies will have the same real willingness to pay only if they have the same real income and face the same real prices. Thus, the appropriate exchange rate for converting values into a common currency is the exchange rate the equalizes market prices.

This type of exchange rate is called a purchasing power parity (PPP) adjusted exchange rate. The Penn World Table includes a list of PPP-adjusted exchange rates for 168 countries, based on price surveys conducted by the OECD and the World Bank. PPP-adjusted exchange rates can differ markedly from financial exchange rates (the conversion rates offered in international financial markets). For example, in the five-country health study, the financial exchange rate between Dutch guilders to Portuguese escudos at the time of the study was 91 escudos/guilder. The PPP-adjusted exchange rate was 60 escudos/guilder. This difference of 50% reflects the difference in market prices between the Netherlands and Portugal.

This issue has not disappeared as a result of currency unification. Even though both the Netherlands and Portugal now use the euro, there remain differences in market prices between the two countries. An individual living in the Netherlands with an annual income of 50,000 euros has a very different standard of living than an individual with identical preferences with the same income in Portugal, and will likely have different willingness to pay for public goods.

When the policy site is smaller than an entire country, the analyst may need to worry about differences in prices even within a country. At the time of the five-country study, for example, prices for market goods in Lisbon were 45% higher than the national average for Portugal. When city or regional PPP indices are available, those should be used to account for local differences in prevailing prices.

A more difficult issue is differences among countries in in-kind income. In many countries, health care, college tuition and retirement income are provided free of charge to all residents. These represent a supplement to the real income of the citizens in those countries. Citizens of these countries need to save less money for college expenses and retirement needs, and consequently can afford to pay more for public goods. The challenge is quantifying these types of in-kind income, so that total income can be measured in consistent ways across different countries.

## III. Differences in Measurable Attributes of the Users

Typically, we think of the value of an environmental good as being determined by three different sets of factors: the characteristics of the good itself (quantity, quality), the context within which the good exists (availability of substitutes, etc), and the characteristics of the users who value the good (income, age, experience). When conducting any benefit transfer, whether international or within a country, it is important to account for differences in the good and its context. When possible, a study valuing a good similar to the good in the policy site should be chosen. When enough different sites have been valued, a meta-analysis may be possible that estimates a value function that includes characteristics of the good as arguments.

As for the third set of factors, measurable characteristics of the users, the most striking issue in international benefit transfer is differences in the level of incomes across countries. Even within the EU, average per capita GDP measured in PPP terms varies by over a factor of five between the richest and the poorest countries.

Because most existing valuation studies were conducted in the U.S. or Western Europe, international benefit transfer often involves transfer of a value from a high-income country to a low-income country. One common, simple approach to dealing with income differences between the study country and the policy country is to multiply unit values by the ratio of income in the policy country to income in the study country (or per capita gdp). This approach assumes that willingness to pay varies proportionally with income, an assumption that is typically not found to hold within individual studies. More typically, within a given country we find that willingness to pay increases with income, but at less than a proportionate rate. Using the income ratio as an adjustment will tend to overcorrect for income differences when the policy country is much poorer than the study country. Still, when justifying environmental investments, this approach may be defensible as providing a lower bound estimate.

A conceptually better approach is to apply a value function. In order to estimate such a function, variability in income is needed in the source data. This variability typically comes from variation within the sample of users surveyed at the study site. For example, we may discover that willingness to pay for a public good valued at a study site is higher for users with higher income. We use this variation to estimate a value function. If the average income at a policy site is higher or lower than that at the study site, the value function adjusts for that difference.

This approach is probably defensible when the difference in measurable characteristics between the study site and the policy site is small, so that the average at the policy site falls well within the range of observations at the study site. However, when conducting international benefits transfer, this may not always be the case. A valuation survey conducted in Northern Europe will include respondents with varying levels of income. However, few respondents will have incomes as low as those found in some developing countries. Simply plugging the average user characteristics from a low-income policy site into a value function estimated in a high-income country can lead to serious problems.

First, there is the familiar problem of extrapolating outside the range of the data. Particularly in socialized economies, the range of income within which most of the respondents fall may be fairly narrow relative to the mean. The variability in the data may not be sufficient to identify curvature in the relationship between income and willingness to pay. But, small changes in curvature have big implications when transfering the value function to a policy country where average incomes may be one tenth those of the study country.

The second issue is that the source of the variability, variation among individuals within the study country, is different from varation among countries. The implicit assumption is that two individuals in different countries will have the same willingness to pay if they have the same income (appropriately converted). It is not clear however that a very wealthy individual in a poor country will necessarily have the same willingness to pay for the public good as a poor individual in a wealthy country, if those two individuals have the same absolute income. Relative income may matter as well. This is an issue that can only be adequately addressed by comparing value functions estimated from wealthy countries to value functions estimated from poorer countries.

## IV. Differences in culture, etc.

Not all factors that are important in determining values are measurable. Cultural heritage, shared values and shared experiences can also affect values for public goods. The value of preserving bald eagles in the United States is probably quite different from the value in Canada. Values for cultural heritage goods and landscapes are probably especially sensitive to culture and shared experience. A highly-valued traditional landscape in England may not evoke similar values in Spain, and vice versa.

In the context of the five-country health valuation study, we confronted cultural differences in attitudes towards health, as well as differences among countries in average health status, health infrastructure, and quality of the health care system. Differences in health status can be treated as a measurable characteristic of the individual. Even differences in attitudes might be captured by additional questions (for example Likert-type agree/disagree questions) in the original study, though the same problem mentioned earlier in the context of income differences, i.e. the use of variability within a country to predict differences in values between countries, is likely to arise.

More difficult to deal with are differences among countries in characteristics that do not vary within each country. In most countries, health infrastructure and health care quality do not vary much across individuals (the U.S. being a notable exception). A survey conducted in Norway, where everyone has access to care of similar quality, cannot reveal how individuals will value health in a country with better or poorer access or quality of care.

At least health care quality and access can be quantified. It is perhaps possible to take advantage of variation in health care quality across countries, and estimate a value function from values estimated in multiple countries. However, the data needs to do this are large. In the five-country study, we conducted over 1000 in-person interviews. However, when considering factors that vary by country but that do not vary within each country, we really only had four degrees of freedom to work with. It is not at all difficult to think up more than four factors that vary by country that might affect willingness to pay for health.

## V. Validity Tests across Countries

Given all of the difficulties in conducting international benefit transfer, how well does it work? This was the central question explored in the five-country health study. In that study, five different episodes of ill health were valued. In in-person interviews, willingness to pay to avoid each of the five episodes was elicited. These were converted to a common currency using PPP-adjusted exchange rates.

Imaginary benefit transfers were then conducted. Each imaginary transfer was conducted as an n-1 out of sample projection. All of the data from every country except one was used to construct a transferred value estimate. This transferred value, $WTP_T$, was then compared to the value estimated from the policy country, $WTP_P$. The transfer error was calculated as the percent difference between the transferred estimate and the policy site estimate

$$TE = \frac{\left|WTP_T - WTP_P\right|}{WTP_P}$$

A total of 20 transfers were conducted. Each transfer was performed using a simple unit value transfer, a unit value transfer using the income ratio adjustment procedure, and a value function transfer.
The average transfer error over all transfers was 38%. Over three quarters of transfers resulted in transfer errors less than 50%. 92% of transfers resulted in transfer errors of less than 75%. For isolated transfers, the transfer error was very high (as much as 230%). There was little difference in the performance of the three different transfer protocols. These transfer errors are similar, both in the size of the average and the range, to those found in Rosenberger's review of intra-country transfers.

The magnitude of these transfer errors is inflated, because the criterion ($WTP_P$) is not known with certainty. The measured transfer error is the combination of the true transfer error plus error in the measurement of $WTP_P$. To explore how large this latter source of error might be, sham transfers were conducted within each country. Using Monte Carlo resampling, two samples were generated from the same original data set from the same country. A $WTP_T$ was calculated from one of the two datasets, and a $WTP_P$ calculated form the other. This was repeated 1000 times for each country. The average sham transfer error was 16%. The average transfer error found between countries, 38%, should be assessed relative to this background level of random sampling error.

## VI. Should values be adjusted?

One issue that has not received much attention in the benefit transfer literature is the issue of whether values should be adjusted when transfering from one jurisdiction to another, or from one population of users to another. Consider the example of valuing changes in mortality from drinking water contamination. Suppose that we know that the value of a statistical life (VOSL) in Greece is lower than the VOSL in Sweden, due to lower incomes. Should we use different VOSL estimates in the two countries?

First imagine that Greece is considering an investment in water quality control that will reduce mortality rates in Greece. Obviously, Greece should use its own VOSL in evaluating that investment, rather than adopting Sweden's value. However, imagine that the EU was deciding which investments it should make. If it uses Sweden's VOSL to value reductions in mortality in Sweden, and uses Greece's VOSL to value reductions in mortality in Greece, it would direct more resources to saving swedish lives than to saving greek lives. It is politically (and probably morally) more defensible to use a common VOSL to value mortality changes in all member countries. The U.S. EPA has come to a similar conclusion regarding adjusting VOSL values to account for the age of the population at risk; it has chosen to use a common value for all statistical lives even though there is some evidence that older individuals have somewhat lower VOSL's than younger individuals.

## VII. Concluding remarks

None of the difficulties in conducting international benefit transfer outlined here are wholy unique to international transfer. Even the issue of currency conversion exists for intra-country transfers. The points I am making in these comments are more a matter of degree. International benefits transfer throws into sharp relief many of the issues that exist when conducting any benefit transfer.

On the whole, the empirical evidence is that international benefit transfer is as valid as intra-country transfer. No doubt it can be done poorly, but when done well, within reasonable limits, it can generate transfers with acceptably low potential transfer errors. When the alternative is no value estimates at all, international benefit transfer is a useful tool.

## References

Rosenberger, Randall S. 2001. "Testing the Validity of Benefit Transfer: A Site Correspondence Model." In J.J. Fletcher (comp.), 2001, *W-133 Benefits and Costs of Resource Policies Affecting Public and Private Land*. Western Regional Research Publication, Fourteenth Interim Report. Proceedings from the Annual Meeting, Miami, FL, February 26-28, 2001. Morgantown, WV: Department of Agricultural and Resource Economics, West Virginia University. Pp. 99-120.

Ready, Richard C., Ståle Navrud, Brett Day, Richard Dubourg, Fernando Machado, Susana Mourato, Frank Spanninks and Maria Xosé Vázquez Rodriquez. "Benefit Transfer in Europe: How Reliable are Transfers Between Countries?" *Environmental and Resource Economics* 29(September 2004):67-82.

# Discussant Comments on Presentations from Session 3

## Eric English

***National Oceanic and Atmospheric Administration (NOAA)***
***USA***

### 1) Comments on "Publication Measurement Error in Benefit Transfer." (Randall Rosenberger, presenter)

Because benefit transfer involves drawing conclusions from the previous valuation literature, the journal review process is likely to have significant effects on benefit transfer outcomes. Understanding these effects is an important aspect of benefit transfer research, and this paper takes the crucial first steps in some important ways. In particular, it explores systematic differences in valuation results corresponding to the body of literature from which the study was obtained.

Pursing the topic further will require overcoming many difficulties. First, exploring the reasons for the differences seems like the first step. This could assist with decisions about which studies are the most relevant for a given purpose. However, understanding the purpose of each study individually will always be an important part of relying on previous research. Understanding differences across literature types may be most useful for meta-analysis.

Second, there may be no useful definition of "representative" in the context of the valuation literature. As this paper points out, publication bias has received greater attention in the medical literature than in the economics literature. It may be that correcting the bias is more tractable in the medical literature because several studies will examine the same research question. There may be variation across subjects and study design, for example, but the drug and the disease are the same across studies. In contrast, resource valuation almost always involves different populations and different sites. Preferences across people vary more than biology, and variation in site characteristics make each study difficult to compare to the next. For this reason, a random sample of valuation studies is unlikely to be more representative of any correct value for an environmental site or amenity. Literature values for health effects may apply to a set of outcomes that is more comparable across populations, though preference variation still makes the notion of "representative" hard to define.

Finally, the question of measurement error arises frequently in benefit transfer and the formula used in this paper is

$$Expected \;\; Deviation = E\left|\frac{BT - PR}{PR}\right|$$

Here BT is a transferred study and PR is primary research. Since both of these are random variables, unless BT and PR are perfectly correlated, this is an upper bound estimate of deviation associated with BT.

### 2) Comments on "Aquatic Resource Improvements and Benefits Transfer: What Can We Learn From Meta-Analysis?" (Robert J. Johnston, presenter)

Meta-analysis is crucial in identifying characteristics that matter most when undertaking a benefit transfer. In some sense all valuation research is a benefit transfer, because it would be unwise to ignore the collective knowledge of past studies when designing and interpreting primary research. Meta-analysis

contributes to this collective knowledge in a way that is systematic but also contributes to intuition.

The facet of meta-analysis that is both informative and frustrating is the great number of moving parts that are involved. These lead to a host of possible interpretations, and the possibility to see two sides in any result. For example, Johnston's analysis suggests that in-person CVM gives lower estimates for recreational catch WTP, but higher estimates for water quality WTP. Does this mean that respondents are more likely to feel concerned about water quality issues in the presence of an interviewer, sensing the importance of being socially responsible? Or could in-person CVM be more accurate in both cases? The second explanation would make sense if respondents have trouble understanding the less familiar aspects of water quality issues, which can be explained in in-person interviews. For recreational anglers, on the other hand, overcoming an upward bias from hypothetical payments could be the most significant effect of in-person interviews.

One important issues raised throughout the session was the validity of function transfer, and in particular, whether function transfer is more accurate than value transfer. The first paper (Rosenberger) described meta-analysis as the "outer envelope" of functions particular to each study. It would be interesting to explore to what extent function parameters (on income, for example) vary between the meta-analysis function and functions specific to each study. In other words, how great is the tangency between functions used in function transfer, and the meta-function that presumably is more correct for benefit transfer.

### 3) Comments on "Benefit Transfer in Europe: How Reliable Are Transfers Between Countries?" (Richard Ready, presenter)

This paper shows how convincing a rigorous benefit transfer can be while highlighting the obstacles inherent in comparing populations. On the one hand, respondents in the five countries ranked the various health outcomes in the same order of importance, and the most direct comparison of values indicated comparable levels of willingness to pay across counties. On the other hand, the standard methods of controlling for differences across populations reduced the comparability of results. This could mean that assumptions commonly accepted for function transfer are incorrect, at least when applied to populations separated by culture and language.

One problem with controlling for income across cultures is the importance of frame of reference in determining spending patterns. For example, position in the income distribution could be an important predictor of willingness to pay along with absolute income. This would be particularly true across cultures, where frame of reference is defined within a distinct language and culture. Two individuals living in the UK and Portugal might have the same absolute income, but the resident of Portugal would be higher in the income distribution. Such differences have been shown to affect levels of charitable giving, for example, even across communities in the United States.

The test for accuracy of the benefit transfer was presented in the context of the variance of the primary research. This was a helpful comparison, which could perhaps be made explicit in the expression:

$$E\left|\frac{BT-PR}{PR}\right| - \frac{E|PR-\mu|}{\mu}$$

The expected deviation of benefit transfer compared to primary research must control for the expected deviation of the primary study from it own mean value. It is worth noting that unless BT and PR are perfectly uncorrelated, this is a lower bound estimate of deviation associated with BT. That is, deviation between BT and μ that is not expressed in deviation between BT and PR is unaccounted for in this expression. The study presented in this paper uses the same survey instrument for each country, and so there would likely be significant correlation. Such a study, naturally, suggests how well BT would perform under the most ideal circumstances.

**4) Comments on "Understanding and Accounting for the Spatial Geography of Ecosystem Goods and Services." (Matthew Wilson, presenter)**

This paper synthesizes information from the literature on resource valuation and applies it in a very sweeping manner to large geographic areas. I'll begin by pointing out the difficulty many economists have in accepting the premise of this research agenda in ecological economics. One of the main objections is the practice of adding marginal values to generate a total value. For comparison, consider the value per acre of the marginal shopping mall multiplied by the land area of Maryland. The result would be a big number, but not very meaningful number.

However, I'm willing to accept the notion that the figures presented in this paper represent a total inventory of potential marginal losses. I also recognize the importance of emphasizing the value of ecosystem services in planning decisions. A balance must be struck between the drawbacks of excessive homogenization in resource valuation versus the value of making environmental costs accessible for analysis in concrete terms.

# Question and Answer Session

## For *Session 3: State of the Science*

*This section presents a transcription of the Q&A session for the following presentations from Session 3:*

*Matthew Wilson, University of Vermont, USA*. Accounting for Ecosystem Services in a Spatially Explicit Format: Value Transfer and Geographic Information Systems.

*Randall Rosenberger, Oregon State University, USA*. Publication Measurement Error in Benefit Transfers.

*Robert Johnston, University of Connecticut, USA*. Aquatic Resource Improvements and Benefits Transfer: What Can We Learn from Meta-Analysis?

*Richard Ready, Pennsylvania State University, USA*. International Benefits Transfer: Methods and Validity Tests.

*Responses to questions are coded as follows:*

*MW: Matthew Wilson, University of Vermont, USA*
*RRo: Randall Rosenberger, Oregon State University, USA*
*RJ: Robert Johnston, University of Connecticut, USA*
*RRe: Richard Ready, Pennsylvania State University, USA*
*EE: Eric English, National Oceanic and Atmospheric Administration, USA [session chair]*

EE: I just had a couple questions, starting with Randy Rosenberger's paper. The question about publication bias -- makes me wonder whether something actually fits that. And I think the issue was raised that we don't get a random sample of the empirical evidence. I think the question is, would a random sample of the empirical evidence actually be more correct than the selected sample. It makes a difference in the medical profession in the sense that each study we look at is looking at something a little bit different. And so, a random sample of empirical evidence didn't necessarily correct in any sense, either. Richard Ready made a good point that validity testing often includes variance from two sources, both the benefits transfer value and the primary research value, and so that oftentimes we do get overestimates of the inaccuracies of benefits transfer. And I was seeing in one of the slides that Randy had has some very high errors, but those have to compare with the variance of the primary research. I thought Rob Johnston's paper was very interesting. One thing it raised in my mind was that there are many, many moving parts, once you put all the different studies into one large analysis, and that leaves room for multiple interpretations of some of these results. Just to give you an example, in-person CDM gives lower estimates for a recreational catch, but if you use in-person CDM for water quality I guess you get a higher value. And I'm learning it's possible it's more accurate in both cases, because in each case something different is causing that deviation. In other words, for the case of water quality maybe there's a lack of familiarity with the goods, so an in-person survey brings someone up to speed and maybe creates some value that wouldn't have been there if they're not familiar with the goods. On the other hand, for a recreational catch, it could be the case that maybe there's a bias in the hypothetical nature of the question and an in-person survey allows somebody to overcome that bias and make it less hypothetical. Also a really interesting paper by Richard Ready et al., and I just wanted to raise a couple of issues. It seemed

like Portugal and Spain on the one hand and then Norway and the Netherlands and England on the other hand, it almost seemed like there was some sort of systematic difference, the low-income countries having a higher willingness to pay, and you raised a couple of possible explanations for that. Another one could be frame of reference, someone who's not as well off in Portugal compared to somebody in England who's higher up in the income distribution, a lot of times how rich the field depends on where we stand in the distribution, not where we are in absolute terms. Also the question with the cost of living adjustments really reflect differences in income, or is it just a choice to live in a more expensive city like Lisbon when you could live somewhere else in Portugal, and it's more a function decision than a difference in income that's reflected in those higher prices? And [inaudible], probably a lower-bound on a deviation associated with benefits transfer unless the benefits transfer and primary research are perfectly uncorrelated for cases, they're all the same survey instrument. Those are issues I wanted to raise and many others have questions, might raise some other issues.

Q: Question for Randall Rosenberger on publication bias. You mentioned the possibility of the prospect of a new journal that is sort of based on applied policy that created new values. As someone who regularly reviews journal articles I'm finding that the methods or the journal articles are becoming more theoretical twisty or trying to develop a new spin on a lot of issues, and we're not really getting these new values being generated. What do you say for the prospect of developing -- I was asked a similar question in UK, of forming a journal article. Have you heard any rumblings of something like that?

RRo: No, I haven't actually heard rumblings along what I'm arguing for. About the closest I've heard is that in our journals we have such a low acceptance rate because of the competition that JEEM, one of our premier journals, has become very difficult to publish in. And the estimates of values just are not going to ever meet that. So there were some rumblings about an applied policy version of JEEM to come out, to make it a little more accessible. But even there I don't think they were necessarily arguing for new estimates of value. So my argument is for an e-journalist that we remove the page constraints entirely from the process and don't make those additional hurdles, so that we can easily bring some of the literature, more full reporting and accounting of that literature, forward. So I think it's kind of related to those rumblings, but I haven't heard much of anybody else arguing for this outside of the health sciences, and I don't recall ever seeing that they've ever actually developed one, either, because I think it's sponsorship and resource constraints, also.

Q: Jim Boyd, RFF. This question is for Rob. The one figure where you have a different fish species broken out and there's a variation in the trout willingness to pay but not in, what was it, salmon?

RJ: Those were actually parameter estimates --

Q: [*Jim Boyd*] Okay. I'm wondering if you are sort of agnostic on what was going on with the salmon, but can you go into a little more detail about what your study is picking up in terms of species in a particular location? And are those all deep marine? I'm not a fisherman so I don't really understand. Are these all kind of substitute species in some sense, or it would be really surprising to see your results if these species are in actually really different parts of the landscape, where substitution would be very different, and can you just riff a little bit --

RJ: I'll try to riff to the extent that I can. Basically what we have in the model is interaction between species groups and region. So, for example, although I don't have the paper in front of me and there's quite a bunch of them, in most cases we would, for example, separate out Atlantic salmon from Pacific salmon. They're different species. But the idea is, we also split out, if you notice the different trout species split out. And that was to a certain extent to get at any differences that might be related to different -- we hypothesized that anglers might place on additional fish would vary both according to region and species. And that perhaps the best way to get at it was through an interaction of the two, rather

than just putting in two sets of linear terms. And it seems like that captured it better, compared to -- we ran a whole lot of versions of this model, some where we put in region and then just a set of species dummies. And that just didn't work very well. When we interacted them it seemed to capture that much better. And I think maybe that's what's getting at what you're talking about a little bit more. Because it's a meta-analysis, just a big bunch of data and we're trying to make as much sense out of it as we can, we can't explicitly get at issues between substitution of species as much as you might be able to in a specific study. But what we are seeing, which is nice, is that if you look at the study, the species and areas where you would hypothesize would have lower values like pan fish, for instance, are always way down at the bottom. And the species, independent of region, and the species you'd expect to have higher values independent of region are right up there. And that holds across studies. And so I think we're getting some positive findings from that.

Q: James White from the New South Wales Environment Conservation Department. Very little of my time is spent on the Envalue database. Most of my time as a government employee is spent coming up with assessments and recommendations for policymakers and decision makers about the merits of environmental regulation proposals. And there's been a lot of discussion today about function value transfers and meta-analytical techniques, but then also a lot of concerns about validity and so forth have been trot out as well. What I want is your opinions; from a policy development perspective, how much are these techniques adding to what's being done in the primary studies in terms of benefit transfer? Because to some extent it's starting to look like the primary valuation study peanuts are being crushed by the meta-analytical sledgehammers and tiny little bits and pieces are flying out in all directions, but we can't quite make sense of what's going on with them.

RJ: One thing that occurs to me just briefly, and I've thought about this -- are we just pounding these little things to pieces? But one of the things that I actually like about a meta-analytic approach is that it picks up patterns that you may not be able to find looking at one study in isolation. Particularly, again, do we find these systematic patterns? When you look at water quality studies, in the studies where water quality improvement is larger, are you finding larger willingness to pay values? And I think that can start to answer the question or can start to answer some of the questions regarding underlying validity, and are we measuring something real or, on the extreme critical view, is this just random noise? Or are these constructed by the survey? And so, I think the ability to pick up these overarching patterns is something that's valuable. What you lose in the process, the little pieces, the peanuts, that I think is a question that is harder not to crack.

RRo: Let me just say couple things. When the idea that value function transfer is going to do better than value just kind of naive transfer of unit values, goes back to the why resources research. It's held as an article of faith. And what I was trying to point out is not necessarily true that that doesn't give you any improvement. That comment is specific to value functions that are estimated based on variation within one site, so house to house variation in income, gender, education. I think that value functions that come from, say, meta-analysis or from multi-site studies, where you're motivating the function based on variation from site to site. Now, there's a lot more potential there, both for having something to say about new sites that don't match up with any of the previous sites that you've seen, and also for identifying studies that just may not be consistent. Apparently there's now an Ed Morey random effect. So that is a real nice way. If you found a study that seems to match up well and you say, well, that's the one I'm going to lean heavily on, it still may be worth doing your meta-analysis to make sure that it's kind of fitting within the rest of them, if you have enough studies to do that.

Q: [*James White*] But do you know that the rest of them are right?

RRo: No, but you're going to see studies that you look at and you say it looks okay to me, and you get ten studies that look okay to you, and if nine of them give you about the same answer and one gives you a

very different answer, then there's a little bit of evidence there that something's going on different with the one.

Q: John Hoehn, from Michigan State. I guess, Rob, your figure of willingness to pay for water quality got me to thinking because I wondered about that horizontal axis, water quality, and how consistently people measure things like that when they're estimating a value. We've given a lot of thought to the precision of the value estimate, but what about the precision of the right-hand side variables? The quality or income or those other things that influence value?

RJ: In the case of water quality, that was one of the reasons why we specifically tried to find studies that had used the RFF water quality ladder as kind of a native aspect. And interestingly enough, when you look at the studies that didn't use that as a native survey aspect but we tried to map it, often studies would use good, fair, poor, whatever, which can be mapped fairly easily to the RFF ladder. The dummy variable we put in there to adjust for any difference between those showed that there was a difference. Now that either indicates that there was some bias in the way that we did the mapping, or it means that there's some systematic difference between the studies that use the Resources For the Future ladder as a native part of the study and those that didn't. And I think that gets at maybe what you're suggesting, and that is that there is going to be some variation. I think Kerry said some interesting things. I think it was in his land economics paper about reconciling measurements across studies, and it's, I think, one of the challenges in that some variables in a meta-analysis might be left out entirely simply because you can't reconcile them across studies. And I think that's a challenge. In our case, water quality again, for the ones that use the native ladder, that seems to be pretty standard. Everyone's looking at the same ladder. But in other cases it might be different. Income measurements, for instance, as was pointed out, do you account for cost of living differences across regions? Sometimes you can and other times I found that it's difficult. I don't know if that answered your question or not.

Q: [*John Hoehn*] Yeah, I think it's a pretty significant issue, particularly when we get over to Matt's problem of translating these into ecosystem services. Because we have a part-time matching up, kind of simple metrics we use in valuation with ecological measures.

RJ: I guess my response is, you're absolutely right. It's a challenge in any one study getting the measurements right. And then obviously, when you lump a whole bunch of them together, it kind of smooths it over. I think to a limited extent, the fact that you find these patterns suggests that the systematic elements of these measurements are not being totally overwhelmed by the random elements, but certainly, and that's actually coming back to my last slide, one of the things that in terms of guidance on what's good practice for these meta-analyses would be very helpful, and that's one of the key areas where I thin it would be helpful. How close is close enough when comparing things like income or quality measures across studies?

MW: I'd like to add something. Your study, you're looking at habitat, and habitat of what? Certain species have ranges that are very biophysically linked to the landscape. So I'm not surprised, actually, your salmon values were quite different than, say, freshwater trout. I think we need to investigate more rigorously the spatial distribution. Is trading a habitat within one ecoregion the same as trading a habitat equivalent? I think what I'm saying is that there is a very rich area here, particularly habitat, that's very spatially rooted.

RJ: That's exactly what we would have hoped to find. I think if we had done our study and found that salmon and game fish and pan fish had exactly the same willingness to pay, that's where you say, hmm, maybe there's something going wrong here. That's exactly what we would have liked to find. Certainly, and this gets back to the whole what is in the source study, and a lot of times just even simple data, such as income and sample size isn't there, much less this detailed spatial stuff. In an ideal world, sure, we'd

all love to have it. It's just a matter of getting it in a way that corresponds across studies and can be thrown into a single regression model.

Q: Ian Bateman from UEA. I want to make a couple of statements, specifically a question. First of all, along with Greg Polk and a number of others who aren't here today, Reed at the journal Environment and Resource Economics, and we've actually specifically thought about the issue of the problem of publication bias, specifically for good studies that aren't novel. So they're just providing a new estimate, but they haven't got the methodological twist. And this thing we were concerned about is, if you went down the conventional route, then what you'd end up with is a literature that's just jam packed of weird studies that just do some strange thing. They ask all the questions backwards or something, just so that you can get it in the journal. And you won't get anything that you can actually use for benefits transfer; it is unfair against perfectly good studies that are just providing new estimates. So what we tried to do is [word inaudible] policy, that if a study, it's a compromise policy because the real world is citation and all that and we have to be aware of that. If there's a new study which is really good and it gets through the referees in terms of quality, but there's nothing that's really going to mark it out as a new contribution to literature, as it's normally considered, then what we'll offer an author is a note plus information for readers on how they can find that big, unedited, uncompressed report for their benefit transfer needs. So we are attempting to get at that. The second one is something that really comes up both for Randall and Richard's presentation, about value function transfer and simple value transfer. I just wanted to mention a study that Roy Brouwer were going to talk about, but unfortunately he's ill. It's one that we did recently that is coming out in General Health Economics, and this looks at comparison of function transfer against normal, simple transfer. And what we found was that if you use relatively simple functions that are guided purely by economic theory, then actually they transfer pretty well, and that could be why it got accepted. It's what the editors want to see. But when you try to transfer complex functions, which maybe describe individual sites extremely well but transfer very poorly, and actually work a hell of a lot worse than just simple point estimate transfers. So actually, the point we're trying to argue in that paper is actually function transfer might be the way to go, but perhaps you should just use theoretically driven models rather than these context driven models.

Q: Kerry Smith again. I wanted to pick up, actually, on the two previous points, and I think it's tremendously encouraging, the results that everybody presented, particularly with respect to the meta-analyses, how consistent things were. But let's look at the unit that is being combined from two different dimensions. We had hectares, fish, rungs of a ladder, and different variations on health conditions, as the things that were being pooled within a given meta-analysis or within a given transfer. I'm encouraged obviously that there's signal in that and not exclusively random variation. But if we were to think about the alternative ways we might measure the quantity unit that's associated with the willingness to pay, that might help to explain it. So, for example, in the case of the five country study that Rich was talking about, I wonder if you just looked at the three rightmost variables in your graphs that were more associated with symptom days or something else. The functions looked very close there across countries. Now very close, once you take the others out of the model, then they blow up and look maybe a scaling effect in the graph. I don't know. But the point is, what's the quantity effect? The second thing is that if you look at the meta-analyses that were done, the concept of economic benefit that's being used is different from a random utility model versus a travel cost model versus a hedonic model. And if you start, for example, looking at the random utility models associated with fishing, depending on what the random utility model is, whether it's a repeated discrete choice or it's something else, the alternatives that are involved, the economic concepts that are involved, the interpretation of what the value is for fish and so forth, we all know that. And the question is, how can we account for that as well in the context of the meta-analysis? So that we're not necessarily attributing that to some feature that is really not associated

with that. In other words, that's associated not a study effect or something but it's really a concept effect, if you will. So I'd just be interested in -- the last issue is a conjecture. I would bet that the point that Rich began with, which was that the PTP adjustment is correct, I think that's correct for willingness to pay, but it's not correct for marginal willingness to pay. It's not correct for the virtual price. But it is correct for the willingness to pay?

RRe: Couldn't you just take that formula for compensating variation -- I'd have to check on it.

KS: The derivative -- what I'm really doing, again it would depend on whether you're using Hicksian or Marshallian virtual price. But the fact of the matter is that the virtual price function, in this case Marshallian, doesn't adjust the same way as the Hicksian willingness to pay would. It's precisely because of the homogeneity of degree of zero in prices and income that gets you to that point, and you don't have that in the context. I had never thought about that until you commented on it, and I don't know whether it's right or not, but I think it's right.

RRe: I'll sit down with a pad of paper.

Q: Walter Milon, University of Central Florida. Matt, you introduced something into this that I think is very different than what the other papers are trying to get at, and that is the spatially explicit aspect. And it's interesting that that wasn't originally on the table, yet I expect a lot of the applications of benefit transfer really do try to get at this notion of taking a value and applying it in a landscape context. I guess my question goes to a problem that came up in a lot of the early valuation of life literature. A lot of the studies were based on high-risk groups, and then you tried to apply them to the general population. Obvious problem. It looks like a lot of the studies that have been done really don't take account of any spatial distribution of amenities. I doubt very few studies are done on lousy sites, or sites that don't have problems. I guess the question is, how applicable are the body of studies that do value ecosystem services, how applicable is it to put it into basically a spreadsheet and apply it uniformly across the landscape to come up with aggregate values?

MW: It's a rich question. I think one of the things you're dealing with in some sense is an intellectual legacy, and that is the division within social sciences of geographers, economists, sociologists, and such. One could think -- economists tend to look at income as a strata with which you could compare willingness to pay, but just haven't tended to necessarily look rigorously at the spatial distribution. Now that has changed, land economics and so on. I think that clearly what we're dealing with here is the GIS environment that I was talking about, what I think it enables us to do is increase the clarity and transparency, the specificity of our aggregation. It can be done in terms of socioeconomic units. Your point was an excellent one, Rich, about willingness to pay in Washington, DC, versus Burlington, Vermont. That's a spatial difference that we could pick up with Census block units. So for example, in a GIS environment. Likewise, the habitat of a particular fish species in the Chesapeake Bay versus Lake Champlain, about a physical sense. There are differences there. What GIS really gives us is more specificity, and the ability to map visually, a picture paints a thousand words. I love spreadsheets, too, and I like fancy equations. But I have found, you're absolutely right, in a policy context the map, being able to actually see that these things are spread, basically heterogeneously across the surface, I think it's a very important message to policy makers. In terms of the relational power, the other thing is that we could actually run queries that restrict it to exactly Hicksian measures only or Marshallian measures only. Sure, we could run spatially explicit transfers that restrict in a relational context and test that. So that's all possible with the integration of relational databases and GIS, and we could actually begin to map that. I have not pushed that to the extreme. We're just in the beginning stages. But compared to the early 90s when I was downstairs in the lab as a masters student with Apple IIs doing GIS, we've come a long way. So I think we're on the cusp of something very exciting here. I would say what you were seeing with the

differences in countries and regions, I would say we would see it on a regional scale. I'm sure we would see very interesting things there. So I hope it helps answer the question.

EE: I'd just like to merge a couple things, because you brought up a good point on that, too. One of the other potential biases associated with the literature is that whoever is going to put money behind these, it has to actually be something we're interested in looking at, not just generic-based values. But there are some things that are occurring that Kerry had mentioned one of those. And that was the National Survey of Recreation in the Environment, where if we can get those time series data up now it's really more of a generic look at people's attitudes and preferences toward things. But the Forest Service also has an inventory, the National Visitor Use Monitoring Data, in which they're collecting use and data that we can run some simple trial cost models on. And it's not tied to any policy or any important thing, other than we're going to start sampling all forest visitors across the nation on a rotating basis. So every five years we have a full sample of forest visitors. And based on that maybe we can get some generic baseline values that will tell us that under these conditions, and bring in some other observations. So I agree. I think there are a lot of reasons why our databases may be biased or skewed in a certain direction, and that's just another one. It's just the nature of how we do business.

MW: I just wanted to add one thing. I think one promising area is, I would throw the question out, and I've struggled with this. We know that -- we've seen that during the transfer, say, from the East Coast of the United States, say, to New Zealand, that has significant questions. But what about from Burlington to Maine? Are there spatial boundaries that make sense, within which we can do transfer? And can we articulate those?

EE: I don't have an answer.

RRo: Again, on some of our early travel cost models with the inventory data, I think we are finding some of this. Instead of dividing up based on the political boundaries of the Northeast versus the Southwest, the tight distinctions, what we are finding is quite often these values are driven by underlying characteristics of the user population that is shared by urban areas. So your proximity to an urban area is really a driving force and not necessarily what region of the country you live in. So I think we can start teasing; I think they do exist. But we do a poor job in our individual studies because the spatial characteristics are constant within our site, but once we do benefits transfer across sites the variability that we could pick up in to help identify what these estimates are is missing from our literature. Again, Richard's comment, broader, larger, multi-regional studies, may help give us some baselines to start working in.

RJ: I think part of the problem is you're going to see regional patterns, but they're going to vary depending on what you're looking at. And I don't think that Northeast versus Midwest may be important or Maine versus Vermont may be important for one good, but may be completely irrelevant for something else. And it might be income or age or education that's the strata that matters. You're not going to know until you look.

RRo: Actually, that was my point about ecosystem services. I would postulate air regulation—you're not going to pick up significant inference—but amenity values or recreation values are going to be much more sensitive to those maybe local fine-scale resolution type of issues.

Q: Bill Mates, New Jersey again. This morning someone made the comment that in his opinion, CVM results might be more transferable because you were using a methodology which was perhaps common across regions. I believe the phrasing was that you're manufacturing the data. And I'm wondering, in light of Rich's presentation on the five-country study, whether it might not be the opposite. That CVM is less transferable because you have these cultural imponderables that it's hard to get your hands around. So I guess my question to the panel is whether you see any differences among, let's say, between CVM and other kinds of valuation techniques, in terms of transferability.

RRo: I've been trying to do a meta-analysis on hedonic pricing estimates, and you run into a lot of the same problems with basic information that's not reported, like how far away from the undesirable land use did the data extend, and what's the average house price and the sample size and things like that. It can be done, it's just that we have the same reporting problems we have with CVM. I think that the same cultural issues are going to show up when you start looking at the same scales, as what we're doing with CVM. I don't see that there's going to be a real fundamental difference in how you do either meta-analysis or benefits transfer with hedonics or travel cost versus CVM.

RJ: One comment I just wanted to bring up is that there's two effects. There's the difficulty of the cultural imponderables, but I think a lot of it also is just that these values may be different. And as long as the surveys are designed appropriately and pretested for each country, there might be a difficulty in using exactly the same survey here. We're just going to translate it mechanically. But one of the messages I got is that these values are probably legitimately different. And I think it's easy to jump to the conclusion that, oh, the values are different, therefore we must have done something wrong. The other comment, I think, gets back to Kerry's point. And that is that one advantage of the stated choice methods is, to a certain extent, an ability to control exactly what you're measuring. For example, if you use a choice experiment, you can get a handle on what exactly are we measuring in a theoretical context. Whereas comparing a cross-review and stated preferences, you may have to adjust for that. For example, in the aquatic meta-analysis that we did for the water quality, those were all stated preference studies. And having all those together gives a certain advantage in that you don't have to compare revealed versus stated. So a certain amount of homogeneity can be helpful in that context, anyway.

EE: I would just follow up on that briefly, too. Looking at the literature and the motivations behind some of these studies being published, I don't know that we can have a general statement that one's better than the other, outside of some theoretical considerations. Because we automatically introduce so much variability in what people have to do, the hoops they have to jump through to actually bring these things to the light of day. So it would be nice to have some repeat studies to actually identify what these are. But other introduced variation in this is how the sample responds. Are you getting biased estimates from higher income, lower income, higher education, those types of things? So we've got these multidimensional problems. And when I comment on that we don't have a random sampling of empirical evidence, it's all tied in together with this. That if our meta-analysis is trying to populate this dose-response function from the literature, just like health sciences is doing, because they look at different age groups and gender and different things, and they're saying we're each working and picking out a little piece of this, and then if we can do some meta-analysis and bring it all together, then we can find out exactly what that underlying function is, they at least have some repeat studies involved in what they're looking out. But in our case, there's just so much variation in what we're doing, I don't know if we can have a blanket statement that one is better than the other until we start controlling for some of what the other is, is just where I would go.

MW: I'd throw in one thing. I was recently on an NSF trip to China and went along because of the valuation question. And our Chinese colleagues were very interested in value transfer, benefits transfer. And one of the things that actually was in the Chinese Academy of Sciences and some graduate students had done some benefits transfer with some studies from the US, they were using hedonics. And we assume that hedonics are obviously better than CV. That's an assumption. Don't forget, in China there's no property market. So, they're doing value transfer with hedonics and there's no private property market. When you get into a global context, these assumptions really fall by the wayside. It's an anecdote, kind of intraocular test there, struck me when I was there.

# 6. State of the Science (Session 4)

## Section Contents



Note: Session 4 also included a presentation by V. Kerry Smith (North Carolina State University, USA), titled, "Structural Benefits Transfer." At the request of the presenter, the presentation is not included in this proceedings document.

# "Geographical Information Systems (GIS) as the Last/Best Hope for Benefit Function Transfer."

**Ian Bateman[1*], Julii Brainard, Andy Jones, and Andrew Lovett**

***Center for Social and Economic Research on the Global Enviornment (CSERGE)***
***School of Environmental Sciences, University of East Anglia***
***Norwich, NR4 7TJ, UK***

***[1] i.bateman@uea.ac.uk***
**** Presenting author***

**Presented during Session 4.**

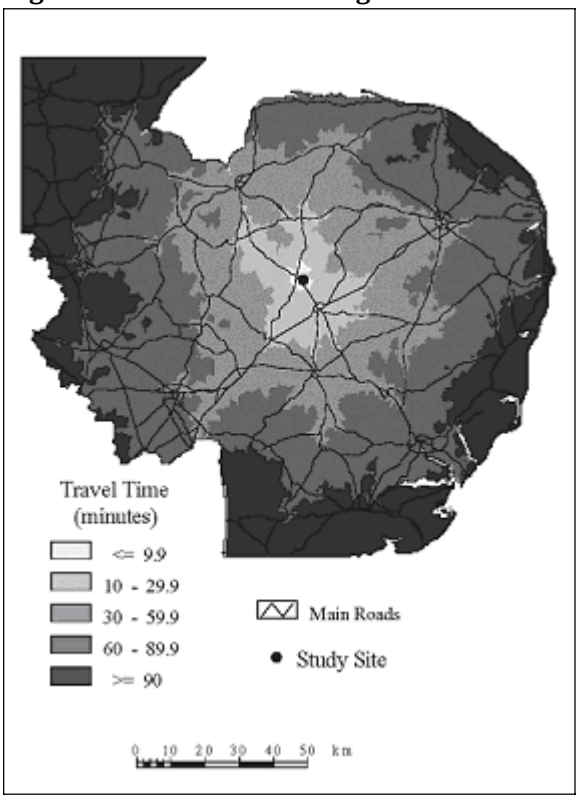
Benefit transfers have to date failed to adequately incorporate the complexity of the natural, social, economic and demographic environment within analyses and that this has led to a persistent failure of most studies. Here we argue that geographical information systems (GIS) offer a highly flexible and practical array of functions for incorporating this spatially referenced complexity. As such we feel that they represent the best (and possibly last) hope for successful benefit function transfers. The paper illustrates this approach via a case study concerning the transfer of functions describing the recreational benefit value of one type of open-access resource; woodlands in Great Britain. This draws upon surveys conducted both by the researchers and the UK Forestry Commission amounting to more than 13,000 interview records obtained from woodland sites across the country. In discussing this we draw upon work described in Bateman et al., 1996, 1999b,c, 2003 and forthcoming; Bateman and Jones, 2003; Brainard et al., 1997, 1999, 2001; Jones et al., 2002; and Lovett et al., 1997.

Benefit transfer typically involves the inference of values for some resource site which policymakers are interested in (the 'policy site') based upon prior research estimating values for similar sites elsewhere (the 'survey' sites). One of the more sophisticated approaches to benefit transfer is to estimate a value functions based on data from a set of survey sites and then use this function to predict values at the unsurveyed policy sites. In effect the assumptions here are that all sites share a common set of predictor variables and while the level of these variables may change across sites, the coefficient values estimated for the survey sites apply to the policy sites. One of the criticisms of prior studies (which have typically failed to support the hypothesis that such functions can be transferred) is that they rely upon a very limited set of predictor variables and that even these are poor approximations of the complex environments which characterize a recreational site. GIS directly address this criticisms by allowing the researcher to generate an extensive set of high quality predictor variables for both survey sites (to feed into the estimation of benefit functions) and policy sites (to provide the level of predictor variables at those sites, to which coefficients estimated at survey sites may be applied allowing the derivation of recreation values for policy sites).

These joint operations of estimating benefit function models for survey sites and transferring these to policy sites involve a number of the GIS functions described previously. In our work on developing a GIS-based benefit function transfer methodology we have attempted to incorporate in an accurate yet readily reproducible manner the complexity of environmental and socioeconomic factors which determine recreational visit decisions; in this case to open-access woodlands.

An initial task was to link records concerning visitor outset locations to the spatial coordinates of destination sites. This required not only GIS data acquisition functions but also certain data processing operations such as the conversion of visitor outset postcode records to their spatial coordinate equivalents. This was achieved by using the GIS to link spreadsheet records, holding visitor survey responses, through a postcode database and on to a spatial grid. GIS impedance routines were then used to link outsets and destinations via the road network, adjusting for travel speeds on different road qualities and allowing for varying congestion levels to yield isochrones (lines of constant travel time) such as those illustrated in Figure 1.

**Figure 1: Isochrones showing travel times to a recreation site.**

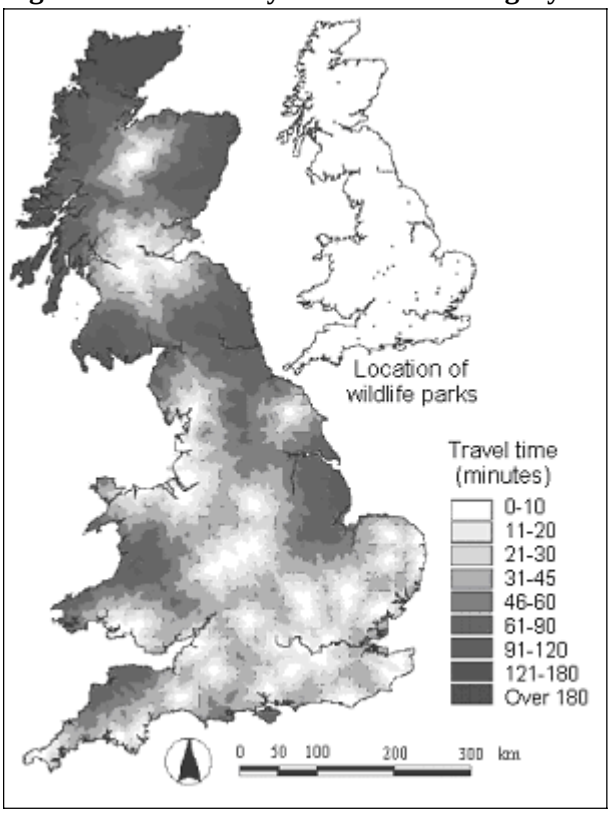



For modeling purposes we are interested not only in visits to the set of woodland sites for which we have survey records, but also to other potential woodland recreation sites. This requirement was addressed through further data acquisition routines importing images from satellite sources until a full coverage of Great Britain was assembled.

A second task was to apply GIS distance and connectivity functions to generate accessibility measures from each outset location to each destination. Here connectivity impedance routines were used to incorporate data on the full road network with data on the quality and congestion of roads and resultant road speeds. Of course in order to estimate robust statistical models we are just as interested in the decision not to visit a particular (or any) site as in the records of visitors. To capture this information, GIS connectivity operations were iterated across a high resolution (500 metre cell size) regular grid covering the entirety of Great Britain. For each cell accessibility was measured to every woodland across the country. Data driven inverse weighting routines were tested to replicate the functional form of the prominence given to more accessible sites. Spatial distribution routines were also used to incorporate further weights allowing for differing attraction values for woodlands according to their size. Data concerning the facilities and attractions offered at woodlands were also incorporated into the analysis.

One important determinant of visitation rates is the substitute and complementarity relationships which may exist with regard to other attractions. Therefore alongside the measures of accessibility to other woodlands mentioned previously, GIS data acquisition, distance function and connectivity routines were used to assess the impact upon woodland visitation of a highly diverse set of attractions. This included open access countryside attractions such as coastal beaches, heathlands, National Parks, etc., open-access man-made attractions such as castles and historic houses and developed attractions requiring entrance fees such as National Trust properties, theme parks, zoos and wildlife parks and urban attractions. Figure 2 illustrates an accessibility surface for one such attraction.

**Figure 2: Accessibility surface for a category of recreation attractions.**




As adjustment needed to be given for the obviously uneven distribution of population across such a large study area, further data acquisition and spatial overlay functions were used to import data from the UK census. This also permitted the incorporation of data on the spatially varying characteristics of that population including its demographic, socio-economic, ethnic nature.

GIS spatial overlay functions were used to compile these diverse data sets into a single unified database. Benefit value functions were estimated using count data models applied using multi-level modelling techniques which controlled for the impact upon error structures of repeated observations being obtained from a given forest site. Results showed, perhaps not surprisingly, that location is vital to the determination of visitor numbers and corresponding values. Reducing travel times by locating recreation sites near to areas of high population was by some margin the single most important factor influencing visits. By contrast, site facilities, other than the basic provision of walking tracks given at all sites, only exerted a weak influence upon visit numbers. However, the proximity of other attractions proved highly significant in determining visits. While the presence of other woodlands acted as substitutes, reducing visits, numerous complementary relationships were identified including boosts to visit numbers from nearby open-access sites including inland water attractions, coastal beaches and heathland areas. Developed attractions requiring entrance fees also boosted woodland visits including National Trust sites and urban attractions. A number of socioeconomic, demographic and ethnicity variables also proved significant, for example visits were higher in areas with higher income and retired populations.

Benefit function transfer testing is typically achieved by omitting certain sites and using functions based upon the remaining subset to estimate values for those omitted sites, these values then being compared with those estimated directly from data collected at those sites. While this is a reasonable procedure and was successfully carried out for this study, arguably this type of internal validation lacks

the objective weight of comparison with some external criterion measure. Furthermore some policymakers remain sceptical regarding non-market values. Consequently, in a separate analysis, we compared our estimated visit numbers with official visitor counts. Figure 3 graphs our predicted visitor numbers against official estimates. As can be seen there is a good correspondence between these figures. Table 1 reports simple OLS models of this relation, first with an intercept term and then, as this is clearly insignificant, by dropping this constant. As can be seen the slope coefficient is insignificantly different from unity (with a small degree of variance). In effect we cannot reject the hypothesis that our GIS-based transfers are providing good estimates of actual recreation demand.

**Figure 3: Graph comparing official counts of recreational visits to British woodlands with visits predicted by GIS based models; linear trendline for model including intercept.**

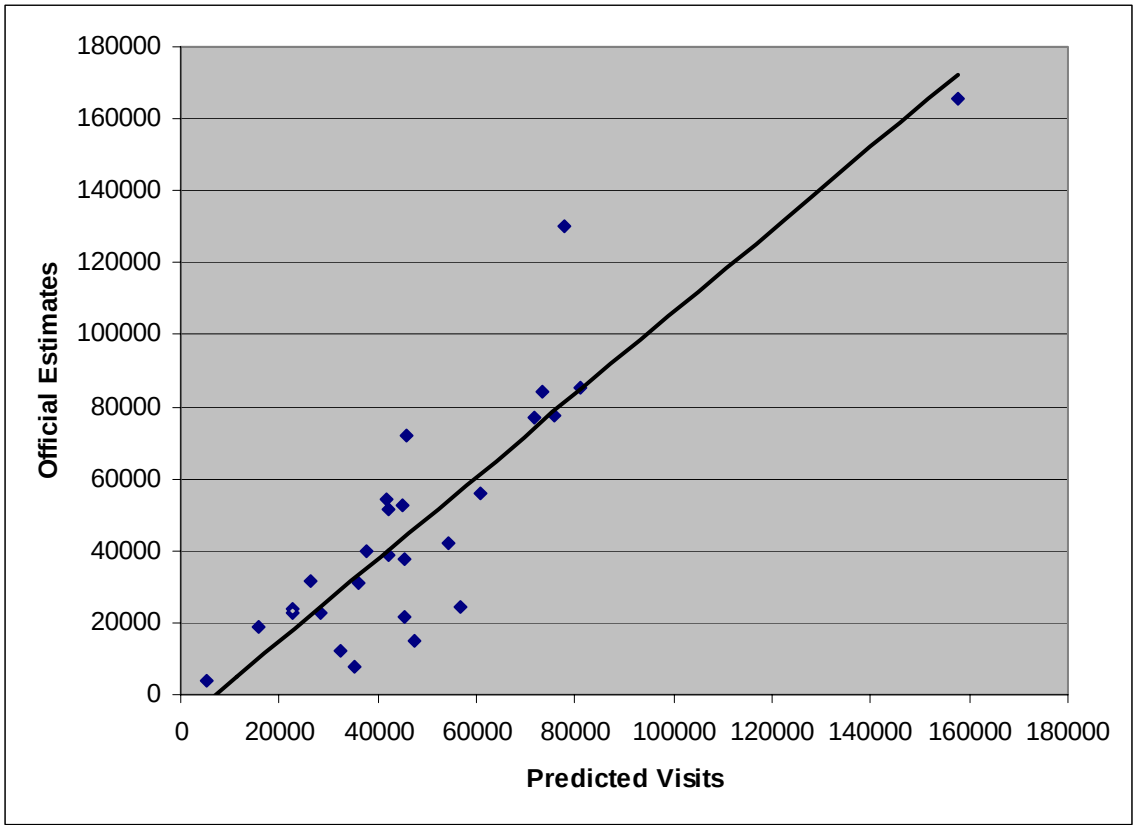


**Table 1: Regression models relating official counts of visitors to woodland sites (the dependent variable) to predictions of the number of visitors obtained from GIS based analyses.**

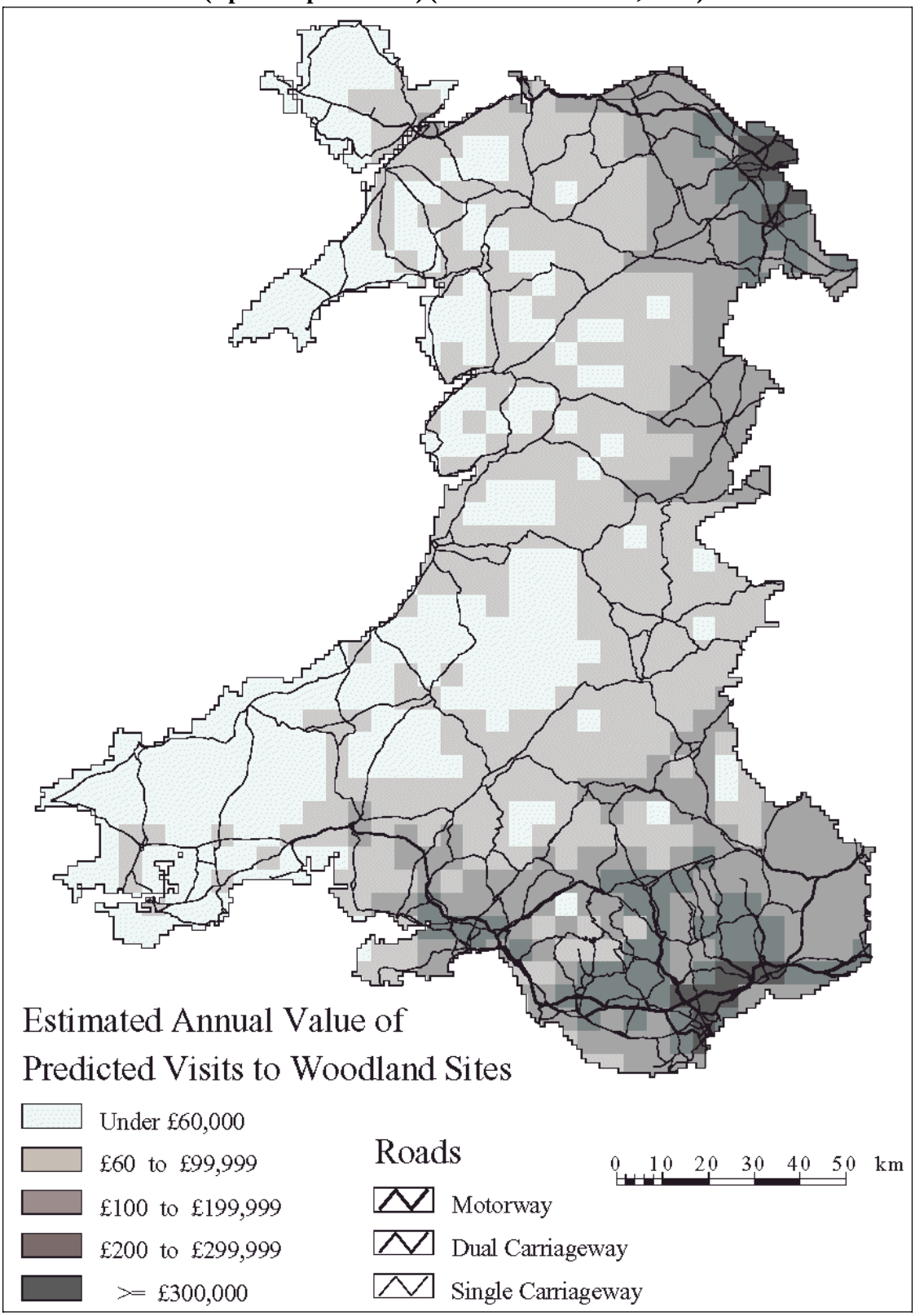
| | Model with intercept | | | | Model without intercept | | | |
|---|---|---|---|---|---|---|---|---|
| | Coef. | s.e. | t | Sig (p) | Coef. | s.e. | t | Sig (p) |
| Constant | -8105.9 | 6740.7 | -1.203 | 0.240 | n/a | n/a | n/a | n/a |
| Predicted visits | 1.144 | 0.119 | 9.650 | 0.000 | 1.021 | 0.060 | 17.014 | 0.000 |
| $R^2$(adj) | 78.0% | | | | 91.4% † | | | |

Note: † Estimates of $R^2$ for models without constants are not comparable with those which include an intercept. Instead this measure expresses the proportion of the variability in the dependent variable about the origin explained by the model.

The above results suggest that, when performed using GIS to capture the complexity of the real world environment, benefit function transfers may yield acceptable approximations of demand and values at policy sites. Furthermore, although the initial GIS manipulations required to produce digital map layers of pertinent substitutes and complements may be analytically demanding, once these are produced then do not need to be reconstructed from scratch from future analysis. Rather they can be reused and only occasionally updated (say every few years) to allow for changes in road networks, population distribution and new attractions. In essence therefore we have a policy useable tool which appears capable of delivering the objective of benefit transfers; an acceptable degree of accuracy in predicting visits and values at policy sites.

Once derived and suitably tested, GIS benefit transfer functions can also be used to assist in the fundamental task of economic analysis: identifying the optimal allocation of limited resources. An example of this undertaking is given in Bateman et al., (2003) through the construction of GIS value maps for recreation demand, timber yield, carbon sequestration, agricultural values and cost-benefit analysis of land use change. Figure 4 illustrates a map of potential recreation demand values generated by transferring GIS generated travel cost functions estimating the benefits of locating recreational woodlands in different locations across the entirety of Wales. The pattern shown confirms to prior expectations with values being highest for sites located in areas of high populations (e.g. around Cardiff in the south of the country) and with good road infrastructure access (e.g. the area in the north-east of the country which can readily be accessed by populations from the large conurbations of Liverpool and Manchester). Conversely, recreation values are lowest in the upland middle and coastal western areas where local population density is low and accessibility is poorer. Such maps are ideally suited for allocating of resources so as to optimise economic values. Unfortunately as Bateman et al show, actual planting of forests has been guided not by economic values including non-market recreation benefit, but rather by a desire to minimise market land purchase costs. This has lead to concentrations of woodland in the lowest value central areas of the country; a situation which constitutes a classic market failure.

**Figure 4: GIS generated map of the value of predicted woodland recreation demand for potential forest sites in Wales (£ per site per annum) (from Bateman *et al*., 2003)**



**References**

Bateman, I.J., Brainard, J.S., Garrod, G.D. and Lovett, A.A., (1999b) The impact of journey origin specification and other measurement assumptions upon individual travel cost estimates of consumer surplus: a geographical information systems analysis, *Regional Environmental Change*, 1(1): 24-30.

Bateman, I.J., Garrod, G.D., Brainard, J.S. and Lovett, A.A. (1996) Measurement, valuation and estimation issues in the travel cost method: A geographical information systems approach, *Journal of Agricultural Economics*, 47(2): 191-205.

Bateman, I.J. and Jones, A.P., (2003) Contrasting conventional with multi-level modelling approaches to meta-analysis: An illustration using UK woodland recreation values, *Land Economics*, 79(2): 235-258.

Bateman, I.J., Lovett, A.A. and Brainard, J.S. (1999c) Developing a methodology for benefit transfers using geographical information systems: modelling demand for woodland recreation, *Regional Studies,* 33(3): 191-205.

Bateman, I. J., Lovett, A.A. and Brainard, J.S. (2003) *Applied Environmental Economics: a GIS Approach to Cost-Benefit Analysis,* Cambridge University Press, Cambridge.

Brainard, J.S., Bateman, I.J. and Lovett, A.A., (2001) Modelling demand for recreation in English woodlands, *Forestry*, 74(5): 423-438.

Brainard, J.S., Lovett, A.A. and Bateman, I.J. (1999) Integrating geographical information systems into travel cost analysis and benefit transfer, *International Journal of Geographical Information Systems*, 13(3): 227-246.

Brainard, J.S., Lovett, A.A. and Bateman, I.J. (1997) Using isochrone surfaces in travel cost models, *Journal of Transport Geography*, 5(2): 117-126.

Jones, A.P., Bateman, I.J. and Wright, J., (2002) Estimating arrival numbers and values for informal recreational use of British woodlands, *report to the Forestry Commission*, published at http://www.forestry.gov.uk.

Lovett, A.A., Brainard, J.S. and Bateman, I.J. (1997) Improving benefit transfer demand functions: a GIS approach, *Journal of Environmental Management*, 51(4): 373-389.

# "The Incorporation of Prior Information and Expert Opinion in the Transfer Method: The Bayesian Approach."

**Carmelo León[1*], F.J. Vázquez Polo[1], and Roberto León[2]**

*[1]University of Las Palmas de Gran Canaria, Spain*
*[2]University of Leicester, United Kingdom*
***Presenting author***

**Presented during Session 4.**

## 1. Introduction

Benefit transfer methods, as applied in environmental valuation, involve the use of past information for predicting the value of new environmental goods. There are different approaches to benefit transfer, which principally depend on the type and amount of information used in the formulation of predictions (e.g. unit value, benefit function and structural approaches). The overall problem is to formulate accurate predictions for out of sample information. However, these predictions may be subject to error, and therefore extra effort should be placed in developing techniques and information that reduce the prediction error.

The application of Bayesian methods can be useful as an alternative approach to Benefit Transfer. It allows the researcher to incorporate prior information in a framework where the prior distribution can be updated in the light of new information, using the most efficient updating method as given by Bayes' theorem. On the other hand, since Bayesian methods are based on prior distributions, and on their combination with sample data, much effort has been made on the elicitation of the prior distribution from expert opinion and other sources of information.

The elicited distribution can be used to form predictions on the value of new policy sites. Thus, the Bayesian methods provide us with two related areas for application in Benefit Transfer: i) The framework of eliciting prior distributions and forming predictions based on the elicitation process, and ii) The framework of forming predictions utilizing Bayes' theorem, by combining a prior distribution summarizing past information with some sample information.

Thus, the elicitation methods can be applied without a Bayesian context. The techniques involve the utilization of experts' of opinion, and how to elicit this opinion using statistical procedures. Expert assessment was one of the earliest Benefit Transfer methods; The Bayesian techniques allow researchers to deal with it in a statistical setting.

Some of the research questions that can be asked in the application of the Bayesian approach to Benefit Transfer can be posed as follows:

1. Can the information of the study sites be complemented with some information from the policy sites?
2. How could the prior information from the pool of study sites be combined with sample data?
3. What impact could have prior information on predictions for the new policy site?
4. What methods can be used to elicit expert opinions and predictions about the value of a new environmental good or policy site?
5. How can the elicited experts' information be combined with sample observations on the new policy site?

6. How accurate are expert's predictions with respect to on-site observations on the policy site?
7. What would be the effects of new-site sample observations on expert's predictions?

An important feature of the Bayesian approach is the possibility of using some on site sample information for improving predictions for the new policy sites. In addition, the emphasis on the prior distribution is another crucial characteristic which by itself is useful for providing predictions on policy scenarios. It is clear that past information allows the analyst to define a prior distribution of past study sites. However, experts have prior beliefs about future results, and the question is how to elicit these beliefs as represented by a statistical distribution. Prior beliefs can be based on the information from past studies and on prior experience.

Thus, the elicited prior distribution could serve to form predictions on new policy sites; and secondly, it could be updated in a Bayesian framework. The prior distribution might reflect the expectations from rational economic agents, in the sense that predictions should be accurate if they know the model generating the data in future studies. However, predictions are not accurate under limited information, or when the model is not correctly specified. In this case there might be a role for incorporating on-site sample information from the new policy site, since this could update the prior distribution, improving prior predictions. Therefore, expert opinion could provide adjustments to the new situations, based on previous knowledge and expertise on the underlying data development.

## 2. Simple Bayesian theory

Let us consider that the researcher is interested in estimating parameter $\lambda$, which is the consumer surplus to be obtained from a new policy site, and can be a function of unknown parameters. If there is some knowledge on the possible values to be obtained in an empirical study, this information can be represented with the specification of a prior density distribution $\pi(\lambda)$, which contains the probability of observing parameter $\lambda$ before any empirical data is collected, based on all available evidence from past experience. The prior distribution could also incorporate beliefs from expert opinion.

If data is collected from the new policy site, this will be useful to define a likelihood function $f(x \mid \lambda)$, which represents the likelihood of observing sample $x$ given that the population behaves according to parameter $\lambda$. This sample information allows the researcher to update her prior beliefs by applying Bayes' theorem. That is:

$$\pi(\lambda \mid x) = \frac{\pi(\lambda) f(x \mid \lambda)}{\int_{\Theta} \pi(\lambda) f(x \mid \lambda) d\lambda} \propto \pi(\lambda) f(x \mid \lambda) \qquad (1)$$

This is the expression for the posterior distribution, which is derived by combining the prior distribution and the likelihood function, and where $\propto$ denotes proportionality.

## 3. Joint prior modelling

Let us consider that the analyst has access at least to the mean consumer surplus from each study site in order to evaluate a pooled prior distribution. Following León *et al.* (2002) each study site could be evaluated with a distribution represented by the mean. Let us assume a mixed distribution for the set of study sites, which is defined as a convex linear combination of prior distributions.

$$\pi(\lambda) = \sum_{j=1}^{m} w_j \cdot \pi^j(\lambda) \tag{2}$$

where $m$ is the number of study sites, $\sum_{j=1}^{m} w_j = 1$, and $\pi^j(\lambda)$ is the prior distribution or density for each study site $j$. The weights $w_j$ represent the similarity of study site $j$ with the policy site. These weights do not need to be exogenously assessed by the decision- maker. They could be determined by analyzing the characteristics across the set of study sites, and using factorial design in order to allocate higher weights to the most similar sites. If there is only one study site which is relevant, for instance $s$, then $w_s = 1$.

The specification of the joint prior distribution requires the distribution for each of the study sites to be defined. Assuming a least informative distribution, such as maximum entropy (ME) prior, is a convenient way to model limited study site information based on mean consumer surplus. An alternative could be to specify a more structural, but flexible distribution, such as shifted Beta, i.e.

$$\pi^i(\lambda) = \frac{\Gamma(\alpha_j + \beta_j)}{\Gamma(\alpha_j)\Gamma(\beta_j)(b_j - a_j)^{\alpha_j + \beta_j - 1}} (\lambda - a_j)^{\alpha_j - 1} (b_j - \lambda)^{\beta_j - 1}, (j = 1,...,m) \tag{3}$$

where $a_j$ and $b_j$ are specified in the domain of the benefits for each study site. This distribution is continuous and defined over an interval from $a_j$ to $b_j$. The specification of the parameters leads to alternative families for the distribution.

The analyst could also find useful to collect some sample information from the policy site, in order to improve predictions upon the specified prior distribution, by combining both sources of information utilizing Bayes' theorem. The sample information can be assumed to be obtained following some non-market valuation method, such as contingent valuation or stated preferences, which involves the specification of the likelihood function of sample observations. León *et al.* (2002) considered a contingent valuation double bounded dichotomous choice model for the elicitation of WTP, and combined a multinomial likelihood function with the specified prior distribution by using numerical methods.

However, the development of Monte Carlo simulation methods allows for the combination of most non-market valuation likelihood models with prior distributions.

## 4. Experts' elicitation model of the prior distribution

The prior distribution can be elicited from expert opinion utilizing statistical elicitation methods. The elicited distribution could serve to form predictions on the new policy site, thus they are usually based on the predictive distribution. There are various types of elicitation techniques. In structural elicitation, experts are asked to assess directly the distribution of parameters, e.g. what would you think of the distribution of $\alpha$ and $\beta$? In predictive elicitation, experts are asked to make statements about predictive distributions of observable quantities, e.g. what is your median for the next observation?

In any elicitation process, there is first a choice of the functional from, or the model the analyst would like to elicit from experts. Secondly, there is a set of questions which are put to the expert in a sequential and iterative process, in order to set up the appropriate information that would allow her to specify the correct model; and finally, in this process there should be some checking tasks, in order for the answers to convey some statistical properties.

Thus, the elicitation procedure starts by a number of questions that the expert should answer based on her experience and expertise. The following assumptions are useful in order to place the elicitation process in the context of non-market valuation: i) experts have an information set which is made of the results from all past studies on environmental valuation, and are familiar with basic concepts of statistics. It is also convenient, although not necessary, that experts have experience conducting field work, thus they have been in similar or identical situations as the one described in evaluating the policy site; ii) experts are asked to predict results according to a specific model. The elicitation procedure is context specific, not only in terms of the definition of the good to be valued, but also in the methods to be used; iii) Le us consider a contingent valuation model. The questionnaire would contain all the elements of the non-market scenario, following standard protocols such as Arrow et al. (1993).

The elicitation process has the object to elicit consumer surplus $\lambda$, and is actually carried out on the predictive distribution, which gives the probability of observing new sample data, given past experience and the results of previous studies. That is,

$$m(y \mid x) = \int_{\Theta} f(y \mid \lambda)\pi(\lambda \mid x)d\lambda\,, \tag{4}$$

where $f(y \mid \lambda)$ is the likelihood for the sample observations which would be generated from a specific study for the new policy site, given parameter $\lambda$. This likelihood does not need to be the same as the one generating past observations.

Following León et al. (2003) suppose the analyst chooses to elicit the parameters of a shifted Beta density, such as:

$$\pi(\lambda) \propto (\lambda - a)^{\alpha-1}(b - \lambda)^{\beta-1} \tag{5}$$

where $a < \lambda < b$, i.e. $a$ and $b$ are the lower and upper bounds defining the range of willingness to pay as determined by the expert; $\alpha$ and $\beta$ are the parameters defining the quantities and the shape of the prior density.

Shifted Beta distributions provide greater flexibility for elicitation, and therefore enhances interpretation by experts, allowing for a variety of shapes and skeweness. In addition, contingent valuation data tend to be skewed, thus centered distributions such as normal and logistic, are not appropriate. It can be shown that Beta is rightward skewed if $1 < \alpha < \beta$, and leftward skewed if $1 < \beta < \alpha$.

The elicitation process could be most informative or less informative, depending on the amount of information which is asked from the expert. The least informative method (LIM) consists of the following steps:

Step 1: Ask the expert for the $\lambda$ (mean) and the $d$ (mode) of the expected results to be obtained from the new policy site.
Step 2: Solve for parameters $\alpha$ and $\beta$, taking into account responses in Step 1, and considering these two definitions:

$$\lambda = a + (b\text{-}a)\ ((\alpha/(\alpha+\beta),$$

$$d = a + (b\text{-}a)\ ((\alpha\text{-}1)/(\alpha+\beta\text{-}2))$$

Step 3: Present to the expert the results on the shape as elicited in Steps 1 and 2, asking for revision and adjustment.
Step 4: Repeat steps 1 to 3 until agreement is attained.

The most informative method (MIM) proceeds as follows:

Step 1: Ask the expert for the $\lambda$ (mean) and the $d$ (mode), and quartiles ($q_1$, $q_2$, $q_3$) to be expected from the policy site.
Step 2: Let $\alpha=\beta=1$, and check whether the closed interval defined by the first and third quartiles (($q_1$ and $q_3$) comprises a 50% high density region for a distribution Beta($\alpha$, $\beta$).
Step 3: If condition in Step 2 is not satisfied, $\alpha$ is increased by 0.01, i.e., $\alpha$+0.01, and the corresponding parameter $\beta$ is generated by:

$$\beta = (\alpha\text{-}1)((b\text{-}a)/(d\text{-}a)) - (\alpha + 2).$$

This step is repeated until parameters $\alpha$ and $\beta$ satisfy the following two equations:

$F(q_1; \alpha, \beta) = 0.5$, and $F(q_3; \alpha, \beta) = 0.75$; where F is the Beta cumulative function. When convergence is achieved, interval $[q_1, q_3]$ defines a 50% high density region for prior parameters $(\alpha^*, \beta^*)$.

Step 4: Consistency is checked by considering whether $q_1$ does satisfy $(q_1; \alpha^*, \beta^*) = 0.25$, and the prior mean $\lambda = \alpha^* / (\alpha^* + \beta^*)$.

Step 5: If either the elicited first quartile or the mean deviate in more than 30% from those specified in Step 1, then the expert is asked to reassess the elicited quantities, until consistency is achieved.

Predictions for the new policy site can be based on the elicited prior distribution. However, predictions can be subject to forecasting error, because the experts might not handle all the appropriate information about the correct model. If the analyst wishes to improve predictions, the elicited prior distribution can be combined with policy site sample information using Bayes' theorem. Any form for the likelihood function could be considered, based on the appropriate model for sample observations. For instance, the posterior distribution which results from combining a shifted Beta prior with a loglogistic likelihood does not belong to any standard family of statistical distributions. Therefore, this problem can be solved by utilizing Markov Chain Monte Carlo methods in order to evaluate the posterior distribution by simulation of a succession of random values. After convergence is reached, the values in the succession, called Markov Chain, can be considered as approximate draws from the posterior distribution.

## 5. Data sources

*Study Sites*

The study sites for the evaluation of the joint prior distribution were a set of natural areas in Spain, which had been studied following non-market valuation methods. The information on mean consumer surplus for each study site was used to construct a prior distribution which can be combined with sample information from some potential policy site. All available studies focused on the valuation of the recreational experience by visitors. Although most studies included the travel cost method, we considered only results based on the application of the contingent valuation method. The payment vehicle was in all cases an entrance fee to be paid for a one day recreational experience, and the elicitation format utilized in the studies was either single or double bounded dichotomous choice. The mean value estimates were converted to 1997 prices. All studies excluded protest responses, and modelled the willingness to pay distribution as a lognormal or loglogistic distribution.

*Policy sites*

For the policy sites, we conducted a study on three National Parks in Spain: i) Teide National Park in Tenerife (Canary Islands), with 15000 hectares features endemic highland vegetation species as well as Mont Teide, a volcano which is the highest peak in Spain at 3714 mts. It receives 3 million visitors per year; iii) Taburiente National Park in La Palma (Canary Islands) features 5000 hectares of endemic

species of pine forests, and receives about 240,000 visits in a year; iii) Aigüestortes i Estany de Sant Maurici National Park (Aigüestortes) located in the Pyrenees, on the Catalan French border, near Andorra, with 14000 hectares. The main attractions are the mountains and small lakes. It receives 300,000 visits per year.

The natural areas for the policy sites do not match each other in their environmental characteristics, since the National Park system protects the finest examples of the principal natural environments in Spain. They are similar in terms of their relative demands and recreation activities, rather than in terms of their physical characteristics.

*Survey work*

The fieldwork on the proposed policy sites was conducted in 1997 using the contingent valuation method. After pre-testing and focus groups, parallel samples were taken randomly in each of the parks, with 699 subjects in Taburiente, 1045 in Teide, and 643 in Aigüestortes, i.e. a total number of 2387 individuals. The questionnaires and the valuation scenarios were the same for all of the parks. The payment vehicle was a hypothetical entrance fee for access. The valuation question focused on the recreational experience, incorporated a preservation motive for the reasons to pay, with a remark that all visitors would have to pay. The elicitation format was double bounded dichotomous choice based on a five bids vector, designed upon open ended pre-test responses and the values of other natural areas.

*Experts' elicitation experiment*

In order to test for the performance of the statistical elicitation methods based on expert opinion, we conducted an experiment with a group of students in the Bayesian Econometrics course. 19 students were screened based on their knowledge of both environmental economics and statistical techniques. Students were trained in contingent valuation models, and read thoroughly on valuation experiences in Spain and other countries. Their knowledge was checked by a written and oral exam in which only 5 students passed on statistics and on general knowledge on valuation to be experts for the experience. These students were informed about the policy sites to be valued, and were given the questionnaire for field work. They were also asked to assume double bounded dichotomous choice elicitation format to be modelled with a loglogistic distribution, and that all protest responses were excluded from the statistical analysis. After an extensive study and training period with statistical methods and real non-market valuation data, these subjects were subject to the LIM and MIM presented above, with the aim of eliciting the prior distribution on which forecasts for the new policy sites could be based.

## 6. Results

*Classical transferability across National Parks*

The results for the differences in socioeconomic characteristics across the three policy sites showed that they were not statistically different at the 95% level. The main implication is that potential differences in

the results might not be attributed to population differences, but referred to the particular features of each of the policy sites. The estimation willingness to pay with sample information using a likelihood function based on a flexible generalized gamma distribution revealed that the results were not the same across the three parks. Aigüestortes NP showed the largest mean and median value, whereas Taburiente NP presented the lowest median value. These results were confirmed by the likelihood ratio statistics, since the general hypothesis of equality between the parameters of the three estimated models was clearly rejected, i.e. the estimated models were not interchangeable with each other. Transferability was also rejected across any pairs of National Parks.

*Joint prior information and sample data*

The interesting question is what would be the results if prior information is incorporated, in order to adjust sample information by the information accumulated from the set of study sites. This prior was modelled following a mixture prior distribution, as explained earlier. However, to check for the sensitivity to the prior, we compared the results of a less informative specification (maximum entropy - ME) with a full, but flexible, parametric model (shifted Beta). In addition, the information utilized for the definition of the prior could be based on the most likely study site natural area, or on the extreme bounds of willingness to pay defining the prior distribution.

In Table 1, we can see that posterior results are not significantly different, according to credible intervals, between Teide and Aigüestortes, while significantly lower values are obtained for Taburiente National Park. Thus, the Bayesian model has led to statistically similar posterior distributions for two parks that share nearly all their characteristics. This does not mean that the sample results are transferable across similar sites. The interpretation is that the Bayesian model could improve predictions, because sample results can be corrected by expert judgement, as reflected in the prior assessment of the mean value for the new policy site.

**Table 1. Posterior results and 90% credible intervals (in brackets) Ptas.**

| | Lower Bound | | Weighted Average | | Upper Bound | |
|---|---|---|---|---|---|---|
| National park | ME prior | Beta Prior | ME prior | Beta Prior | ME prior | Beta Prior |
| Teide | 1948 (1879, 2007) | 1904 (1837, 1962) | 1950 (1881, 2009) | 1937 (1869, 1996) | 1951 (1882, 2010) | 1947 (1879, 2006) |
| Taburiente | 1634 (1553, 1707) | 1582 (1504, 1651) | 1637 (1556, 1710) | 1623 (1543, 1695) | 1638 (1557, 1712) | 1636 (1556, 1709) |
| Aigüestortes | 1966 (1877, 2047) | 1891 (1805, 1968) | 1970 (1881, 2051) | 1947 (1859, 2026) | 1971 (1882, 2052) | 1965 (1876, 2045) |

In addition, the posterior distribution is not significantly different across Teide and Aigüestortes no matter the prior distribution, but there is some sensitivity to the choice of the prior mean. The sensitivity of posterior mean to the prior increases as the prior distribution becomes more informative, i.e. although there are no relevant differences when a ME prior is employed, there is more sensitivity to the choice of the prior mean for a more rigid and informative structure, such as the Beta distribution.

*The amount of sample information*

Another interesting question is what would be the effect of the sample size on posterior predictions for the policy sites, considering the combination of the joint prior distribution and the sample observations. The answer to this question is useful if any sample information is going to be used for improving predictions based on prior distributions. The analyst could base her predictions just on the prior distribution or could take some sample observations in order to correct for forecasting errors. Thus, the crucial question is what would be the amount of sample information needed for accurate predictions.

Although we could not answer this question here, it is clear that there would be need for more sample information as the prior information coming from the study sites is more limited and imprecise, and vice-versa. Thus, we can think of a potential trade-off between prior and sample information which should be investigated in further research. In order to shed some light on the sensitivity of the results to sample data, we took a 10% random subsample from the full policy sites samples. The results showed that smaller sample sizes tended to be more sensitive to the prior mean when the analyst utilized more rigid distributions to model prior information. This sensitivity is expected to be larger for smaller sample sizes. Since posterior efficiency was reduced by smaller sample sizes, the analyst might be willing to give up posterior efficiency in order to benefit from lower costs in posterior studies.

*Experts' elicitation results*

The experiments with experts allowed us to obtain the prior distribution, as elicited utilizing the methods outlined above, with the aim of comparing the results with those obtained with on-site samples utilizing non-market valuation methods. Tables 2 and 3 shows the quantities and the parameters of the elicited priors for Teide and Taburiente respectively. The errors between the assessed mean and first quantile are not allow to exceded 30%. These errors vary considerably across experts, with an average of 15 %.

It can be seen that all experts have different predictions about the mean values to be obtained in an on-site CV survey. However, experts coincide on significantly larger values for Teide than for Taburiente. On average, the mean value for Teide exceeds that of Taburiente by about 25%. This also applies for quartiles and the maximum WTP. Thus, experts predicted a shift to the right in the distribution for Teide.

**Table 2. Experts' assessment elicitation results for Teide National Park (Ptas.)**

| Quantity | Expert | | | | | |
|---|---|---|---|---|---|---|
| | #1 | #2 | #3 | #4 | #5 | Average |
| Mean | 1775 | 3700 | 2500 | 1300 | 1200 | 2095 |
| Mode | 1000 | 2500 | 1000 | 800 | 900 | 1240 |
| First Quartile | 700 | 1300 | 700 | 300 | 600 | 720 |
| Median | 1200 | 2700 | 2200 | 1190 | 1000 | 1658 |
| Third Quartile | 1500 | 4300 | 3300 | 1350 | 1400 | 2370 |
| Max WTP | 3200 | 10000 | 7500 | 3000 | 1900 | 5120 |
| $\alpha$ | 2.1 | 1.54 | 1.13 | 3.98 | 0.42 | 2.76 |
| $\beta$ | 3.42 | 2.62 | 1.85 | 6.96 | 0.36 | 6.51 |
| Deviation % | 30 | 0 | 10 | 20 | 10 | 30 |

**Table 3. Experts' assessment elicitation results for Taburiente National Park (Ptas.)**

| Quantity | Expert | | | | | |
|---|---|---|---|---|---|---|
| | #1 | #2 | #3 | #4 | #5 | Average |
| Mean | 800 | 3000 | 1800 | 950 | 1500 | 1610 |
| Mode | 600 | 2000 | 1250 | 600 | 900 | 1070 |
| First Quartile | 500 | 1500 | 960 | 250 | 700 | 782 |
| Median | 750 | 2500 | 1500 | 600 | 1200 | 1310 |
| Third Quartile | 1000 | 3500 | 1700 | 825 | 2000 | 1805 |
| Max WTP | 1600 | 5000 | 5000 | 2300 | 3000 | 3380 |
| $\alpha$ | 1.33 | 0.64 | 4.46 | 2.52 | 0.72 | 2.69 |
| $\beta$ | 1.55 | 0.46 | 11.38 | 5.31 | 0.35 | 4.65 |
| Deviation % | 7.6 | 0 | 20 | 22 | 30 | 20 |

When comparing these results with those obtained with modelling the on-site contingent valuation data, it turned out that no expert matched the sample results, although two of their predictions for the mean were within 10% of error. Three of the experts underestimated the values of both parks, while two of them elicited overestimated results. Nevertheless, average results for the pool of experts were more approximate to the sample results, with deviations of less than 10%.

Thus, experts were more accurate in predicting the relative values, while the average mean across experts was relatively more successful for the absolute value. The combination of the prior distribution with on-site sample data revealed that experts' error decreased as the sample information raised and is considered in estimating the value of a new policy site. When large sample sizes are considered, the prior has no relevance to form predictions, since the large new information allows the expert to update his predictions accurately.

## 7. Conclusions

The application of Bayesian methods to Benefit Transfer introduce a formal approach to deal with prior information in predicting the value of new policy sites or environmental goods. The approach involves the use of Bayes' theorem, where the prior information can be updated in the light of new information, thereby improving out of sample predictions. On the other hand, the prior distributions can be elicited utilizing statistical methods in the context of predictive elicitation.

Thus, since Benefit Transfer is based on past information on the values of similar sites and/or characteristics of an environmental good, it is clear that there might be a role for expert judgement in interpreting and adapting this information set to new contexts. Expert assessment techniques allow the analyst to elicit the prior distribution, which can be utilised in practice to predict the values to be obtained in an empirical study.

If the available empirical evidence is not satisfactory then there would be a case for collecting further sample information. On-site data could be useful for updating the prior distribution in the light of new evidence. The influence of the prior, and therefore the potential predictive error, diminishes as the sample size increases because of the information from the new site.

Experts participating in an experiment on the value of natural areas produced assessments that do not match the empirical results obtained with sample information. A consensus approach around the average revealed to be more successful. Experts performed better in predicting the relative values of two of the National Parks considered in the study. Therefore, the values elicited from experts might be more useful in predicting the ranking of different and alternative goods.

Further research would be needed in developing more intuitive elicitation methods, which could help to obtain the prior distribution from simple and straightforward questions. The methods can also be expanded to elicit models with covariates, which can be useful when the values are dependent on sociological characteristics of the relevant population, and can be applied to other models of non-market valuation, such as the travel cost and the hedonic price models.

**References**

Arrow, K. Solow, R., Portney, P., Leamer, E., Radner, R. and Schuman, H. (1993): "Report of the National Oceanic and Athmospheric Administration Panel on Contingent Valuation". *Federal Register* 58, pp. 4602-4614

León, C.J., Vázquez-Polo, F.J. and León-González, R. "Elicitation of Expert Opinion in Benefit Transfer of Environmental Goods", *Environmental and Resource Economics*, 26 (2), pp. 199-210, 2003.

León, C.J., Vázquez-Polo, F.J., Guerra, N. and Riera, P. "A Bayesian Model for Benefit Transfer. Application to National Parks in Spain", *Applied Economics*, V. 34, pp. 749-757, 2002.

# Discussant Comments on Presentations from Session 4

**Erik Helm**

***U.S. Environmental Protection Agency, USA***
***USA***

*[This section presents a transcription of Erik Helm's remarks.]*

When Rich first asked me to do this, he asked me to review, of course, the papers—and to also add some input from my experience so far in utilizing benefit transfer in our work at the EPA. Luckily I can call more on that than the papers, so that's good.

First of all I'd like to speak to Ian's paper. The GIS application is, obviously, it's going through a revolution now. We're seeing its involvement in all matters of benefit transfer, not only in filling in the data gaps that we don't have from these studies but in characterizing the populations as presented that we apply our values to.

So far in our office we have used GIS to determine population levels around specific sites that we're regulating, and we're actually also using GIS to characterize populations that are affected in terms of environmental justice issue. But we haven't applied Ian's decay factors yet or broken it out by income or socioeconomic variables and producing a decay factor for those finer grades of the socioeconomic variable. I think that's going to be important for the future.

Ian's paper had a site study or a case study that he used, and it was great to see in his presentation that he applied this case study to other sites with verifiable data to show that his estimation was in fact reliable across different sites. Because that's a problem we run into a lot. The selection of a case study, since our office usually does national-scale rules, we can either try to do a broad analysis or we can attempt to put our resources into a few case studies and evaluate those bodies in terms of their environment and economics in depth. And the fact that he showed that this was in fact applicable to other sites around country is very important, and I'd like to see that. In fact, his analysis used a rather simple, you could say simple travel cost model, where most of the variation was produced or represented with the site or the travel distance to site, and that's a positive thing because not that I'm trying to get out of work, but if these rather more simple analyses actually are preferred to complex site models, that might be important for national benefits rules. And again, a great paper.

Kerry's presentation. I was with you on some of the earlier work, the NOAA work stuff. [inaudible] ... paper five days ago for the Clean Sky Analysis. The five extra days did not help, so I have to leave that to him to explain.

And Carmelo's paper. That was very interesting to me, the Bayesian analysis. For us it is an ordeal to collect new data. For some of you who are less familiar, we have a Paperwork Reduction Act in this country, where we have to go through OMB to obtain permission to do these types of studies, where we actually go out and people, say, a stated preference question. And there are several hurdles involved with that, including obtaining permission for focus groups, obtaining permission for the pretests, and obtaining permission to do the actual final survey. And it's a process that can take several years to complete, unless Jim is here, and he's my desk officer, so I have to say that he is a bit more cooperative and he has allowed us to condense the format and hopefully obtain sample surveys within a much smaller time frame.

But in general it's a very laborious effort. So the sooner that we can use small sample information, augment it with our prior knowledge in this Bayesian framework, and retain some reliable estimates, it's very encouraging to see and I'd like to see that work continue.

Again, Carmelo's work is dependent also on the year prior distributions. And in fact I believe he found that the more flexible distributions actually transferred better, and that goes along with Ian's analysis where the more simple transfer function actually worked better on large scale, so I'm pleased to see that.

And that's about it. I'd like to thank them for presenting their papers and I believe we're going to try Carmelo's approach. We have some data that we could apply that to, and I don't know about Kerry's.

# Question and Answer Session

## For *Session 4: State of the Science*

*This section presents a transcription of the Q&A session for the following presentations from Session 4:*

*Ian Bateman, University of East Anglia, UK.* Geographical Information Systems (GIS) as the Last/Best Hope for Benefit Function Transfer.

*V. Kerry Smith, North Carolina State University, USA.* Structural Benefits Transfer.

*Carmelo León, University of Las Palmas, Spain.* The Incorporation of Prior Information and Expert Opinion in the Transfer Method: The Bayesian Approach.

*Responses to questions are coded as follows:*

*IB: Ian Bateman, University of East Anglia, UK*
*KS: V. Kerry Smith, North Carolina State University, USA*
*CL: Carmelo León, University of Las Palmas, Spain*
*EH: Erik Helm, U.S. Environmental Protection Agency, USA [session chair]*

EH: If you gentlemen would come up we can start the questions from the audience and then get to our break and then session five.

Q: Jim Boyd. I have a question for Ian, and it goes to the interpretation of some of your maps of Wales. I think in the upper right, and I'm thinking about the net benefit maps, those would be the net benefits for marginal preservation change. Have you thought about the issue of how over time as the chunk of preservation gets larger and larger, how dynamically those maps change and how to deal with that issue?

IB: Thank you very much. You're absolutely right. It's not like a static shift that you get. In effect, what you're identifying through those maps is the optimal location for the first forest, if you like. To what extent do you have to therefore just reiterate the whole analysis? We felt that the only thing that you probably would have to go through again was the recreation site, and our reason was this. The contribution of Wales, the country, to diminishing global warming, the whole thing, you're not actually going to change the marginal value of an extra ton of carbons sequestered, that sort of thing. Fairly similar, really, on the agricultural side, because we're part of the global market. And similarly, with timber. So it is the recreation one where you should expect quite a dynamic change. And what you would have to do is rerun the model again, but it's quite easy to do because you saw in those transfer functions that it's got relationships with the availability of substitutes. So what we do is, suppose you stick in your marginal forest and say that's the very best place we can put it, right on the edge of Cardiff, for example. And then you recalculate the new recreation map with that substitute variable slightly changed. And it will actually cause nice little holes around existing forest or shifting out that way. We haven't done it, but we don't really see it as a particularly difficult task to do that. But you're absolutely right in your interpretation of what those maps are actually saying. Thanks.

Q: Jim Laity from OMB. I also have a question for Ian. I think I followed fairly well your description of how you use GIS to get physical, model physical quantities. Timber harvests, agricultural losses, tons of carbon sequestration, and visitors to potential sites. Unless I missed it I don't think you really talked about how you put values on those things. And for timber and agriculture I assume it's

market values. For recreation I assume it's a travel cost model, but I'm wondering if -- it seems to me, it looked like your conclusion was that the best place to put a forest would be the place where it would get the most visitors. It's not intuitively obvious to me that that necessarily maximizes consumer welfare because there's also congestion effects, and a lot of people might actually value a forest that has fewer visitors in it. And so, you get more people but they may all get less surplus, and I'm wondering if that factored into your estimation of value. And then for the carbon sequestration, I assume there was a stated preference survey or something to value. I really don't have any idea how, but it seems to me, I guess the punch line is how you derive those values will make a huge difference in the results you come out with. And I wonder if you could say a little bit about that; and it seems like the GIS part is very precise, very encouraging in terms of the physical quantities, but I'm not sure it really, really solves the problem of the valuation at the end of the day.

IB: Thank you; that's a great question. Let me just go through one of them. Agriculture, yes we look at market values. We're looking essentially to exercise, one is just straight market valuation. In the EU that's a very misleading estimate of the underlying shadow value of that produce. And so we undertook a really very extensive shadow pricing exercise in which we looked -- we used existing literature; I wish I could remember the most up to date. So if we went back to the Anderson and Tylus work and then come close with some much more recent work that I'm afraid escapes me, but what you're really doing is looking at what the market price would be if subsidies were removed in this world, which unfortunately it's never going to exist in the EU. And you're looking at the straight price subsidies. You're looking at the input subsidies. You're then looking at the real second-round effects upon developing world agriculture and how that feeds back into world prices. It was a nightmare to do, actually. But it was entertaining to actually work through all those ramifications. And it's something that I've never really presented much because in some ways it's quite tedious. But I think it's interesting and exciting to undertake. Timber, essentially the same thing. It's just that you haven't got the massive weight of subsidies. There are some subsidies in the UK. What used to be some tax breaks, which are still affecting supply and demand now, and there's some actual recreation subsidies that are fairly puny compared to agricultural subsidies. Carbon, we actually use the updated version of the Fankhauser work, so that's really -- I'm not sure what the correct term is -- damage cost assessment. He's looking at quite a nice global warming science model and actually looking through what are the damages of global warming, and he comes up with some very nice figures, which are actually, instead of just being a unit value it's actually profiled across time, depending on discounting functions and also depending on some things that you make about abatement. And so actually what you really get is a great sensitivity analysis, depending on which one of those you want to take. I just showed one of those. Recreation, yes, we're looking at travel cost models, so we're looking at consumer surplus. Those estimates will imperfectly reflect congestion because they're based on travel cost surveys, and there's a well-established literature on the fact that travel cost estimates don't perfectly reflect congestion problems and I fully accept that. It's not perfect. It's about as imperfect as most regular travel costs but it wasn't a really high tech travel cost study in terms of the economic methodology was pretty standard, standard travel costs.

Q: Rob Johnston, University of Connecticut. I may regret this but I'm going to do my best at asking a question of Kerry. As I understand it, the structural transfers you're talking about essentially is a triangulation of evidence from a variety of sources under a preference structure, which imposes that correspondence with theory that we like. My question is, could you speak to the promise of your method where you have a lot of evidence from one source? For example, when we talked about some of the meta analyses yesterday, you might have a whole lot of evidence from stated preference models, where you've got non-use values that might not have nice correspondence between things you can observe and the

market. Can you say something about how you could apply in the promise of structural transfers in a case such as that?

KS: I'll try not to talk too long. First, I forgot to thank -- the work that we're doing is funded by EPA and I forgot to acknowledge that, as well as thank the organizers for inviting us to present. Obviously one of the issues that you're getting into with non-use values is that you're imposing a non-separability, that is a separability, in principle, on the structure associated with preferences. So that one could investigate the character of the connections between the separable and the non-separable structure and how it influences the relative importance of use and non-use values. I don't think that there's anything particularly distinctive in that application relative to the assumptions we might make with a revealed preference approach. For example, we could assume weak complementarity or we could assume some form of substitution relationship between the particular amenity and the market good. At the end of the day the kind of analysis we're going to have to conduct is to evaluate how sensitive our results, both in terms of the character of the transfer of values, and what interests me more, the character of the recovered parameter measures are to the structure that we assume. So the first question is, we need to do the background work that investigates how sensitive the results are, in the same way that we're doing from the estimation perspective. With respect to the sensitivity, when there's one method, say contingent valuation, that's being used, clearly one can, the more estimates that are available, the more you can move away from calibration to estimation. One thing that somebody could say is you're saying nothing more, and I'll acknowledge this, than the specification of the functions we use for meta analysis. I'm simply saying let's take, rather than treating these as a kind of approximation, let's take some structure, try to impose that on it, and then we could test for consistency within the context of the maintained assumption associated with that structure. It's a great question. We could do that. That's certainly possible. It simply hasn't been done up to this point.

Q: Steve Stewart, University of Arizona. And another question for Kerry. You answered part of my original question but my second question is this. You mentioned that the only people doing structural transfers are the group that you put up on the board. Do you have any idea why we haven't adopted your approach?

KS: The algebra is just so much fun. As somebody said, my presentations are so incredibly clear. I don't know. I think that maybe, obviously the approaches that we're using right now can be viewed as approximations so that anything I would write down as a function of form for the willingness to pay function, the ones that I came up with, you could say well just do a Taylor series expansion on those and you'll get the models I'm estimating. So what's the big deal? Well, the question is are we going to impose the rigor that's associated with making sure we don't predict an estimate that will exceed our income for willingness to pay. And for the most part, many of the transfers that we've done up to this point are associated with relatively small changes. So it's like saying Smith is worried about this problem that is a non-problem typically. I come up with one of these analytical niceties that don't have much impact at the end of the day. Well, it really depends as the scale of the problem gets bigger, or as we say well, we've got clear skies, we've got another one that's associated with air quality, we're going to be having this initiative on mercury, we're going to have some other things. And we want them all to add up consistently. That's when it starts to happen. Or if you take Ian's example, if you said well, maybe if you put these parks out there you'd affect the labor leisure choice, that would affect wage rates, that would affect the prices of agricultural products and other products and it would feed back and kick you in the behind. Well, then maybe you want to think about, as the scale of the problem gets bigger. I think it's just a question of people recognize correctly that for many of the early applications the problems don't need the kind of algebraic machinery. But as we get into the bigger scale and more ambitious projects we do, and so I'm just simply saying let's give it a try and see how it works. That's all.

Q: [*Steve Stewart*] I would just add really quickly that I kind of, in approaching a different problem in a similar way, but I wasn't even thinking about it as a benefit transfer problem, but looking at wholesale transfers of water out of agriculture into environmental and municipal uses in the West, using very much the same techniques, but of course you put it much more elegantly than I ever would.

Q: Louis Queirolo, NOAA fisheries, Alaska region. I think this is for Kerry but I'd invite any of the panelists to respond. And depending on how good John's memory is this would be deja vu all over again for him. Fifteen years ago I asked him this question right across the street. Namely, what are the implications, I guess for Kerry's model, when you're assessing conversion of a public asset into private holdings, when the correct measure is willingness to accept compensation, which is not income-constrained? We're still struggling with this willingness to pay for an action which converts the property right associated with the asset. So I'd be curious to hear from you and the other panelists on that issue. Please don't say willingness to accept is just too hard to measure.

KS: The advantage of the structural approach is that you can measure what you want to measure and then recover what you want to use. That is willingness to accept simply changes the baseline that's associated with the particular alteration that you're evaluating. But as you're basically saying, you are entitled to these levels of quality or this level of asset, and this is the compensation that would be required to maintain the benchmark utility level that you've realized with that particular asset available. And the challenge has been that we've not been able to recover estimates of that. Well, if I can calibrate a preference function that consistently represents individuals' tastes, then I can calculate from that preference function a willingness to accept. Now that makes it seem way too simple. The fact of the matter is that everything you do in that context is a function of the preference function that you start from. But it is going to give you a bound on how much of a difference it's going to make and what it's going to rely on are two features. The first is the way in which the environment asset or its services enters preferences in a non-separable way in connection to things like labor that are associated, or leisure in this context, that are associated with the primary income sources that a person has. The way you make that assumption is going to drive what you're going to get out as a willingness to accept a kind of measure. But at least it's a way forward. It's a way of getting started with this. We can go to people, we can measure what is credible. We then calibrate the preferences. We start looking at how sensitive our results are to the functional forms we use, and we have a basis for taking some first steps. We never want to forget that those steps are driven by the functional specification we start from. That's just a complicated way of saying we could have gotten willingness to accept by just looking at Michael Hanemann's papers and making the appropriate adjustments to the willingness to pay measures to recover willingness to accept.

# 7. Alternative Approaches (Session 5)

## Section Contents

# "What's Nature Worth? Using Indicators to Open the Black Box of Ecological Valuation."

**James Boyd**

***Resources for the Future***
***USA***

**Presented during Session 5.**

***Editorial Note:***
This article first appeared in Resources, published quarterly by Resources for the Future, an independent research institute focused on environmental, energy, and natural resource policies (www.rff.org). The citation for the original article is:

Boyd, James. 2004. "What's Nature Worth? Using Indicators to Open the Black Box of Ecological Valuation." *Resources* 2004(summer): 18-22.

# What's Nature Worth? Using Indicators to Open the Black Box of Ecological Valuation.

What is the value of nature? This difficult question has motivated much of the work done at RFF over the last 52 years. If it seems odd that such a question could occupy an institution for half a century, consider both the importance and difficulty of the challenge. Nature and the services it provides are a significant contributor to human well-being, and society makes decisions every day about whether we will have more or less of it. Knowing nature's value helps us make those decisions. The difficulty is that nature never comes with a convenient price tag attached. Ecosystems aren't automobiles, in other words. They are like factories, however. They make beauty, clean air, and clean water, and they feed and house species that are commercially, recreationally, and aesthetically important.

Over the past decades, economic approaches to the "value of nature" question have become ever more sophisticated and accurate. This sophistication has a downside, however: non-economists rarely understand how estimates are derived and frequently distrust the answers given. To non-economists, environmental economics presents a set of black boxes, out of which emerges "the value of nature," such as a statement that "beautiful beach provides $1 million in annual recreation benefits" or "wetlands are worth $125 an acre."

How do economists arrive at such conclusions? For one thing, they examine the choices people make in the real world that are related to nature and infer value from those decisions. For instance, how much more do people spend to live in a scenic area as opposed to a less attractive one? How much time and money do they spend getting to a park or beach? The translation of such real-world choices into a dollar benefit estimate is complicated and requires the use of sophisticated statistical techniques and economic theory.

**Problems**
Economic valuation is met with skepticism in part because of the "black boxes" that are used by environmental economists; "black box" being useful shorthand for statistical or theoretical methods that require math or significant data manipulation, stock and trade for economists and some ecologists.

The technical and opaque nature of economic valuation techniques creates a gulf between environmental economists and decision-makers that fosters distrust. Such studies can also be quite expensive and demand the expertise of a relatively small number of economists trained in ecological valuation. The complexity of the studies undermines the ability of economists to contribute—as they should—to the analysis of priorities, trade-offs, and effective ecological management.

Another criticism of economic valuation is that values are "created" through political and other social processes and are not something that can be simply measured or derived by "objective" experts. Technical analysis—the black box—fosters this criticism because it produces results that can only be interpreted and evaluated by an elite cadre of experts.

**Opening the Black Box**

RFF's mission is not only to advance the methodology of environmental economics and other disciplines but also to ensure that its technical research affects policymaking. RFF researchers continue to push the scientific frontiers of ecological valuation and always will. But an additional task is increasingly necessary: communicating to decision-makers what we as economists and scientists already know and agree upon. As a group, environmental economists need to improve the ways in which they communicate the value of nature.

Unfortunately, better communication involves removing (or at least de-emphasizing) much of the technical content of economic methodology. We economists hate doing this. After all, much of the truth may be lost if the discipline of technical economic analysis is removed. But much of the truth is also lost when economists deliver answers that are not trusted or understood by the real-world audiences we must reach.

Here I will talk about a method designed to make ecological valuation more intuitive and thereby address some of the criticisms of economic valuation. Working with colleagues at the University of Maryland Center for Environmental Science, we are studying environmental benefit indicators (EBIs), which are a quantitative, but not monetary, approach to the assessment of habitats and land uses. EBIs strip environmental valuation of much of its technical content, but do so to reach a much wider audience and convey economic reasoning as it is applied to nature. Like purely ecological indicators, they summarize and quantify a lot of complex information. And like monetary assessment, they employ the principles of economic analysis. Our argument is that indicators can help noneconomists think about trade-offs.

We also believe that indicators can improve the way economists communicate ecological benefits and trade-offs. But it should be emphasized that we do not see indicators as a way to simplify assessment. The value of nature is inherently complex; rarely is there a clear-cut, "right" answer to questions such as which ecosystem is most valuable or which ecosystem service provided by a given habitat is most important.

**What are Indicators?**

At the simplest level, indicators can be the number of individuals in a biological community or species present in a habitat. They may also be a measure of the number of days a piece of land is under water or the presence of nearby invasive species that may threaten an ecosystem. These indicators tell us something about the health of a species or ecosystem.

Organized around basic environmental and economic principles, benefit indicators are a way to illustrate the value of nature. A collection of individual indicators about a given ecosystem can capture the complex relationships among habitats, species, land uses, and human activities, resulting in a more comprehensive picture (see Figure 1). Regulators could use indicators to identify locations for ecological restoration that will yield large social benefits, and land trusts could use them to identify socially valuable lands for

protection. Other applications include evaluation of damages from oil spills or environmental impact studies.

The techniques we are developing will be relatively affordable and easy to use. Dozens of the indicators we have been collecting are readily available in geospatial data formats. States, agencies, and regional planning institutions increasingly have high-resolution, comprehensive data on land cover and land use, built infrastructure, population and demographics, topography, species, and other data useful to the assessment of benefits.

**What Matters the Most?**

Indicators should act as legitimate proxies for what we really care about: the value of an ecosystem service. For example, wetlands can improve overall water quality by removing pollutants from ground and surface water. This service is valuable but just how valuable? To answer this question we can count a variety of things, such as the number of people who drink from wells attached to the same aquifer as the wetland. The more people who drink the water protected by the wetland, the greater its value.

But other things matter as well. For example, is the wetland the only one providing this service or are others contributing to the aquifer's quality? The more scarce the wetland, the more valuable it will tend to be. There may also be substitutes for wetland water-quality services provided by other land-cover types such as forests or by man-made filtration systems. Mapping and counting the presence of these other features can further refine an understanding of the benefits being provided by a particular wetland. Does mapping and counting these things give us a dollar-based estimate of the wetland's value? No. But it does lead to a more sophisticated, nuanced appreciation of the wetland's value than we would get if we ignored socioeconomic factors and economic principles.

Traditional regulatory and ecological ecosystem assessment techniques typically ignore socioeconomic factors, such as the number of people benefiting from an ecological function. And they never include assessment of concepts like the service's economic scarcity or the presence of substitutes. This highlights the second important function of benefit indicator systems—they can be used to convey basic economic concepts that speak to value.

**Ecosystem Services and Economic Principles**

Ecologists and economists have identified a wide variety of very important ecological services, including water-quality improvements, flood protection, pollination for fruit trees, recreation, aesthetic enjoyments, and many others. Indicators should be organized around these specific services to help convey a deeper understanding of the service itself.

Also, from both an ecological and economic standpoint, services should be analyzed independently. A typical ecosystem will generate multiple services, but not all services should be assessed using the same data or at the same scale.

The analysis of a service's scarcity and the importance of substitutes are important economic concepts that can be conveyed. Another is the role of complementary assets, which is particularly important to the assessment of recreational benefits. Access via trails, roads, and docks is often a necessary—or complementary—condition to the enjoyment of recreational and aesthetic services. These things can also be counted and relate intuitively to value.

Finally, an indicator system can also feature proxies for risk to an ecosystem service. For example, an ecosystem service may be threatened by an invasive species that can overwhelm more valuable native species, by a rise in sea level if the habitat is in a low-lying area, or by human encroachment if the ecosystem is sensitive to the human footprint. To foster a disciplined communication of results, we are developing indicators for demand, scarcity, substitutes, complementary assets, and risk that are specific to particular services.

**The Importance of Landscape and Scale**

Ecology emphasizes the importance of habitat connectivity and contiguity (or proximity) to the productivity and quality of that habitat. Terms like connectivity and contiguity are inherently spatial and refer to the overall pattern of land uses, surface waters, and topographic characteristics in a given region. Species interdependence and the need for migratory pathways are additional sources of "spatial" phenomena in ecology. The health of an ecosystem cannot be assessed without an understanding of its surroundings.

From an economic standpoint, ecosystem benefits depend on the landscape for an additional reason: because the social and economic landscape affects the value of nature. Where you live, work, travel, and play all affects the value of a particular natural setting. And the consumption of services often occurs over a large scale; examples include recreation and commercial harvests of fish or game, water purification, flood damage reduction, crop pollination, and aesthetic enjoyment.

To ignore, or minimize, the importance of off-site factors misses much that is central to a complete valuation of benefits. How scarce is the service? What complementary assets, such as trails or docks, exist in the surrounding landscape that enhance the value of a service? These questions relate to the overall landscape setting and are, accordingly, spatial in nature.

**What the Audience Wants**

Some audiences interested in the value of ecosystems crave the answer typically provided by economists: a dollar value. Government agencies are regularly called upon to demonstrate the social value of programs, plans, and rules they oversee. Generally speaking, the higher the level of government, the more demand there is for a bottom-line dollar figure for the costs and benefits of regulation. Such results allow politicians and high-level bureaucrats to wrap themselves in a cloak of legitimacy and objectivity.

Less cynically, putting things in dollar terms makes it easier to analyze trade-offs. The dollar benefit of program A can be directly compared to the dollar benefit of program B. Assuming the dollar figures are correct, we know which preprogram is better, and this is why economists prefer this approach. Only by expressing benefits in a consistent framework can the apples of ecological protection be compared to the oranges of alternative actions.

**Conclusion**

Environmental economists need to better communicate trade-offs and the value of nature in a way that educates and confers legitimacy on their own economic arguments. EBIs are an underutilized way to do this. Because indicators avoid technical complexity and the expression of value in dollar terms, however, too many economists reflexively dismiss their value. But the alternative—formal econometric benefit analysis—is unlikely to ever generate results that are holistic enough, transparent enough, credible

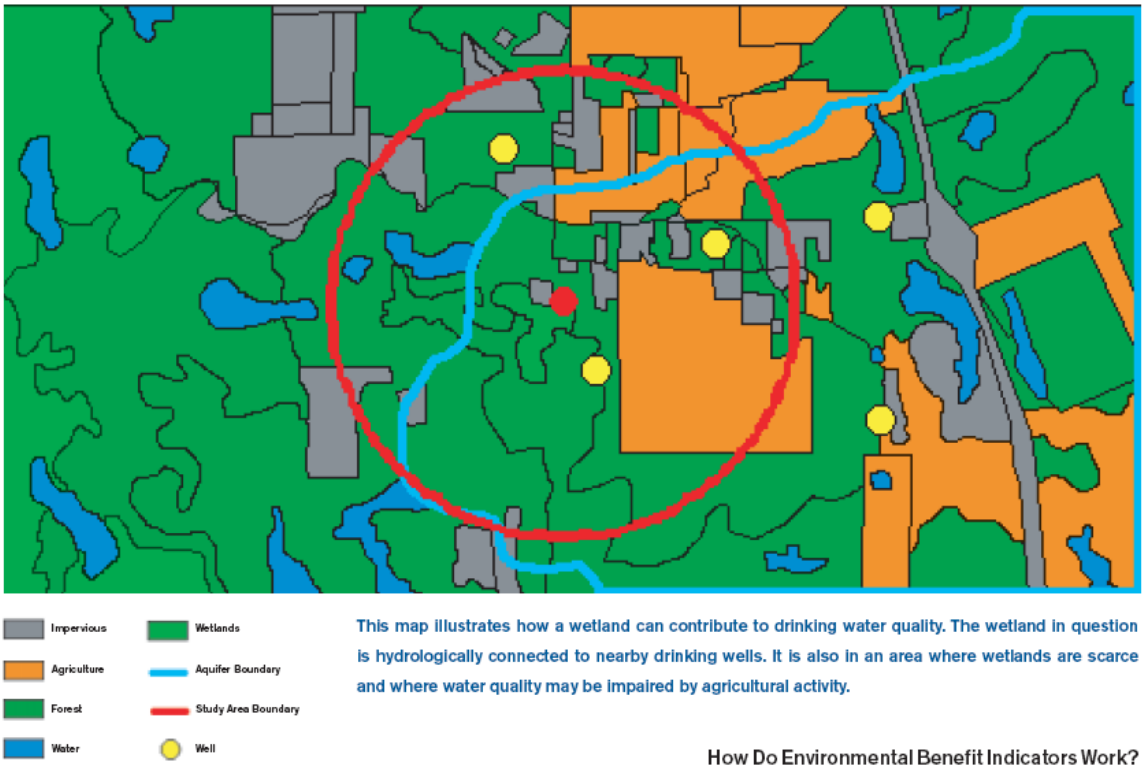
enough, and cheap enough to get widespread practical use. Scientifically sound, econometric analysis should continue to be conducted, of course. But agencies and planners should know that there are alternatives.

Instead of burying the principles of economics in their methodology, economists need to better communicate those principles in ways that resonate with "normal" people. Benefit indicators can help do this by concretely and quantitatively illustrating the relationships that are important to economic analysis. Communicating even a qualitative understanding of economic principles and relationships would be a huge advance for economic thinking in regulatory decision contexts.

Indicators can also be used to track the performance of environmental programs, regulations, and agencies over time—something that gets surprisingly little attention from environmental agencies or economists. To do so would require consistent and large expenditures of time, money, and expertise. But instead of trying to calculate the dollar benefit of a regulatory program over time, agencies could more easily measure things like the number of people benefiting from ecosystem services protected by their programs. This doesn't yield a dollar benefit, but does yield an intuitive number that conveys valuable information.

Given these benefits, indicators are underutilized in local, regional, and executive-level environmental decision-making. We are helping develop tools that are both ecologically and economically sound to address this gap.

**Figure 1**




***How Do Environmental Benefit Indicators Work?***

*Environmental benefit indicators (EBIs) are a way to illustrate the value of nature in a specific setting. An individual EBI might be the presence of invasive species or the number of acres under active cultivation. A collection of indicators about a given area can portray the complex relationships among habitats, species, land uses, and human activities. EBIs are drawn mainly from geospatial data, including satellite imagery. Data can come from state, county, and regional growth, land-use, or transportation plans; federal and state environmental agencies; private conservancies and nonprofits; and the U.S. Census. Regulators and planners can use EBIs to address specific questions, such as which wetland site, among many, is the most valuable? Coming up with an effective answer requires looking at many factors: on-site characteristics, such as the type of wetland; off-site characteristics, including the presence of wetlands in the larger area; and socioeconomic indicators, such as the number of people dependent on wells in the area for their drinking water. The map above graphically portrays how a set of these factors relate to one another in the target area. One of the great virtues of this approach is that unforeseen relationships—such as the amount of A in relation to B— is quickly made apparent.*

# "Introducing Environmental Multi-Criteria Decision Analysis."

**Tom Seager [1*] and Igor Linkov[2]**

*[1] Social and Environmental Research Institute, Inc.*
*2954 Rampart St., Lafayette, IN 47909, USA*
*413.773.9955; www.seri-us.org*
*[2] Cambridge Environmental Incorporated*
*58 Charles Street, Cambridge, MA 02141, USA*
*Linkov@CambridgeEnvironmental.com.*
** Presenting author*

**Presented during Session 5.**

**Abstract**

Environmental problems inevitably involve shared resources, multiple perspectives, and group decision-making processes. In consideration of potentially conflicting value systems or objectives, it may be naive to assume that there is any available alternative that will be preferred by all parties. There may be more than one "best" alternative, depending upon how priorities are judged by different groups. In practice, decision-makers typically must balance information from a variety of different sources (such as science, engineering, law, or public opinion) that comes in many different forms including measurements, models, interviews, or argument. Assessing the performance of alternatives typically engages quantittative, semi-quantitative, and qualitative types of information. Understanding stakeholder and public views in terms of benefit-cost analysis alone may not capture a complete picture of the problem, partly due to the fact that many stakeholder are uncomfortable or inexperienced at evaluating unfamiliar tradeoff between incommensurate criteria (such as toxicological risk and/or income) and partly because the *distribution* of costs, benefit, and risks may be more important to some decision-makers than absolute levels. Accordingly, methods in multi-criteria decison analysis (MCDA) for environmental problems have moved away from optimization (or normative) approaches such as multi-attribute utility theory (MAUT) that are theoretically and mathematically ground in microeconomic theory, and towards more descriptive approaches designed to facilitate deliberation. On such approach is *outranking*, which may be perceived as somewhat *ad hoc*, but is generally accessible to stakeholder and public groups and therefore can facilitate transparency. Moreover, outranking is capable of incorporating a variety of data sources of different quality and scales. Multiple viewpoints can be represented and potential conflicts or opportunities for compromise between different groups can readily be identified (Brans and Vincke 1985). Nonetheless, MCDA methods like outranking have rarely been adopted as part of an analytic-deliberative environmental decision-making process in the US and there is a paucity of literature available to allow new users to gain familiarity with existing case studies.

## Introduction

Environmental decision-making is an increasingly sophisticated problem that requires balancing analytic processes, such as benefit-cost or risk analysis with deliberative processes such as citizen juries and stakeholder or public participation (National Research Council 1996). However, there is no single framework for integrating both expert-driven and public-driven process. Figure 1 depicts a continuum of decision-making approaches ranging from purely political approaches on the left to purely bureaucratic approaches based entirely upon expert opinion on the right. The risk at the left edge of the spectrum is that environmental decisions will become dominated by special interest groups that are capable of manipulating the political process. Whereas at the right edge of the spectrum, the risk is that decision-making will be insensitive to public values (Seager et al. 2005). This paper suggests that one promising approach for an overall integrative framework for analytic-deliberative environmental decision making can be found in multi-criteria decision analysis, or MCDA (Lahdelma et al. 2000) which is a structured approach to analyzing wicked problems that may have no single best solution.

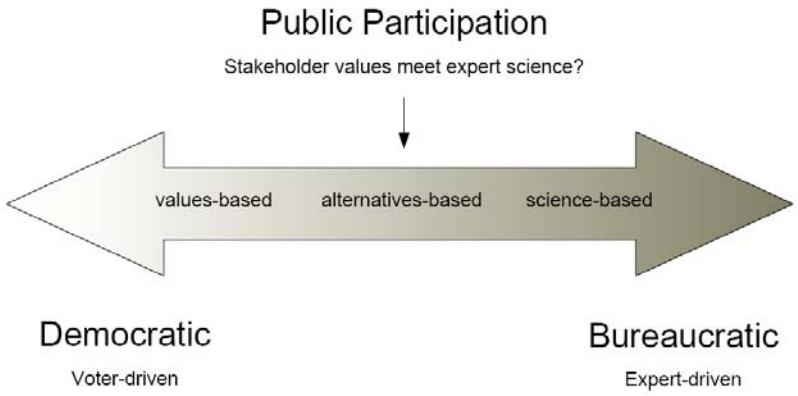



**Figure 1:** Analytic-deliberative environmental decision-making processes require balancing expert and public input.

MCDA approaches are not new (Belton and Stewart 2002, Gal et al 1999, Vincke 1992). A general flow chart describing the overall process is described in Figure 2. In summary, an MCDA problem is one that must satisfy several, often incommensurate, objectives. Alternative must be assessed in relation to quantitative or semi-quantitative criteria that either gauge progress towards those objectives or otherwise are used to judge the comparative merits of the alternatives. The key to the analysis is selecting a method of aggregating the performance assessments on each criterion to create a ranking of which is most preferred. In a case in which all of the criteria can be converted into a single measure of merit (such as money or utility), then a single objective function results that suggests one alternative may be superior to all others. Each criteria is weighted according to its equivalent units in the objective function (such as a price or willingness to pay), and the alternatives judged by either the weighted average or weighted sum. However, MCDA techniques have only recently been applied to problems of environmental decision-making, partly because environmental problems pose a number of specific challenges to traditional MCDA process, and partly because there is a paucity of case studies in the literature from which practitioners may draw to demonstrate the process to prospective or current decision makers (Linkov et al. 2004).

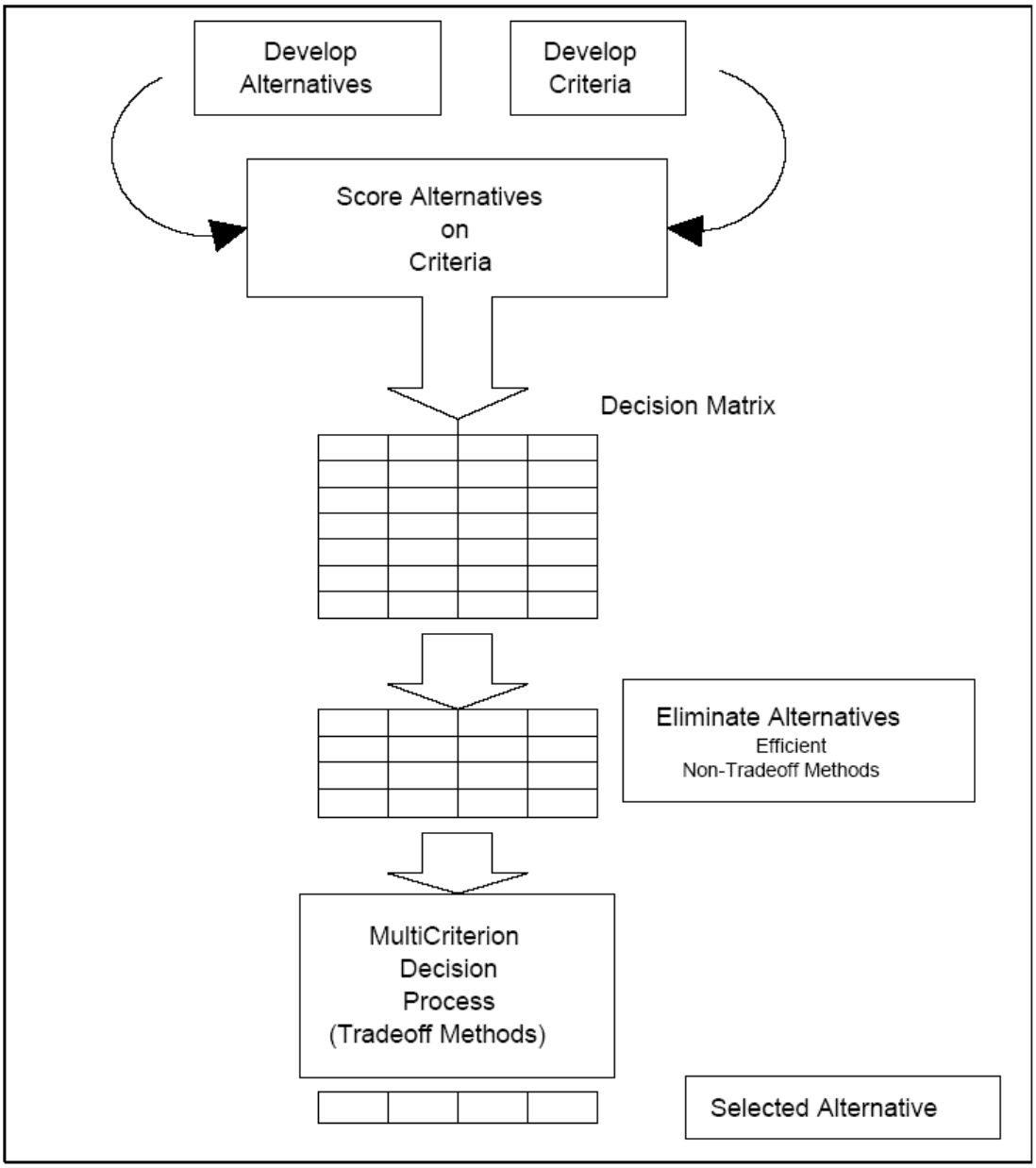



**Figure 2:** A general flowchart for MCDA. (From Males 2002)

Traditional MCDA approaches, such as multi-attribute utility theory, employ mathematical approaches consistent with neoclassic microeconomic theory and are easily amenable to optimization approaches. However, environmental problems typical do not lend themselves to utility-based approaches for several reasons. First, environmental resources are almost always shared by several groups or political jurisdictions, and consequently environmental problems are rarely entrusted to a single decision-maker (Beierle and Crwaford 2002). It is far more likely that multiple stakeholder or public groups are brought to bear, and that multiple perspectives must be represented. Eliciting detailed preference information regarding the relationship between non-market criteria such as ecological habitat or environmental quality can be extremely difficult and resource-intensive as the number of stakeholders or decision makers

increases. This presents a practical obstacle to MAUT-type approaches. Also, the very idea that all criteria can be reduced to a single utility measure may be objectionable to some stakeholders, who may hold that certain criteria (for example, existence value of endangered species versus energy independence) are incommensurate. In this instance, two alternatives with radically different performance profiles may simply be incomparable in the minds of some stakeholders.

Accordingly, new approaches to MCDA have been more recently developed that work around some of these obstacles (e.g. Halmainen et al. 2001, Lahdelma et al. ____). Or example, *outranking* is one approach that departs from microeconomic utility function theory, but solves some of the practical problems associated with comparing criteria that are measured on different scales and in different units (Brans and Vincke ___) . In an outranking approach, stakeholders are asked to communicate a preference for one alternative over another for any single criteria. For example, stakeholder may prefer an alternative that costs one million dollars to an alternative that costs two. However, stakeholders are also able to express preferences for decision criteria that are not quantitative, semi-quantitative, or merely qualitative, such as an aesthetic sense of view or color. These preferences need not be complete; they may be partial. For example, the level of uncertainty in cost estimates (or estimates of any other performance criteria) may be so high that it is not clear which alternative is preferable, although one may be favored. In outranking, it is possible for stakeholders to express a partial preference, or no preference (a tie). Consequently, uncertainty can be built into the analysis, or it can be included as a separate criterion on its own, with each stakeholder expressing a tolerance for different levels of uncertainty by choosing to weight the uncertainty criteria relative to all others. Figure 3 illustrates an example of how two alternatives may be judged so close in performance on one criterion that a stakeholder expresses indifference. This range is known as an *indifference threshold*, and outside that range preferences may be complete, as in a step-wise function, or gradually move from indifference to partial to complete preference as depicted in Figure 3.

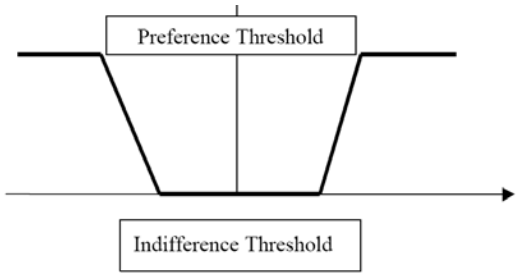



**Figure 3:** Indifference threshold and partial preferences. From Males (2002).

The term outranking refers to the ordering of preferences (first, second, third, etc.) of each alternative with respect to each criterion. That is, all criteria are converted to ordinal (rather than cardinal or other scale) assessments to work around the problem of incomparable scales, ranges, and measurement units. Ordinal assessments are then aggregated according to inter-criterion weights that represent the relative importance of each criterion to each stakeholder. In this way, multiple stakeholders view can be represented by contrasting the ordered alternative preferences of each participant. Whereas linear utility approaches are typically compensatory – that is, extreme overperformance on any one criterion will compensate for underperformance on others, outranking is only partially compensatory. (It is impossible to be ranked higher than first, no matter how much an alternative overperforms). This approach may be more appealing to some stakeholders who hold the view that certain criteria are not inter-tradable. For example, it may be that one group feels that cost savings are not a justifiable reason to accept environmental compromises (or alternatively, another group may feel that once minimum environmental constraints are satisfied, further expenses to maintain higher environmental performance standards are unjustified).

Nevertheless, the elicitation of weights and indifference threshold for outranking analysis may be problematic. Any weighted averaging or summation scheme involves trade-offs between different criteria, regardless of stakeholder objections to the contrary. To the extent that few stakeholders are accustomed to or prepared to make judgments expressed as percentage linear weights, any elicitation of stakeholder values is subject to revision or of dubious integrity. (Which is to say, the weights may be dependent upon the method of elicitation, the stage during the study during which they are elicited, or even the alternatives presented). Consequently, it is important to be able to explore the sensitivity of the results to the weights expressed. There are at least two general approaches to this. The first is to establish *stability intervals* over which the preferred ordering of alternatives for any stakeholder is unaffected by changing weights. Figure 4 illustrates stability intervals that represent the strength of conviction of four different stakeholder groups with respect to alternatives for contaminated dredged material management. Groups with strongly held views are typified by wide stability intervals with expressed or estimated weightings near the middle of the range. In this case, the preference ordering of alternatives is not sensitive to small changes or errors in weighting. However, groups (such as 'Balanced') that express a weighting on the cusp of the stability interval may be susceptible to changing their minds about a preferred alternative, or may be open to compromise. I this way, potential conflicts or opportunities for compromise between different groups can be explored using MCDA and this analysis make actually facilitate deliberative decision-making processes. Secondly, a stochastic multi-attribute analysis (SMAA) is capable of characterizing the alternatives as those *most likely* to dominate or rank highly (with respect to other alternatives) over a range of weight spaces (Lahdelma et al ____). In this case, preferred alternative orderings are examined over the entire range of weight-spaces, and those alternatives ranked highest over the greatest space are judged most likely to be preferred by the greatest number of stakeholders. SMAA can thereby prioritize alternatives for further consideration *even in the complete absence of elicited weights*. It should be noted, however, that selection of assessment criteria will constrain the analysis, and should not be conducted without stakeholder or public input.

Although outranking presents a practical alternative to utility-based approaches that is easily accessible to most stakeholders, the disadvantages is that outranking represents a somewhat *ad hoc* approach (compared to utility theory). This is evidenced by the fact that the ranking of alternatives that are most preferred may be dependent upon which inferior alternatives are included in the analysis. For example, in utility theory the attributes of the first or second alternatives are independent of the third and fourth. However, in outranking, alternatives are judged only in comparison with one another and consequently, they are not judged independently. Nonetheless, to the extent that outranking can be employed to help elucidate the trade-offs involved in a decision, identify conflicts, foster compromise or consensus, and one the whole facilitate deliberative processes, then the approach could be important to environmental decision making for identifying a small set of desirable alternatives, if not a single 'best' one.

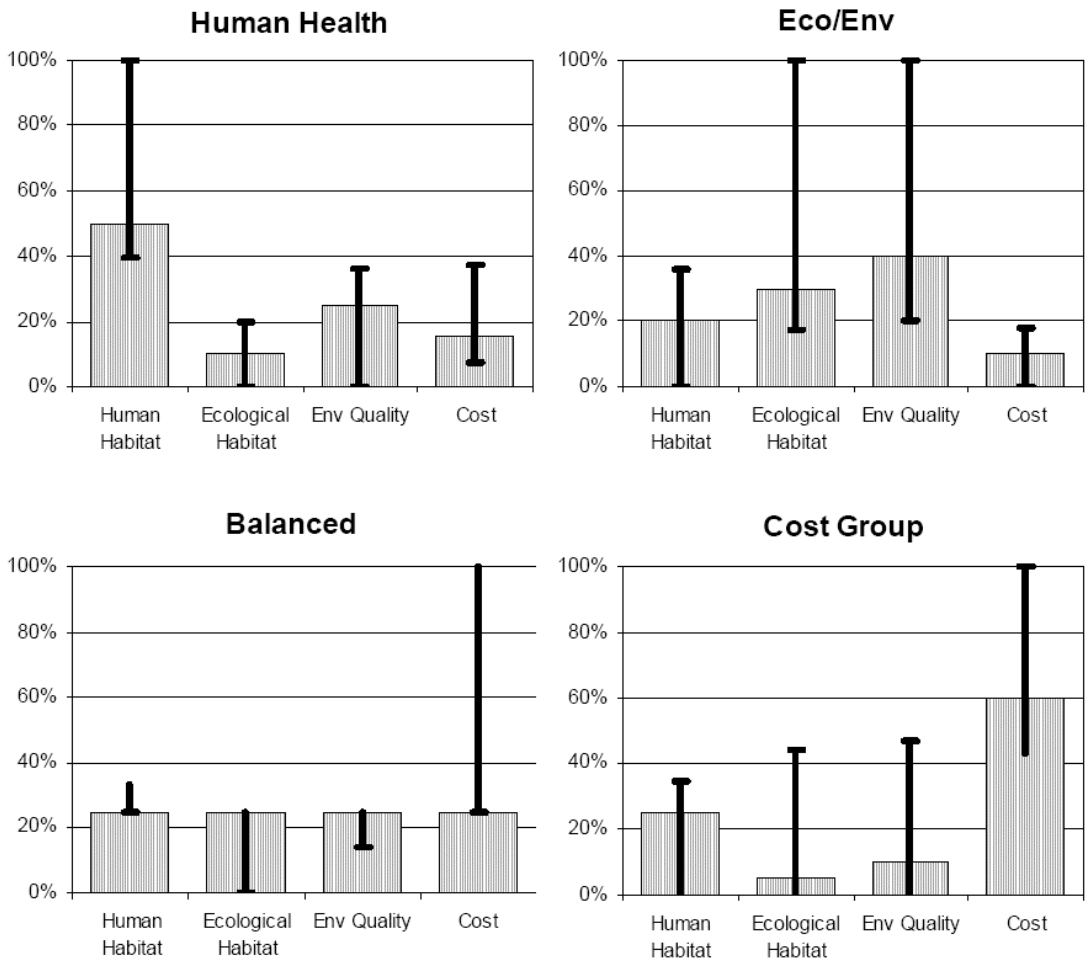



**Figure 4:** Stability intervals (represented as error bars) indicate the range of criteria weights over which the first two predicted preferred alternative orderings are unchanged. Upper bounds are indicative of the extent to which a criterion can be overweighted (at the expense of other criteria) without altering the preferred ordering. Lower bounds represent are indicative of the limit to which a criterion may be underweighted. From Seager et al. 2005, copyright by the authors.

**Acknowledgments**

This paper a result of the USEPA *International Workshop on Benefits Transfer* held in Washington DC 21-22 March, 2005 and was made possible in part by the financial support of the USEPA. Comments by Rich Iovanna and Randal Bruins of the USEPA were very helpful in the scoping and presentation of this work.

**References Cited and Further Reading**

Belton V, Stewart TJ. 2002. *Multiple Criteria Decision Analysis: An Integrated Approach.* Kluwer Academic Publishers: Boston MA.

Beierle T, Cayford J. 2002. *Democracy in Practice: Public Participation in Environmental Decisions.* Resources for the Future: Washington, DC.

Brans JP, Vincke PH. 1985. A preference ranking organisation method: The PROMETHEE method for multiple criteria decision- making. *Mgt. Sci.* 31(6):647-656.

Gal T, Stewart TJ, Hanne T. 1999. *Multicriteria Decision Making: Advances in MCDM Models, Algorithms, Theory, and Applications.* Kluwer Academic Publishers: Boston MA.

Hamalainen RP, Kettunen E, Ehtamo H. 2001. Evaluating a framework for multi-stakeholder decision support in water resources management. *Group Decision and Negotiation*. 10:331-353.

Kiker G, Bridges T, Varghese A, Linkov I, Seager TP. 2004. Multi-criteria decision analysis: A framework for structuring remedial decisions at contaminated sites. In *Comparative Risk Assessment and Environmental Decision-Making* edited by I Linkov and AB Ramadan. Kluwer Academic Press: Boston MA. ISBN 1-4020-1895-9.

Kiker G, Bridges T, Varghese A, Seager TP, Linkov I. 2005. Multi-criteria decision analysis at contaminated sites and related areas: A review of applications and synthesis for future challenges. *Integrated Environmental Assessment and Management*. In press.

Lahdelma R, Salminen P, Hokkanan J. 2000. Using multicriteria methods in environmental planning and management. *Environmental Management*. 26(6):595-605.

Lahdelma R, Salminen P. 2001. SMAA-2: Stochastic multicriteria acceptability Analysis for group decision making. *Operations Research.* 49(3):444-454.

Linkov I, Sahay S, Kiker G, Bridges T, Seager TP, Belluck DA, Meyer A. 2005. Multi-criteria decision analysis: A comprehensive decision analysis tool for risk management of contaminated sediments. *Risk Analysis.* Under review.

*Linkov I, Sahay S, Kiker G, Bridges T, Seager TP. 2005. Multi-criteria decision analysis: a framework for managing contaminated sediments. In* Strategic Management of Marine Ecosystems *edited by Proth JM, Levner E, Linkov I. Kluwer: Amsterdam. In press.*

Linkov I, Varghese A, Jamil S, Seager TP, Kiker G, Bridges T. 2004. Multi-criteria decision analysis: A framework for structuring remedial decisions at contaminated sites. In *Comparative Risk Assessment and Environmental Decision-Making* Linkov I, Ramadan AB (eds.). Kluwer Academic Press: Boston MA.

Males R. 2002. *Beyond Expected Value: Making Decisions Under Risk and Uncertainty*. Report prepared for US Army Corp of Engineers Institute for Water Resources: Alexandria VA. Contract #DACW72-99-D-0001.

National Research Council. 1996. *Understanding Risk: Informing Decisions in a Democratic Society.* Stern P, Fineberg H (eds.) National Academy Press: Washington DC.

Rogers SH, Seager TP, Gardner KH. 2004. Combining expert judgment and stakeholder values with PROMETHEE: A case study in contaminated sediments management. In *Comparative Risk Assessment and Environmental Decision-Making* edited by I Linkov and AB Ramadan. Kluwer Academic Press: Boston MA. ISBN 1-4020-1895-9.

Seager TP, Lambert JH, Gardner KH. 2005. Fostering innovation in contaminated sediments management through multi-criteria technology assessment and public participation. *Risk Analysis.* Under review.

Seager TP, Rogers SH, Gardner KH. 2005. Multicriteria decision analysis as a framework for combining expert knowledge and public values: A case study in contaminated sediments management. *Risk Analysis*. Under review.

Seager TP, Linkov I, Cooper C. 2005. Performance metrics for oil spill response, recovery, and restoration: A critical review and agenda for research. In *Strategic Management of Marine Ecosystems* edited by Proth JM, Levner E, Linkov I. Kluwer: Amsterdam. In press.

Seager TP, Gardner KH. 2005. Barriers to adoption of novel environmental technologies: Contaminated sediments. In *Strategic Management of Marine Ecosystems* edited by Proth JM, Levner E, Linkov I. Kluwer: Amsterdam. In press.

Seager TP. 2004. Understanding industrial ecology and the multiple dimensions of sustainability. In *Strategic Environmental Management* by O'Brien and Gere Engineers. John Wiley & Sons: New York NY. ISBN: 0-471-09221-5.

Vincke P. 1992. *Multi-Criteria Decision-Aid*. John Wiley and Sons.

# "Cost Effectiveness and Incremental Cost Analysis."

**Shana Heisey**

***Institute for Water Resources***
***U.S. Army Corps of Engineers***
***USA***

**Presented during Session 5.**

**General Approach of the Corps of Engineers**

The Corps of Engineers (Corps) has a long history of conducting economic analyses on traditional water resources investments, such as flood damage reduction projects and navigation improvements. Benefit-cost analysis, incremental cost analysis and cost effectiveness analysis have been integral to Federal water resources planning. Traditionally, these analyses have focused on projects' monetary costs and benefits. Cost effectiveness analysis was the means to identify the least costly means to achieve a range of project benefits; subsequent incremental cost analysis was used to scale project size by judging whether increasing economic benefits are worth their additional costs. In the mind 1980s, the Corps adopted the principles of cost effectiveness and incremental cost analyses for use in planning and justifying mitigation for fish and wildlife habitat losses caused by projects for flood damage reduction, navigation, and other developmental purposes. Costs for mitigation were essentially the same types of financial costs incurred for other project purposes, including such features as engineering and design, real estate, construction, operation, and maintenance. Benefits for mitigation were found to be more problematic. Corps guidance published in March 1988 advised analysts that:

> "monetizing some benefits, e.g. those of habitat units, is not routinely achievable. Nevertheless, incremental cost analysis is an essential context or framework in efficient and documented planning. Justification, scale, and tradeoff decisions cannot be efficiently made and evaluated without reference to incremental costs…. District Commanders [are] to include in their recommended plans, and other alternative plans, such justifiable measures for fish and wildlife purposes as they find should be adopted to obtain maximum overall project benefits (monetary and non-monetary)." USACE EC 1105-2-185, 11 March 1988, p 2.

Corps involvement in the environmental arena was expanded with the Water Resources Development Act of 1986, which gave the agency formal jurisdiction to implement projects for the sole purpose of ecosystem restoration. Corps leadership determined that restoration benefits were similar in nature to those of mitigation and as such should not be evaluated in strictly monetary units. This determination was made explicit in general planning guidance published April 2000, which stated:

> "The Corps objective in ecosystem restoration planning is to contribute to national ecosystem restoration (NER). Contributions to national ecosystem restoration are increases in the net quantity and/or quality of desired ecosystem resources. Measurement of NER is based on changes in ecological resource quality as a function of improvement in habitat quality and/or quantity and expressed quantitatively in physical units or indexes (but not monetary units)." USACE ER 1105-2-100, 22 April 2000, p 2-2.

Although much of the rationale behind the decision to restrict Corps environmental benefit analyses to non-monetary outputs was not recorded, a report sponsored by the National Research Council, "Restoration of Aquatic Ecosystems, Science, Technology, and Public Policy", offers an interesting perspective and may have been influential. The report stresses the difficulty in determining the appropriate method for evaluating the value of structure and functions performed by ecosystems. While benefit-cost analysis was identified as a common approach for evaluating investments, the committee determined expressing environmental values through individual preferences measured in terms of monetary equivalence had not been entirely successful. "Success in such measurement efforts has been achieved in specific instances, but widespread application of the measurement approaches has not occurred. This limited use represents… the experimental nature of the valuation approaches and … a lack

of agreement on the philosophical bases for assigning such values. Of even greater concern is that benefit-cost analysis requires a static view of human preferences." (Restoration of Aquatic Ecosystems, p 358-359) The alternative approach recommended by the committee was one based on opportunity costs. Such a framework would lead analysts and decision makers to determine a sufficient level of investment, to answer the question "How much restoration is enough?" This is the approach followed by the Corps for over two decades of environmental work.

Instead of monetary units, environmental scientist in the Corps developed and utilized other metrics to quantify the ecological impacts of different actions that could express the specific restoration or mitigation objectives of each project. As the restoration mission developed, these evaluation techniques varied by the type of output and ranged from simple acreage estimation to complex system models. It was determined that no single unit of output or measurement technique would be applicable for all situations and each unique planning setting would need to determine an acceptable analytical approach. Regardless of the approach taken, including anything from stream miles restored to an Index of Biotic Integrity or Habitat Evaluation Procedure, the results came to form the environmental "output" information for the Corps' economic efficiency evaluations: Cost Effectiveness and Incremental Cost Analyses.

The purpose of cost effectiveness and incremental cost analyses in environmental planning in the Corps is to promote the efficient production of environmental outputs. These are two separate and sequential analyses performed first to filter inefficient and ineffective investment alternatives and second to compare the increase in benefit levels achievable from different plans. Specifically, cost effectiveness analyses identify plans as inefficient when another alternative can produce the same level of output at a lower cost. Ineffective alternatives are those where another plan provides a greater level of output for the same or less cost. While each plan in the cost-effective set provides an efficient and effective way of achieving a particular level of benefits, the productivity of the different plans is not the same. The plan with the lowest average cost per unit of output can be considered to be the most efficient or most productive plan; Corps planners consider this the first "best buy" plan. However, the first best-buy plan is not necessarily the optimal plan because the objective function in ecosystem restoration and mitigation is not to minimize average costs but to maximize net environmental benefits. This first plan represents the minimum scale alternative that should be selected over the option to implement nothing. In the array of cost effective alternatives there may exist additional efficient levels of investment. The suite of efficient or "best buy" plans can be identified by calculating the marginal cost per unit of the added output from larger plans using each successively determined "best buy" plan as the base for the calculation. The best plan overall is the alternative where the incremental cost of the additional units provided by a "best buy" plan is judged by the decision-maker to be equal to (or not more than) the marginal benefits of the last unit of the output being produced.

Proper use of Cost Effectiveness and Incremental Cost Analyses can help decision makers allocate limited resources more efficiently and avoid the selection of economically irrational plans and projects. The result of these analyses is an array of alternatives acceptable at different investment levels, which contrasts sharply to the single best plan and investment level resulting from benefit-cost analysis. This set of alternatives allows decision makers to progressively compare varying levels of environmental outputs and determine if each subsequent level of investment yields benefits comparable to the increase in cost.

**Cost Effectiveness and Incremental Cost Analyses Application: Elizabeth River**

In June 2001 the Corps of Engineers, Norfolk District, completed a study that analyzed the feasibility of conducting environmental restoration in the Elizabeth River ecosystem. The watershed encompasses approximately 300 square miles of coastal, southeastern Virginia. Located in a highly urbanized area, less than one tenth of the watershed remains undeveloped. The river has suffered over three centuries of industrial use and urban development, leaving it one of the nation's most polluted rivers. Studies indicate that the surface area of the river basin was reduced by 26% between 1872 and 1982 and as much as half the river's tidal wetlands were lost 1944 and 1977. Among other objectives, the Corps and non-Federal sponsors evaluated the benefit of identifying and restoring wetlands throughout the system. Initially a set of 30 potential restoration sites were identified but early screening narrowed the list to eleven candidate sites for detailed investigation. At each site the study team determined the appropriate combination of excavation or filling required to obtain proper elevations for tidal wetlands, then the necessary grading; layering with suitable soil; removal of exotic vegetation; and planting of native vegetation. For each location the implementation costs included the costs of all required improvements, as well as real estate and material disposal costs. Implementation, maintenance, and monitoring costs were annualized over fifty years at the Federal discount rate. Environmental outputs at each wetland site were calculated using two distinct methodologies:

1. Habitat units were calculated using the U.S. Fish and Wildlife Habitat Evaluation Procedure for the clapper rail. This bird was considered an indicator species that represents the overall health of a saltwater marsh habitat. This procedure is designed to capture the quality and quantity of habitat in an ecosystem. An evaluation was conducted on the projected condition of the wetland without any specific Federal involvement. A separate evaluation determined the quantity of "habitat units" expected to be present if the Corps implemented its restoration alternative at the site. The difference between these two evaluations yielded the environmental benefit from restoring the site.

2. A functional assessment scoring method developed by a team of local scientific experts. This evaluation technique determined seven functions provided by the wetlands, including primary production, fish and wildlife habitat, water quality, erosion buffer, flood buffer, aesthetic value, and educational value. At every restoration site, each function was scored on a scale of 1-5 (lowest to highest) and added together, making 35 the highest functional score possible at a site. As with the Habitat Evaluation Procedure, the benefit of environmental restoration was the difference between a site's functional score with and without Federal involvement.

These costs and outputs were used in the cost effectiveness and incremental cost analyses. The District utilized the Corps' software program, IWR-Plan, to conduct the analyses and the results are displayed below. The non-commensurate nature of the two environmental benefit approaches required individual analyses. Below are the graphs showing cost effective and incrementally justified alternatives resulting from an evaluation using the Habitat Evaluation Procedure. As there were no restrictions on the combinability of the different wetland sites, over 2,000 combinations were possible, ranging from the smallest alternative, doing nothing, to implementing improvements at all eleven sites. Of these, as shown in Figure 1, only a small subset, ninety-two, were cost effective.
**Error! Objects cannot be created from editing field codes.**

Analysts conducted incremental cost analysis on this narrowed array of ninety-two plans. These results are displayed in Figure 2. Each box in the graph represents a different alternative; the alternatives each represent the best means of achieving a given level of investment. Formulation in this project was such that the efficient increments give the proper order to implement each of the wetland sites. Specifically, the first box tells that if only one site is restored it should be the Northwest Jordan Bridge site. If a higher level of investment is justified, the second box indicates both the Northwest Jordan Bridge and Grandy Village sites both should be restored. This continues until the final box, which represents improving all eleven wetland sites. The width of the each box on the graph displays the incremental output from each alternative and the height shows the incremental cost per unit of output.
**Error! Objects cannot be created from editing field codes.**

Selection between the eleven alternatives shown in Figure 2 was based upon the significance of the resources being restored and the determination that several of the increments did not provide benefits equal to their cost. The study's recommendation was to restore eight of the eleven sites, which together provided over eighteen acres of restored wetland and buffer habitat. The final three sites fell at a breakpoint in the incremental cost curve, displayed in Figure 2. A relatively large incremental jump in costs is required to achieve a relatively small incremental benefit. For the three sites not recommended, the study team determined that the costs, logistical constraints, and public opinion outweighed their environmental benefits.

## REFERENCES

Committee on Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy. 1992. Restoration of Aquatic Ecosystems, Science, Technology, and Public Policy. National Academy Press. Washington, D.C.

U.S. Army Corps of Engineers. 1988. EC 1105-2-185, Fish and Wildlife Mitigation Planning: Incremental (Marginal) Cost Analysis. Washington, D.C.

U.S. Army Corps of Engineers. 2000. ER 1105-2-100, Planning Guidance Notebook. Washington, D.C.

U.S. Army Corps of Engineers, Norfolk District. 2001. Interim Final Feasibility Study and Environmental Assessment, Elizabeth River Basin, Virginia, Environmental Restoration Study. Norfolk, VA.

# Discussant Comments on Presentations from Session 5

**Randall J.F. Bruins**

***National Center for Environmental Assessment***
***Office of Research and Development***
***U.S. Environmental Protection Agency, USA***

Our three presenters have done an excellent job of outlining some attractive alternatives to benefit-cost analysis (BCA) that may help us avoid altogether the difficulties of benefits transfer.[24] All three approaches seem capable of capturing key ecological and economic dimensions of the decision at hand and of enabling quantitative comparison of policy alternatives. Jim Boyd's ecological benefit indicators (EBIs) flexibly combine various individual metrics and adapt readily to spatial display. Multi-criteria decision approaches (MCDA), as described by Tom Seager, can make the key trade-offs that underlie decisions more accessible to groups and can facilitate deliberation. And cost effectiveness and incremental cost analyses (CE/ICA), as discussed by Shana Heisey, can ensure that a given ecological objective is obtained at minimum cost.

But we shouldn't rush too quickly into a discussion of which of these approaches is the best alternative, or whether they are even good alternatives to BCA at all. Studies focused on ecosystem management (e.g., Gregory and Keeney, 1994; McDaniels, 2000; USEPA, 2001) often refer to decision context as critical to structuring a decision-making process. Understanding the decision context requires clarity as to *what* decision is being made, the legal and social *motivations and constraints* for the decision, and the *parties* to the decision and their roles. Previous talks in this workshop have already shown us that context is a key element in benefits transfer. So now let's reflect very briefly on each of these three aspects of decision context to see what may be implied for the usefulness of BCA or these alternatives.

Before doing so, let me state that I will have to make some generalizations about these methods. My generalizations may not be entirely fair, because many variations of each method exist and my knowledge of them is incomplete. But I hope that the back-of-the-envelope nature of the following analysis will not obscure my larger point, which is that the question of decision context looms large when one considers alternatives to BCA, just as it does when one considers how to transfer benefits.

Let's consider first what kind of decision is being made (Figure 1): Are we in a narrowly focused mode or are we thinking broadly and strategically? CE/ICA is useful for selecting among alternatives similar in type, according to a given ecological objective; e.g., acres of habitat suitable for a given species.[25] The method is not capable of comparing action and no-action alternatives. EBIs also compare similar options. Different sets of indicators can respond to different objectives; however, they do so one-at-a-time. By contrast, BCA, assuming it can be done well (and this is no small assumption), can compare dissimilar options including the no-action alternative. However, MCDA is the approach best suited to strategic planning because it facilitates group discussion of objectives and creative thinking about alternatives.[26]

Next consider one aspect of the legal and social framework (Figure 2): Are we in a relatively informal or ad hoc process, where any approach that facilitates consensus is acceptable? Or are we bound to the use of formal methods, whether that formalism is procedural, theoretical or both? EBIs appear to be tailor-

[24] The views expressed in these comments are those of the author and do not necessarily reflect the views or policies of the U.S. Enviornmental Protection Agency.

[25] In Shana's example, various salt marsh restoration opportunities in the Elizabeth River estuary, USA, were compared according to two different objectives: a habitat suitability index for the clapper rail and a functional scoring method. Under these two approaches, the resulting site rankings appeared to be nearly identical but under other circumstances ordering can vary.

[26] This statement is not intended to be limiting; MCDA can also be used for narrowly focused decisions. In a more sophisticated graphic MCDA would be shown as spanning the entire axis in Figure 1.

made for a relatively informal decision setting. Few rules govern index construction, and the spatial aspect of the indices is capable of evoking a variety of geographically embedded meanings, thus producing deeper insights concerning the decision at hand. Yet because of its informality and reliance on graphics, the method could be used manipulatively. MCDA entails some procedural and theoretical formalism yet puts minimal constraint on stakeholder conceptions of value. BCA and CE/ICA are both intended to be formal and objectively verifiable. When doing BCA, practical decisions about what ecological benefits to try to include do introduce an element of informality, but whatever benefits are included must be treated rigorously. This level of formality is required in many governmental decision contexts.[27]

Finally let's consider the nature of involvement that is sought (Figure 3): Are we seeking to engage the decision-makers or merely inform them? MCDA directly engages groups in the valuation process, and this is aided by its relative transparency. As for EBIs, unless a front-end process can be specified that involves decision-makers in indicator design (such as a process to establish value hierarchies), this method, albeit relatively accessible, it is not directly engaging. BCA may engage *individuals,* by surveying them (except, of course, when benefits are transferred), but it mainly informs, using methods that, as Jim has argued, most decision-makers cannot understand very well. While CE/ICA is strictly an analytic method, it has the advantage of being relatively intuitive.

In conclusion, I have shown that different dimensions of decision context spread these methods out differently. Therefore, any arguments about what is "the best way to go" regarding BCA or alternatives must start by specifying the context in which a given approach is appropriate.

**Reference List**

Gregory, R. and R. L. Keeney. 1994. Creating policy alternatives using stakeholder values. Manage. Sci. 40(8):1035-1048.

McDaniels, T.L. 2000. Creating and using objectives for ecological risk assessment and management. Environ. Sci. Policy. 3:299-304.

USEPA. 2000. Guidelines for preparing economic analyses. EPA/240/R-00/003. Prepared by the National Center for Environmental Economics, Washington, D.C. Available at http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html.

USEPA. 2001. Planning for ecological risk assessment: developing management objectives. External Review Draft. EPA/630/R-01/001A. Risk Assessment Forum, Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C.

[27] As evidence of this formality, Shana's presentation cites U.S. Army Corps of Engineers manuals defining the CE/ICA approach, and U.S. EPA (2000) has published guidelines for economic analyses including BCA.

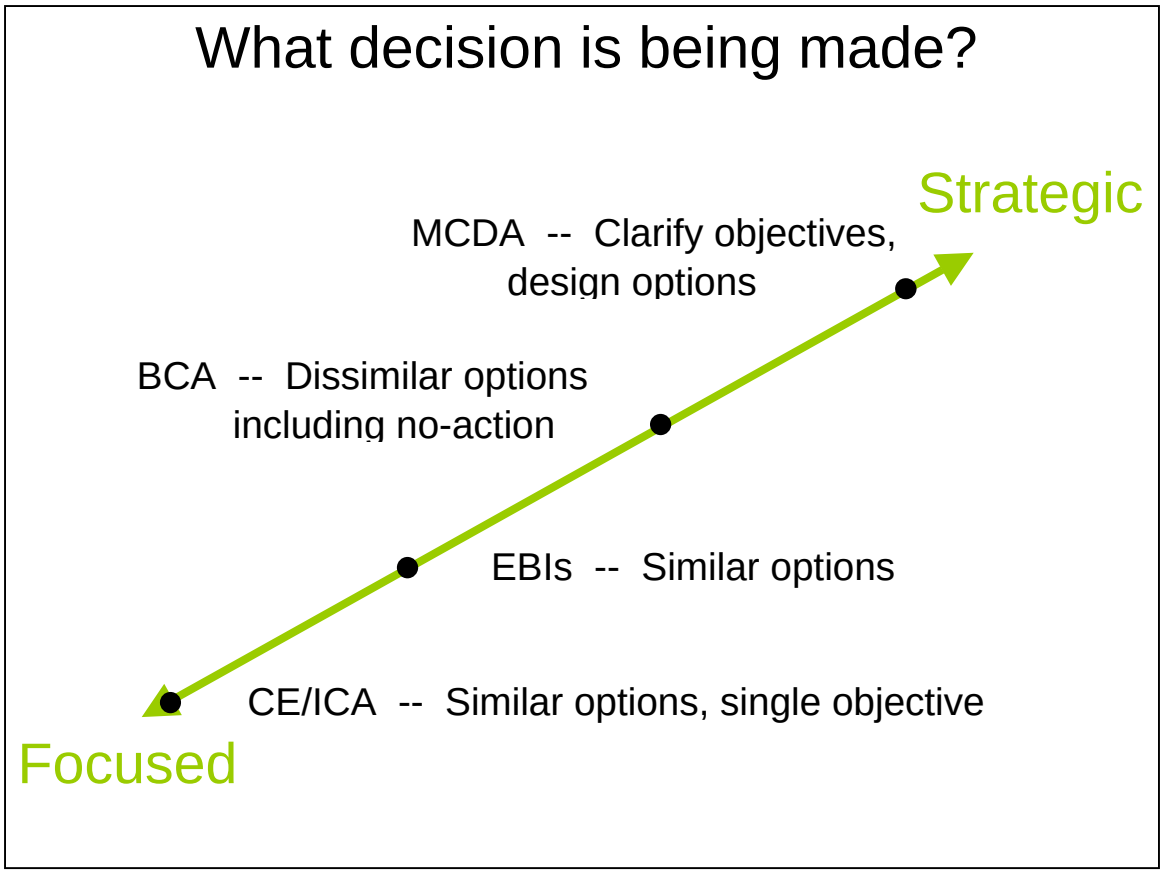

What decision is being made?
Strategic
MCDA -- Clarify objectives, design options
BCA -- Dissimilar options including no-action
EBIs -- Similar options
CE/ICA -- Similar options, single objective
Focused

**Figure 1**

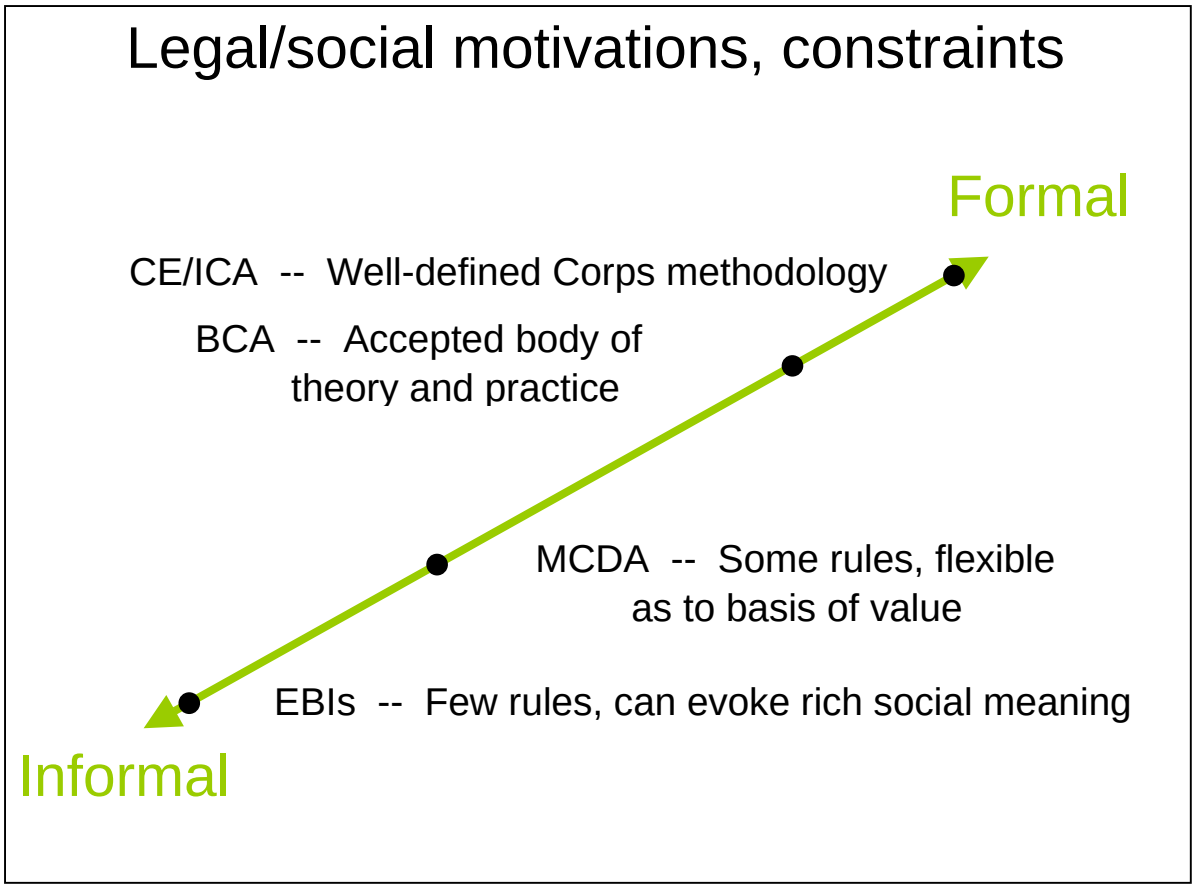

Legal/social motivations, constraints
Formal
CE/ICA -- Well-defined Corps methodology
BCA -- Accepted body of theory and practice
MCDA -- Some rules, flexible as to basis of value
EBIs -- Few rules, can evoke rich social meaning
Informal

**Figure 2**

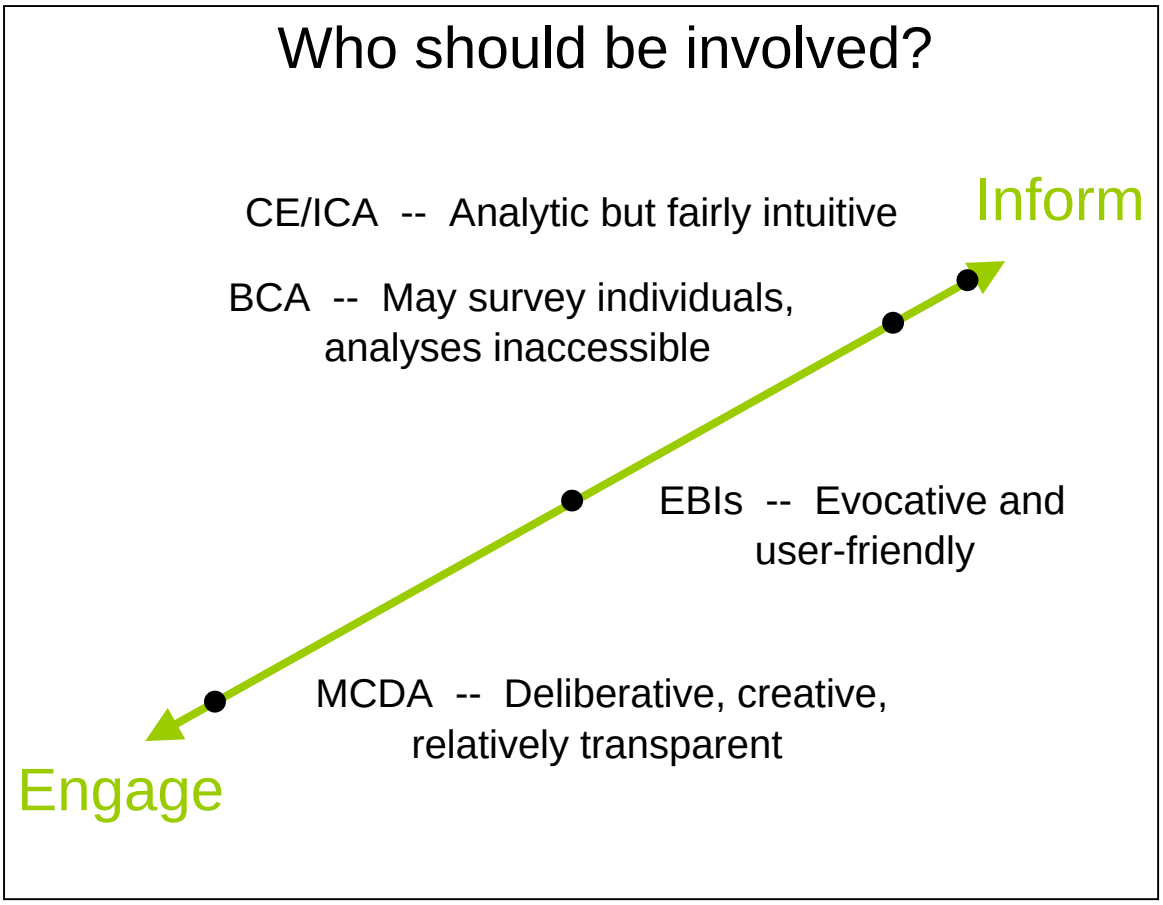

Who should be involved?
CE/ICA -- Analytic but fairly intuitive
Inform
BCA -- May survey individuals, analyses inaccessible
EBIs -- Evocative and user-friendly
MCDA -- Deliberative, creative, relatively transparent
Engage

**Figure 3**

# Question and Answer Session

## For *Session 5: Alternative Approaches*

*This section presents a transcription of the Q&A session for the following presentations from Session 6:*

*James Boyd, Resources for the Future, USA*. What's Nature Worth? Using Indicators to Open the Black Box of Environmental Valuation.

*Tom Seager, Purdue University, USA*. Introducing Environmental Multi-Criteria Decision Analysis.

*Shana Heisey, U.S. Army Corps of Engineers, USA*. Cost Effectiveness and Incremental Cost Analysis.

*Responses to questions are coded as follows:*

*JB: James Boyd, Resources for the Future, USA*
*TS: Tom Seager, Purdue University, USA*
*SH: Shana Heisey, U.S. Army Corps of Engineers, USA*

Q: [*Robert Johnston*] Question for Jim. I kind of took two messages, or a number of messages, out of your talk. And I'm trying to figure out how to reconcile them in my own mind. And the one message I got from the beginning was that in terms of presenting our results to policy makers, that economic complexity is bad. Because people don't understand it—what is this consumer surplus stuff, anyway?—so we want to kind of keep it simple, stupid, in a sense. On the other hand, it also sounded like you were saying that ecological complexity is a great thing. More ecological complexity is great, it helps people make good decisions. And I'm looking at those two statements, and I'm thinking, well, to a certain extent complicated is complicated. So how do you justify that, that economic complexity is bad but ecological complexity is good?

JB: I would definitely want to try to preserve economic complexity in the sense of getting across -- we call it our basic principles, like those determinants of willingness to pay, scarcity, substitution and all that kind of thing. Now I call that, that is sort of simple, but I think in the context of public decision making, even getting across concepts like that, we shouldn't think of that as really that simple. And then on the ecological side, I think you're detecting, I may be overcompensating a little bit -- I do think the economic analysis that I see tends to overreduce the ecology, and I'm just pushing it a little bit further that way. But it's a good point, and I've had people, when I actually start displaying all this stuff, say, "You think that's easier?" It isn't always easier to understand. But I take your point. I just think that certainly it's about -- first of all, I'd like ecologists to be dealing more with our principles and I'd like us to be doing a little bit more with theirs. And that's really the message I want to get across.

Q: This is maybe more of a comment than a question. There is one ecologist here, maybe more than one, but I'm an ecologist. And I was really intrigued when you said that if I heard you right you were saying that managers or decision makers could deal with ecological complexity reasonably well, because that hasn't been my experience. They glaze over with complicated eco stuff as easily as they do with complicated economic stuff. And it might be that the phenomenon you encountered is that ecologists are

used to the connectedness of it all, and there's a lot of connectedness of it all in economics as well, and maybe that's part of what you were detecting there.

Q: Yeah, I also want to make a comment on this point, and I think this is consistent with what Jim was saying. And that is that in a lot of cost-benefit analyses you're starting from two poles. The goal is to bring them both closer together. So it's not that we want a hugely complicated ecological model that will be equally confusing and perhaps equally obscure the effects for policy makers, but right now, for example, in water quality, what we often have is the basis for the research, is that a single unidimensional model, a water quality ladder that essentially goes from poor to medium to good water, and maybe policy makers can handle a little bit more multidimensional complexity than that in trying to really understand what the benefits of a particular policy might be.

JB: Just to be clear, I'm starting from -- to look at the use of HEP units and the HSI kind of stuff, that to me is good example of where the ecology could be a little more complex, I think, certainly in theoretical and empirical ecology has moved well beyond those kinds of measures. And I think that economists can handle it and OMB can probably handle it. But it's striking that balance.

Q: Mine's also more of a comment, probably more appropriate to Dennis's session. But I'd like to challenge particularly the academic folks that are here with the fact that everyone's just assumed that primary studies are better. And believe me, I've worked for a federal agency looking at decision making, and believe me, I have seen some pitiful primary studies, because people said, "We have to do it. We have to do something specific to this place." I would challenge you -- that's not an appropriate assumption that, just because it's a primary study, it's better. Something that has been around and vetted and people understand maybe better. So as a follow up to what Jim said on methodology, the same kind of point. New, certainly, not better. We've seen this with drugs. Just because it's new doesn't mean it's a better approach, and for decision making it may be, again, something that people are familiar with and has been vetted, the least like Jim said, maybe the known evil may be better than something where the unknown effects are there.

Q: One quick comment. I was hoping somebody would address the question that Tom had asked: where do economics fit in? I was sitting here all the time thinking this is all economics to me, and I know Igor, he left already, he and I had this argument, a long time thing, where he thinks multi-criteria decision analysis is not economics; I think it's a subset of economics. Maybe it's just something that economists have done before and so have engineers, and I was wondering if anybody would address the question.

# 8. Debating the Basis for Benefits Transfer (Session 6)

## Section Contents



Note: Session 6 also included a presentation by Jim Laity (Office of Management and Budget, USA), titled, "Use of Benefits Transfer in Regulatory Analyses." At the request of the presenter, the presentation is not included in this proceedings document.

# "Benefits Transfer: Time for a Peer-Reviewed Valuation Journal."

**John Hoehn**

***Department of Agricultural Economics***
***Michigan State University***
***East Lansing, MI 44824***
***USA***

**Presented during Session 6.**

## Introduction

Benefit transfer uses existing primary benefit studies to make an inference about the benefits of a policy proposal for which there is no primary benefit study. In so doing, benefit transfer is analogous to a conventional sampling problem where one makes an inference about a population parameter by means of a sample. With benefits transfer, the sample is usually composed of the mean value estimates from a set of existing benefit studies. The validity of sample and inference depend on the extent to which there is a definable population that encompasses both the means in the sample and the benefits of the policy proposal. For instance, a transfer may use risk reduction benefits estimated in hedonic studies of industrial wages. The validity of the transfer depends on whether the policy proposal would impact a population similar to those earning industrial wages. If the policy proposal affects industrial workers, the transfer seems valid. However, if the policy affects risks to adults in leisure activities or hazards to children, the relevance of the transfer is doubtful.

Viewing benefits transfer as a sampling problem sheds light on both its limits and its potential. Benefit transfers are useful and informative when four criteria are met. First, there needs to be an adequate number of primary benefit studies with estimates that address the same population parameters as those needed to evaluate the policy proposal. Second, studies that are not relevant to the defined population parameters are identified and filtered out of the sample before conducting the transfer. Third, the relevant independent variables are known and available to adjust the value estimates across differences in demographic and economic factors. Fourth, the estimates are computed using valid econometric models and error structures.

In this paper, I briefly illustrate how the criteria influence benefit transfer choices and outcomes. My conclusion is that the first criterion is the most limiting factor; relevant benefit transfers require a database of reasonably up-to-date primary studies. Moreover, existing incentives to researchers, particularly academic researchers, are insufficient to replenish the database of primary studies as older studies become outdated and new policies focus on different environmental goods and services. One way to alter these incentives is to create a peer-reviewed journal dedicated to the rigorous reporting of benefit estimation studies. I address this latter point in the concluding section.

## Sample Errors and Biases in Benefit Transfer

The potential for benefit transfer varies across different areas of environmental policy. The potential seems highest for single attribute goods such as generic recreation activities, occupational safety, and airport noise. With these types of goods, there are large numbers of studies from which to draw a sample. Rosenberger and Loomis (2000), for example, draw on 701 primary benefit estimates to estimate user day values for generic recreation activities. In addition, the theoretical models for valuing generic recreation sites and single attribute goods are reasonably well understood. With recreation activities, there is a rigorous theory of user day values that characterizes when such values are stable and when they are likely to diverge from an underlying theory standard (Morey, 1994). Single attribute goods such as occupational safety and airport noise also have standard valuation models, though implementation of these models varies in the independent variables used to control for the influence of other factors (Viscusi and Adly, 2003; Nelson, 2004).

Benefit transfer is more uncertain as one moves to areas of environmental policy where there are fewer primary benefit studies and where there is less agreement about the underlying theory of valuation and measurement. For instance, user day values do not have a stable structure when quality varies (Morey,

1994), so user day values may not be stable when analyzing the sensitivity of fishing day values to changes in water quality across fishing sites. Also, in considering benefit transfer for multidimensional goods such as groundwater and ecosystems, it is difficult to specify a generally acceptable form for the benefit transfer equation. The independent variables for such transfer equations are not well understood and the protocols for measuring the quantities and qualities for such goods are not well established (Ruijgrok, 2001). After an extensive review of these and other difficulties, Gregory Poe, Kevin Boyle, and John Bergstrom (2002) conclude that the "amalgamation of a number of studies and theoretical constructs may lead to misleading magnitudes of [the value] coefficients" (p. 159) in transferring of groundwater values.

A recent meta-analysis by Woodward and Wui (2001) illustrates the difficulties in transferring benefits for multidimensional goods and ecosystems. The compiled data set used in the meta-analysis was composed of 65 observations of mean values for wetland ecosystems estimated in 39 different primary studies. Other than the size of a wetland, there was no consistency in the way the primary benefit studies measured wetland quantities and qualities, so the researchers used categorical 0-1 dummy variables to indicate the presence or absence of wetland attributes such as openness to hunting, openness to bird watching, and the presence of other special amenities. The primary benefit studies used different valuation principles and models, so the benefit estimates were a mixed assortment of hedonic values, consumer surpluses, travel costs values, contingent willingness to pay values, and producer surplus. The researchers included additional dummy variables in the meta equation to describe the type of benefit concept used in each of the primary benefit studies. The wide theoretical differences in dependent variables and uncertainly about the relevance of the independent variables appear to have contributed to mixed statistical results for the meta equation. The overall equation had a high degree of unexplained variation, with the R2 ranging from .37 to .58, and only 4 of 14 quantity and quality coefficients were statistically different from zero.

If used in terms of benefit transfer, it would be difficult to identify the population for which the Woodward and Wui meta equation could be interpreted as a benefit transfer equation. The meta-analysis sample included 14 observations for Louisiana, 8 observations for Massachusetts, 4 observations for Florida, and 7 observations from outside the United States, with the remainder of observations coming from a mix of states. The uneven geography of the sample raises a question of sample selection bias: what geographical population would the meta-analysis represent if used for benefit transfer? Regressions using alternative sub-samples from the Woodward and Wui data show that transferable benefits are sensitive to how one answers the population definition and sampling question. For instance, depending on whether the non-US data are included in the sample, transfer values for wetlands attributes such as bird hunting, bird watching, and commercial fishing impacts differ by as much as 43 percent. Hence, the definitions of the population and selection of the sample have an economically significant impact on the size of transfer values. An ill-defined sample leads to misleading benefit transfers.

The primary barrier to selecting a sample relevant to a specific benefit transfer is the relative scarcity of primary benefit studies relevant to current environmental policies. The number of primary benefit studies does not seem to be growing at a rate comparable to the demand for benefit transfers by policy analysts. More primary benefit studies are needed (Boyle, Bergstrom, and Poe, 2002). At the first benefit transfer workshop in 1992, David Brookshire admonished attendees to be concerned about the limited number of primary studies suitable for benefit transfer. Brookshire was concerned that the relative scarcity of primary studies was likely to deteriorate, since this "...paucity stems from the existing incentive

structure...[where] replication in economics and the publication of data are not viewed as worthwhile" (p. 8, 1992). Ten years later, V. Kerry Smith and Subhrendu Pattanayak repeated the same warning, saying "replication rarely finds a home in refereed journals...Updating results may have...policy value but usually will not be considered important enough to occupy scarce journal space" (p. 273, 2002).

**A Peer-Reviewed Benefits Assessment Journal**

Benefits transfer requires a representative body of primary valuation studies, but publication incentives in economic journals steer researchers toward the new and unique methodological contribution, not the publication of solid empirical estimates based on fully reported standard methods (Smith and Pattanayak, 2002). These incentives not only reduce the publication of empirical work based on standard procedures, but also bias the types of empirical estimates available through methodologically oriented journals (Rosenberger, 2005). The incentive structure is likely to change only when economists and agencies begin to take benefit estimation seriously. Since peer-reviewed publication is critical in establishing the value of research products, improved incentives for benefit estimation amount to improving the opportunities for peer-reviewed publication of benefits assessment research.

There appear to be three ways to increase the opportunities for peer-reviewed publication of primary benefit estimation studies. The first is to create a new peer-reviewed journal aimed exclusively at publishing primary benefit studies. Indeed, given the size of the non-market valuation literature and the number of economists working in the field, the time seems long overdue for a benefits assessment journal focused on the reporting and comparison of benefit estimates. An important step in developing the journal editorial policy would be to identify and publicize clear criteria and protocols for reporting primary benefit assessment studies. Of course, starting a new journal takes a substantial commitment of time and resources on the part of those involved. It certainly requires a small group of dedicated economists to develop and implement the editorial. It is also likely to require at least the initial support of interested governmental agencies and firms that conduct economic analysis of environmental policy.

A second approach is to negotiate special sections dedicated to reporting primary benefit estimation studies in existing journals. Journals such as Ecological Economics already use different editorial standards for different types of articles such as news and views, commentary, literature surveys, methodological contributions, and analysis. It may be possible to work with an editor and editorial board to define unique protocols appropriate for evaluating the contribution of primary benefit studies and replications using standard methods. In other cases, journals may find it appropriate to publish primary benefit studies as notes, rather than as standard articles, but publication as notes reduces incentives for publication.

A third alternative is to publish primary benefit studies as an occasional special edition of a journal or as an edited book. With respect to incentives, two features seem important. First, it is important that such publications be peer-reviewed. Peer-reviewed publications are weighted more strongly in review and promotion procedures than non-peer-reviewed publications, so they offer a greater incentive to potential authors. Second, the special journal or book edition should be published on a recurring, predictable schedule so that authors can anticipate the availability of the publication outlet. Given the amount of activity in benefits assessment research, an annual edition seems appropriate.

Overall, monetized benefits are an essential part of environmental decision-making. Net benefits should not be the sole input into decisions, but should be factored into decisions as essential decision-making

information. Such decisions do not always warrant the costs of new primary benefit studies, and even new primary benefit studies are important to place within the context of existing knowledge. Benefit transfer is a means of fulfilling both these functions--obtaining benefit estimates for routine policy analysis and determining how new primary benefit studies compare against the existing foundation of primary benefit studies. The unfortunate conclusion, however, is that the prospects for benefit transfer are less than certain due to the inadequate number and variety of primary benefit studies. Without increased incentives for the reporting and publishing of high quality empirical work, benefit transfer will be an uncertain and potentially misleading enterprise.

**References**

*Economic Value of Water Quality*, edited by J. C. Bergstrom, K. J. Boyle and G. L. Poe. Cheltenham, UK: Edward Elgar.

Brookshire, David S. 1992. Issues Regarding Benefits Transfer. Paper read at 1992 Association of Environmental and Resource Economists Workshop: Benefits Transfer: Procedures, Problems, and Research Needs, April, at Snowbird, Utah.

Morey, Edward R. 1994. What Is Consumer's Surplus Per Day of Use? When Is It a Constant Independent of the Number of Days of Use? and What Does It Tell Us About Consumer's Surplus? *Journal of Environmental Economics and Management* 26 (3):257-270.

Nelson, Jon P. 2004. Meta-Analysis of Airport Noise and Hedonic Property Values. *Journal of Transport Economics and Policy* 38 (1):1-28.

Poe, Gregory L., Kevin J. Boyle, and John C. Bergstrom. 2002. A Preliminary Meta Analysis of Contingent Values for Ground Water Quality Revisited. In *The Economic Value of Water Quality*, edited by J. C. Bergstrom, K. J. Boyle and G. L. Poe. Cheltenham, UK: Edward Elgar.

Rosenberger, Randall S. 2005. Publication Measurement Error in Benefit Transfers. In manuscript presented at the International Workshop on Benefits Transfer and Valuation Databases, Ronald Reagan Building, March 22-23. Washington, DC.

Rosenberger, Randall S., and John B. Loomis. 2000. Using Meta-Analysis for Benefit Transfer: In-Sample Convergent Validity Tests of an Outdoor Recreation Database. *Water Resources Research* 36 (4):1097-1107.

Ruijgrok, E. C. M. 2001. Transferring Economic Values on the Basis of an Ecological Classification of Nature. *Ecological Economics* 39 (3):399-408.

Smith, V. Kerry, and Subhrendu K. Pattanayak. 2002. Is Meta-Analysis a Noah's Ark for Non-market Valuation? In *Environmental and Resource Economics*.

Viscusi, W. Kip, and Joseph E. Aldy. 2003. The Value of a Statistical Life: A Critical Review of Market Estimates throughout the World. In Working Paper 9487, National Bureau of Economic Research. Cambridge, MA.

Woodward, Richard T., and Yong-Suhk Wui. 2001. The Economic Value of Wetland Services: A Meta-Analysis. *Ecological Economics* 37:257-270.

# "Alternatives to Benefit Transfer: Broadening the Concept of Environmental Valuation."

**Clive Spash**

***Professor***
***Geography & Environment Department, University of Aberdeen; and***
***Socio-Economic Research Programme, Macaulay Institute, Aberdeen, AB15 8QH, UK.***
***Tel. (44) 1224 498200; e-mail c.spash@macaulay.ac.uk***

**Presented during Session 6.**

## Introduction

Lack of information on the monetary values associated with environmental improvements has led to calls for monetary benefit transfer. Benefit transfer is a sub-category of value transfer because both costs and benefits can be unknown and therefore regarded as in need of transfer. More generally a lack of information in both economic and natural sciences can lead to demands for information transfer of which value transfer is a sub-category. Thus, information transfer can involve natural science data, say on cause-effect relationships, and economic data, say on damage costs of increased pollution. Value transfer is attractive because it aims to achieve a set of policy objectives, similar to those of cost-benefit analysis, with the addition of a low cost proviso and fast delivery time.

In this paper questions are raised as to the ability of value transfer to meet the claims being made for it. The need to be aware of the uncertainty associated with estimated values is discussed first and this implies being aware of the policy context within which these numbers will need to be defended. Claims made for the advantages of cost-benefit analysis in general and benefit transfer in particular are critically reviewed and caveats stated. This leads to a discussion of potential alternatives which can also address a range of policy concerns and may prove more defensible.

## Validity and Uncertainty

The extent to which value transfer is able to meet its promise depends upon which type is being discussed and the accuracy of estimated values required. Value transfer can be very basic with a direct transfer of a mean unit value from a study site to a policy site, involving strong assumptions of similarity between individuals, units and sites. A more theoretically robust approach is to transfer an entire value function which requires data on the independent variables across sites. However, the latter can be costly, time consuming and have high data requirements which make the choice of a primary study equally attractive. Normally, value transfer will be across space from an original study site to the policy site and also across time because the study site values have been estimated at sometime in the past.

Bergland et al (1995) report errors in spatial transfer of mean WTP was in the order of 20 to 40 percent, while Downing and Ozuno (1996) estimated transferred values could range from 1 to 34 percent. During the workshop, March 2005 in Washington DC, errors in the order of 750% were cited for idealised spatial transfer tests (i.e., normal transfers would be expected to have larger errors not least because they involve both spatial and temporal transfer). In order to know what are typical errors from the standard methods of transfer being applied more studies will be necessary. In order to know the acceptability of the errors a comparison is needed with those typically found in standard cost-benefit studies. Stirling (1997) has shown that external costs associated with energy production vary widely across studies forcing him to use a logarithmic scale to fit the estimates into a single diagram and allowing any ranking of energy sources desired by choice of estimate. For example, externalities (cost per kilowatt hour) from coal power vary by a factor of more than 50,000. If the above figures are typical then benefit transfer may be deemed acceptable, although many may be unaware of the uncertainty surrounding primary valuation studies. Yet different applications will have different levels of acceptable error.

A range of applications have been discussed for value transfer. These include avoiding original studies in cost-benefit or cost effectiveness analysis, transferring figures into firm or national environmental accounts, and specifying compensation for environmental liability cases. Overall results from validity tests show that the uncertainty in value transfers, both spatially and temporally can be considerable. As a result, environmental value transfer has been recommended only where the demand for accuracy is

relatively low (Navrud and Bergland, 2001 p.12). This requires having a sound knowledge of what the values will be used for, the expected level of accuracy and robustness, and their comparability to alternatives which might achieve the same ends.

In all value transfer applications the defensibility of the figures will be the ultimate test. If the stakes are high then the political liability of using uncertain numbers will also be high. One area of application where figures are most hotly contested is compensation payments for environmental damages (for example the high profile Exxon Valdez case Arrow et al., 1993; Hausman, 1993). Here original primary data collection (i.e., contingent valuation) is already highly contentious so that value transfer would seem unlikely to be defensible. The general point is that the context in which values are intended to be used determines their acceptability. Value transfer seems limited to use where rough and ready indications of values are regarded as sufficient.

**The Pros and Cons of Value Transfer**

Indeed once the context of the decision process is analysed more carefully the expected advantages of value transfer can seem exaggerated. The attractiveness of alternatives also depends upon the specific stated objectives which value transfer is meant to deliver. Some typical objectives can be summarised as follows: aggregation, commensurability, ranking alternatives, promoting environmental concerns, reducing costs and saving time. However, each of these supposed advantages has associated caveats.

(i) Single measures of monetary value only arise if there is no attempt at sensitivity analysis, but if comprehensive sensitivity analysis is conducted then the apparent simplicity disappears. Indeed the valuation study can quickly begin to resemble a multiple criteria analysis. However, sensitivity analysis is typically neglected or superficial (Merrifield, 1997).

(ii) Monetary measures are meant to offer a metric for comparison of all entities. Commensurability is seen as the norm by economists but rejected by philosophers and indeed would seem unacceptable to any science allowing pluralism (O'Neill, 1996; Chang, 1997; Martinez-Alier, Munda and O'Neill, 1998). The problem that arises is that many values in society fail to be reducible to a common metric and attempts to do so effectively remove the original value concept, e.g. the value of "existence" as a willingness to pay sum of a third party. There are many values which are purposefully protected from reduction to a money metric, such as life and liberty. Some values, such a friendship, are defined by their being non-traded and therefore non-comparable in such terms.

(iii) Transferred values are meant to help in ranking alternative options but because economists regularly accept that their figures are only one input into a decision process they cannot do so in any meaningful sense. If there are many inputs then there are many criteria and the actual decision is being made on the basis of multiple criteria analysis.

(iv) Benefit transfer provides value to the environment where it would otherwise have none. The problem here is that the environment has many values being expressed in many different ways. If the institutions of government are only able to measure environmental values in a narrow way then they are seriously flawed. People can be shown empirically to hold a variety of reasons for valuing the environment and wanting to see it protected. The danger is that promoting the environment as a valuable commodity removes a range of reasons why it is valued which have little to do with markets and commodities.

(v) The above points all apply to cost-benefit analysis but the distinguishing feature of value transfer is meant to be a low cost and fast delivery. This may be the case for basic unit transfer but falls down once function transfer is adopted. In addition the argument assumes existing data which is

relevant and robust for both unit or function transfer. If numbers fail to be robust they will be challenge (perhaps legally) leading to further costs. The argument also ignores the fact that policy processes go beyond a single decision so that while single decision savings may occur these can lead to cumulative costs exceeding alternatives and/or poor decisions due to limited overall vision ("piecemeal policy" or policy by default).

**Alternative Means of Making Choices**

There are three broad groupings of approaches to aiding decision processes which can either complement or replace value transfer depending upon circumstances. First are measures of motives underlying human behaviour which have developed quantitative scales for analysis and prediction. Second are multiple criteria analyses which place economic analyses in the context of other decision variables. Third are the range of approaches aiming to involve stakeholders and/or the general public in deliberative participatory events.

Environmental valuation, and particularly contingent valuation, has raised a series of concerns over what motivates individuals to state an intention to pay for an environmental improvement. There is now far greater acceptance by economists that psychological motives are important and preferences are often constructed in response to research aiming to discover how people value the environment. However, due to the standard economic acceptance of preferences at face value the motives behind preferences have tended to be weakly analysed. In contrast motivational measures have been a central aspect of behavioural research in social psychology. These provide quantitative scales of public opinion relating to a specified behaviour and the basis for agreement or disagreement with a behaviour. Models in social psychology separate general and specific attitudes, social norms, and behavioural action measures, e.g., perceived behavioural control (Fishbein and Ajzen, 1975; Ajzen, 1991). A more neglected aspect is that of ethical norms which can also be categorisation for use in analysing behaviour. Such categorisation has also been applied to understanding intended willingness to pay (Spash, 2000; Spash, 2000). The overall result is to broaden the model of environmental valuation well beyond that normally considered in economics as shown in Figure 1. Investigating such models leads to an acceptance that individuals hold multiple values when considering environmental entities and quality change (Spash, 2000).

If multiple values are accepted there is a short step to desiring the use of methods which can explicitly take them into account. Multiple criteria analysis covers the range of methods developed to do just that. As mentioned earlier, this is also the logical outcome of good sensitivity analysis. Different multiple criteria analyses can vary in their weighting, summing and aggregating approaches and their theoretical basis (for a review see De Montis et al., 2004). Mapping out value differences and explaining reasons for conflicts between stakeholders is also possible using multiple criteria approaches (Munda, 1995; Stirling and Mayer, 2001). Multiple criteria approaches can be compatible with monetary valuation or value transfer as these can be criteria in the decision matrices. The attraction of such approaches is that they directly try to address the elements which economists' typically mention but never specify when referring to "other factors" as being important in decision processes.

The use of open multiple criteria analyses which address conflicts has also led to such methods being combined with participatory approaches. Stakeholder or vested interest groups can be brought together in different formats and results analysed to understand why conflicts arise and to aid consensus seeking. Methods such as mediated modelling, scenario analysis, and social multi-criteria evaluation have all been used in this way (see the European Community research project ADVISOR

http://gasa3.dcea.fct.unl.pt/ecoman/advisor/). Interest in participatory approaches is widespread in Europe and has also been discussed as a means for addressing flaws in contingent valuation through "deliberative monetary valuation" (Spash, 2001). However, this has raised concerns over the differences between political science and economic approaches (Niemeyer and Spash, 2001).

In the environmental policy arena, and elsewhere, there has been a push for greater public participation e.g. in Europe the Aarhus Convention (European Commission, 1998) and the inclusion of non-governmental stakeholders in project appraisal. Focus groups, citizens juries and consensus conferences are all used to aid decision processes. Of course they also have their own problems such as what attendees represent (O'Neill, 2001).

**Conclusions**

The use of value transfer needs to be more carefully considered in terms of both what is desired by decision processes and what alternatives can offer. The basic approach results in values with large margins of error but primary studies also have very large standard deviations. Both value transfer and primary studies also have a serious range of caveats which must be taken into account rather than accepting the assumed advantages of methods at face value. There are now a serious range of alternatives available for assessing environmental values, concerns and conflicts. This is not to deny that these also have their own problems but rather to note the need for serious consideration as to the best method for any given issue, policy context or problem.

Currently different disciplines tend to be excessively defensive concerning their own approaches rather than be open to alternatives. For example consider designing policy instruments for nitrate non-point pollution control in water bodies. Nitrates can be modelled in water systems and their impacts predicted and farms are one known source of nitrates. Assume a proposed policy instrument has known application costs. The problem is that no cause-effect relationship exists between a farmers production system and the impacts of nitrates in the water body. Policy makers then have a range of alternatives which include: (i) assuming an arbitrary cause-effect model and transferring uncertain benefits of nitrate reduction to attempt estimating an economically efficient nitrate level; (ii) assuming an arbitrary farm nitrate reduction and researching the impacts of different instruments on different farmers behaviour to attempt an effective policy design; (iii) explicitly addressing uncertainties in the system using mediated modelling or multi-criteria mapping to achieve stakeholder acceptance of the problem and agreed management strategies.

Environmental values as estimated by monetary valuation are one specific class of values and they need to be seen as such. Economists do often recognise this in passing but rarely make attempts to be more explicit. Clearly valuation is an interdisciplinary exercise linking natural science with social science, and as such a full range of perspectives on human behaviour is required including social psychology, political science, sociology, and applied philosophy. Improved understanding of environmental values is needed along with institutions which are capable of expressing and protecting those values.

**References**

Ajzen, I. (1991) The theory of planned behaviour. *Organisational Behaviour and Human Decision Processes* 50: 179-211.

Arrow, K., et al. (1993) Report of the NOAA Panel on Contingent Valuation. Washington, Resources for the Future. 38.

Bergland, O., K. Magnussen and S. Navrud (1995) Benefit Transfer: Testing for Accuracy and Reliability. As, Norway, Department of Economics, Agricultural University of Norway.

Chang, R., Ed. (1997) *Incommensurability, Incomparability and Practical Reason*. Harvard: Harvard University Press.

De Montis, A., P. De Toro, B. Droste, I. Omann and S. Stagl (2004) Assessing the quality of different MCDA methods. *Alternatives for Environmental Valuation*. M. Getzner, C. L. Spash and S. Stagl. London: Routledge.

Downing, M. and T. Ozuna (1996) Testing reliability of the benefit transfer approach. *Journal of Environmental Economics and Management* 30(3): 316-322.

European Commission (1998) Aarhus Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters. Brussels.

Fishbein, M. and I. Ajzen (1975) *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*. Reading, Massachusetts: Addison-Wesley.

Hausman, J. A., Ed. (1993) *Contingent Valuation: A Critical Assessment*. Amsterdam: North-Holland.

Martinez-Alier, J., G. Munda and J. O'Neill (1998) Weak comparability of values as a foundation for ecological economics. *Ecological Economics* 26(3): 277-286.

Merrifield, J. (1997) Sensitivity analysis in benefit-cost analysis: A key to increased use and acceptance. *Contemporary Economic Policy* XV(July): 82-92.

Munda, G. (1995) Multicriteria evaluation in a fuzzy environment. *Theory and applications in ecological economics*. Heidelberg.: Physica-Verlag.

Navrud, S. and O. Bergland (2001) Value Transfer and Environmental Policy. *Environmental Valuation in Europe*. C. L. Spash and C. C. Carter. Cambridge: Cambridge Research for the Environment. 8: 18.

Niemeyer, S. and C. L. Spash (2001) Environmental valuation, public deliberation, and their pragmatic synthesis: A critical appraisal. *Environment and Planning C* 9(4): forthcoming.

O'Neill, J. (1996) Value, Pluralism, Incommensurability and Institutions. *Environmental Economics: A Critique of Orthodox Policy*. J. Foster. London: Routledge.

O'Neill, J. (2001) Representation. *Government and Policy* 9(4).

Spash, C. L. (2000) Ecosystems, contingent valuation and ethics: The case of wetlands re-creation. *Ecological Economics* 34(2): 195-215.

Spash, C. L. (2000) Ethical motives and charitable contributions in contingent valuation: Empirical evidence from social psychology and economics. *Environmental Values* 9(4): 453-479.

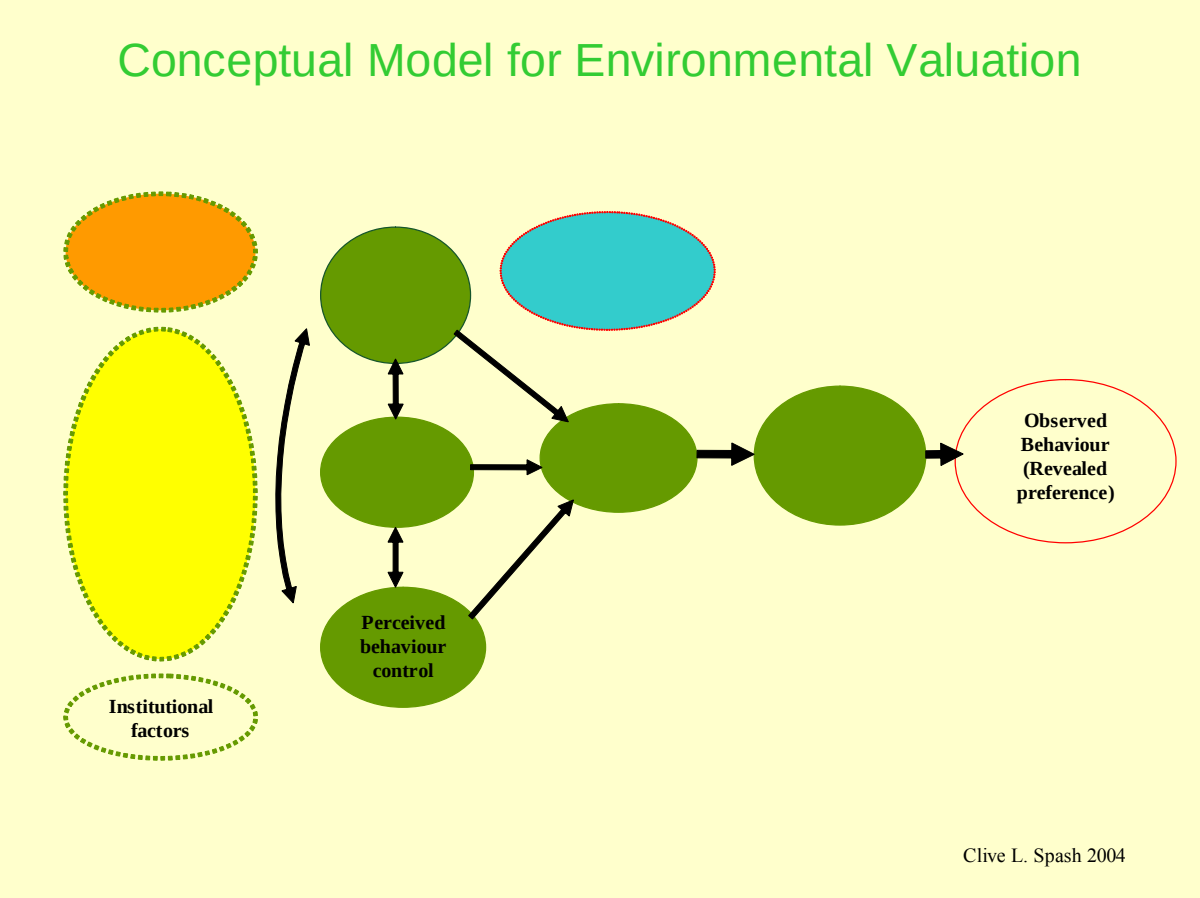
Spash, C. L. (2000) Multiple value expression in contingent valuation: Economics and ethics. *Environmental Science & Technology* 34(8): 1433-1438.

Spash, C. L. (2001) Deliberative Monetary Valuation. 5th Nordic Environmental Research Conference, University of Aarhus, Denmark.

Stirling, A. (1997) Limits to the value of external costs. *Energy Policy* 25(5): 517-540.

Stirling, A. and S. Mayer (2001) A novel approach to the appraisal of technological risk: a multi-criteria mapping study of a genetically modified crop. *Environment & Planning C: Government & Policy* 19(4): 529-555.

**Table 1: Conceptual Model for Environmental Valuation**



# Discussant Comments on Session 6

**Dennis King**

***University of Maryland***
***USA***

**Comments on "Use of Benefits Transfer in Regulatory Analysis" (Jim Laity, OMB)**

1) "*Benefit quantification needs to illuminate, not obscure*."
   Q: Does this always require absolute monetized benefit estimates?
   A: Sometimes NO…but where the answer is YES, we need:
      1) Somebody's estimate of absolute monetized values, typically average values; and
      2) A BT framework for determining by how much target values are above and below average.

2) "*BT is use of valuation information from one set of goods, services, or amenities to estimate value of another set of goods, services, or amenities.*"
   Q: Isn't it sometimes easier and more useful to compare assets (e.g., wetlands) based on their capacities to provide goods, services, or amenities?
   A: I'd say yes. We can sometimes dispense with valuing services altogether.

3) "*Consider market value of Rolex versus Timex, and Omnimedia stock in 2002 versus 2004.*"
   Q: Is there a difference between measuring the dollar value of a product and estimating the dollar value of an asset?
   A: Yes, maybe we need a environmental asset "Value-line" or "Morningstar."

***Comments on "Benefits Transfer: Time for a Peer-Reviewed, Dedicated Journal" (John Hoehn, Michigan State University)***

Q: "*Are monetized benefits essential to good decision-making*?"
A: My view, a reluctant yes…but we need to pounce hard on ecovaluation jokers.

Q: "*What is the appropriate domain of BT*?"
A: Clearly we need "preference-based" (WTP & WTA) oriented BT, but we also need BT based on production function/asset valuation concepts.

Q: "*What were results of meta-analysis…of wetland values?*"
A: My view? Preference-based surveys should be limited to services. I care about how a short-order cook in NJ ranks wetland services…but I don't care what this guy thinks about the types, locations, or attributes of wetlands.

***Comments on "Alternatives to Benefit Transfer: Broadening the Concept of Valuation" (Clive Spash, University of Aberdeen, Scotland)***

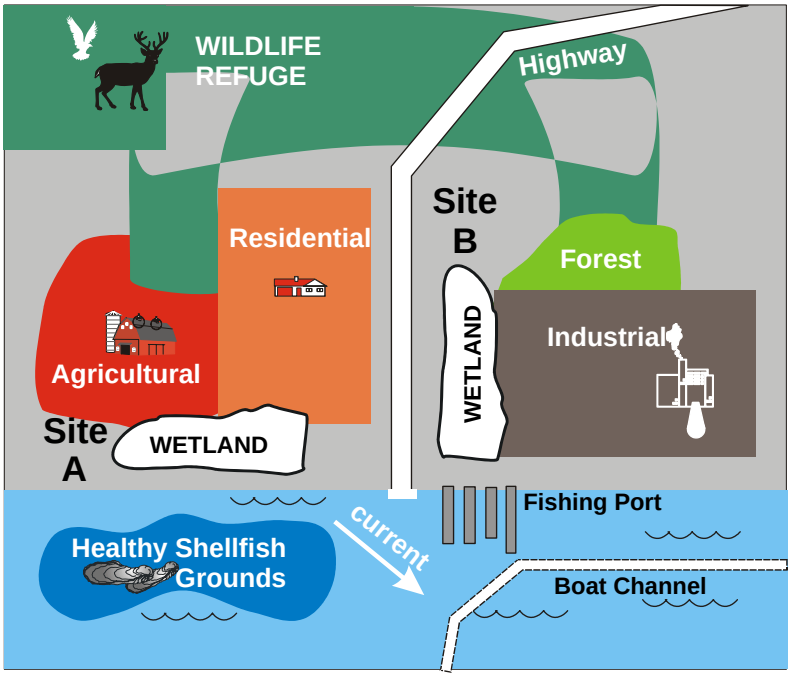
Clive's basic points:

1) *If BT is done by economists and is done poorly, it focuses on a narrow concept of "value" that is unacceptable to non-economists.*

2) *If BT is done by economists (or anyone else) and is done well, it should include "sensitivity analysis"—which makes BT start to look like "multicriteria analysis." This is good…but makes everything much more complicated than typical economic analysis can handle!*

My basic comments:

- I agree…but this isn't typical economic analysis.
- Characterizing the site and landscape conditions that generate environmental services and people's preferences for them is a valid way to prioritize, trade, and assign relative values to many environmental assets.
- If someone has credible absolute $$$ benefit estimates to allocate using relative value indicators or some other BT method …BRING EM ON!



# Question and Answer Session

## For *Session 6: Debating the Basis for Benefits Transfer*

*This section presents a transcription of the Q&A session for the following presentations from Session 6:*

*Jim Laity, Office of Management and Budget, USA.* Use of Benefits Transfer in Regulatory Analyses.

*John Hoehn, Michigan State University, USA.* Benefits Transfer: Time for a Peer-Reviewed Valuation Journal.

*Clive Spash, Macaulay Institute and University of Aberdeen, Scotland, UK.* Alternatives to Benefit Transfer: Broadening the Concept of Valuation.

*Responses to questions are coded as follows:*

*JL: Jim Laity, Office of Management and Budget, USA*
*JH: John Hoehn, Michigan State University, USA*
*CS: Clive Spash, Macaulay Institute and University of Aberdeen, Scotland, UK*

JL: I have two quick comments. First one is I said at the beginning of my talk that I had learned a lot in the last two days and I wanted to say that one of the most important things I'd learned about was simply the existence and the usefulness of EVRI, which I have not been a user of and had not really been aware of up until now. And I found the presentation by Van Lantz particularly informative and enlightening, but I'll simply note that the final average number of stars that each database got at the end, the sort of bottom line of that presentation, was completely useless in terms of actually knowing anything at all about those databases. Because the details of the multi-criteria analysis in which he went through and ranked each of them on a bunch of different things was tremendously helpful to me, and I will probably be using EVRI a lot in the future. Particularly to deal with an issue which I didn't mention but which is important in a government context, which I'll call study selection bias, which is that people doing cost benefit analyses, whether they're stakeholders or government agencies, have a stake in the outcome, and it's impossible for them to be objective in the choice of studies that they use in a benefits transfer [inaudible] of my experience. And having a quick and easy source to go and check whether there are other estimates of particular key parameters that might be different is going to be very helpful to me. The other thing is, I would just like to also warmly endorse the suggestion of having a journal dedicated to good benefits transfer research. It's real discouraging to hear as a practitioner that in the established journals, you can't really get published unless you have a methodological innovation because in government we don't like methodological innovations. That means we have to learn something new and we have to argue with the other agency about whether it's legitimate and all that other kind of stuff. And we prefer to use the methodologies that we've already established and agreed on. And so, seeing more studies that use well-established and agreed-on methodologies would be very helpful to us.

CS: I think there may be a few points about what Jim was saying. I think it supports things I was saying. I think it's interesting, the justification that is required for a single metric. It seems that there's really more than just CVA, as I understand it, especially when you're talking about not using BT as a bottom line, so that there are alternatives. But I'd be interested, especially given your last comment, as to

how you think that the quantification without monetization should occur, what sort of [corrected?] descriptions of benefits you would like to see, and how those different approaches could be used in that to help you. I would be quite interested to know. I thought it was also interesting that the decision makers, as you said, ignore the caveats when single values are presented, and I think that's a pretty common thing that we've seen in the press and elsewhere. That people pick up on single numbers regardless of how bad they are. And the value of the world's key systems might spring to mind. In terms of John's talk, where you started off it was quite interesting that you actually said money benefits assessment is essential, and then you said it was necessary, and illustrated its part of the analysis. I think those are important distinctions. Is it essential, is it necessary, or is it part of the analysis? They are different things, and I think there are very quite important distinctions made that have implications for what we're doing. I was interested also in the fact that you mentioned that the studies are getting too old, and you described studies from the 1980s. And you qualified that by saying preferences are changing. Well, preferences will also be changing, which means the studies will always be going out of date, and we'll always be doing primary studies to catch up, which kind of raises the question about well, what are we doing then in terms of the value transfer issues? So we're going to be doing new primary studies all the time when maybe we don't need to do the transfer all the time as well, and there's an issue in there. You also mentioned that when doing the meta analysis, sensitivity analysis was quite important, and I think that that is an important issue, as I mentioned, across the board for all valuation studies, that we're going to pick up on much more in the sensitivity analysis. In terms of the peer review journals, I thought that was quite an interesting thing because what you've got there is, you've got an institutional failure. That basically you've got these studies out there that aren't valued through the current institutions, which are the journals, and the societies, and the peer review process. But then you're saying that there is a bunch of people, some in quite powerful positions in terms of journals, societies, and the various institutions, who are sitting there saying that they really want their studies valued. So it's something of a contradiction.

JH: I guess I look at it as a question of people here, how do we go about trying to solve this market failure, as Clive mentioned? Somebody, agency, needs to stand up with some funding, perhaps, to get the thing rolling, and I think we also need some professional associations and prominent professionals involved. So think about that one. But I think in terms of preferences, I feel comfortable with the idea that the values change over time. Things like income are growing over time. One of the things I've noticed over 25 years or so of a professional career is the wax and wane of interest in environmental improvement, and it seems to be somewhat coincided with changes in income and prosperity in our economy. But you do notice this over a period of time, that people's preferences, the salience of environmental change, does change over time. So I think it is important that we be up to date. I don't think that means just dropping what's happened in the past or think that these values are so unstable that they're changing every six months or every year. Possibly with the Depression or something you see a dramatic change, but I'm talking about a gradual change in renewal of the basic database, as opposed to having to recreate it every year. In terms of whether it should be part, whether it's essential or necessary, I'm not quite sure I understand that. But I do see benefits assessment being really crucial in policy analysis. It's an important part of analysis, it's a necessary part of analysis in that sense. It's not necessarily sufficient for your decision. You might want other values and know the magnitude of the impacts we're talking about and how they're distributed across the population. So other concerns come in. I hate to see just BCA the only way we make decisions, that it has to pass the benefit-cost test, and if it passes the benefit-cost test we do it. I can see a lot of bad things happening from that. So I do think these other approaches are important and inform us more about the non-value aspects of the policy.

Q: This is Matthew Wilson. This is really for John but it also gets at a larger issue. I wholly support the idea of some kind of peer review journal to provide, to correct the institutional failure, particularly for

interdisciplinary work. And what I want to say -- I've read the preliminary report coming out of the NRC and I noticed there's this whole section there on the structure and function of aquatic systems, and what I haven't seen in these talks are engagement with our colleagues in the ecological sciences about transfer. What I mean by that, Steve Carpenter, Pew scholar at Wisconsin, Stuart Pickett in the Baltimore ecosystem study, there are a lot of colleagues there whom we might engage as we think about the parameters that Ian talked about, and in particularly the function transfers. Ecological parameters. For example, substitutability. Substitutability is an issue on the socioeconomic side, what site is preferred over another site. Substitutability is also an issue for ecologists, in particular forests. I give you an example from the GIS stuff. A forest isn't just a forest isn't just a forest isn't just a forest. The question is why aren't we engaging ecologists? I don't see them as mutually exclusive. In fact, the functions that were discussed earlier need ecological data in them, and I just think -- how do you see the journal type of effort proceeding in that direction?

JH: I do think that would help to encourage more cooperation between economists and ecologists. If you're really concerned about the quality of the estimates, then you have to be concerned about the quality of the explanatory variables. And given our interest in methodological advances, we're willing to kind of settle for dummy variables, because they're not to demonstrate that the estimator works, that it's better than another estimator, or demonstrate the properties of interview method. But if we're really worried about the estimates of value that we get out of the study, then I think that would provide a greater incentive to do a better job defining those ecosystem service variables.

Q: Rich Ready. I wanted to follow up on the idea. I also support the idea of a dedicated journal. I think Clive's point about, well if we value this why are the current journals not doing this? And I think it has to do with just page limitations and I don't think it's feasible to take JEEM or Land Econ and ask them to dedicate hundreds of pages to this kind of thing. My question has to do with your comment about establishing protocols in the review. I'm very concerned about the idea that we establish some sort of standard practice that studies have to meet in order to be included in the collection of available studies. I think we're still trying to recover from the NOAA report in terms of ossifying practice and still fighting the idea that referendum dichotomist choice is the preferred method. If we rewrote the NOAA report now we might say that choice and conjoint is the preferred method, and ten years from now we might be fighting against that with some new idea. So I just wanted to hear you expand on your idea of what you mean by establishing protocols.

JH: I think one aspect of that is in terms of reporting the right data. For instance, Randy mentioned yesterday that in terms of their review there's only a small percentage that report things like income, gender, age. Things you need for, say, aggregating a study or comparing across different studies. Some protocol, I don't know if a journal, it seems like you have more ability to be flexible. I certainly wouldn't want to rule out a method that's well accepted in the literature, such as a mail survey; it would be foolish. There are things to be learned from mail survey data. So the editor and editorial council would have to be fairly careful. But presumably you have people, an editor and an editorial council, who are experts in this area of primary benefits studies, familiar with the methods, and are capable of defining what the key issues are for a particular study, quite a bit in terms of reporting. But also probably issues like sample, defining what the sample is and what the population is, what population you're sampling from, so that it isn't ambiguous if someone wants to do a transfer study; it is more clear than what you'll find in the descriptions right now. A paragraph's too short for these issues. There are critical judgments when you do a survey about what your population is and how you're going to draw a list of respondents and then how you're going to sample those respondents. Those sorts of procedural issues I would see being quite important. Not just to rule in or rule out existing studies, but also to make progress in those areas which get back to how people conduct studies, so that we get more consistency with stated alternatives.

Q: Randy Rosenberger. I just wanted to expand on Richard's comment a little bit, and this is based on a conversation I had with Klaus Moeltner last night while we were slightly inebriated. Part of the process that we're missing is that this research protocol would not necessarily mean go no-go on a publication forum otherwise, but also add into an e-journal, since we have the space, that we could also have the editor's or the reviewer's comments regarding, okay, this is how they did the study, this is their sample size, these are some of the characteristics. What might have been an improvement, or what are some of the areas of concern regarding this estimate? And so it's not saying, well, our sample size protocol is you have to have an N of 57 and you have 56, you're gone. But we can identify these areas. And over time, then, we could start tracking: Do these factors actually matter? Or do we have some consistency? Are we really overrating certain protocol or certain criteria? But I think there are going to be certain protocol out there, that if somebody tried to publish a study that was based on an N of 7, I think we are all clear that's not going to happen and that shouldn't show up anywhere. So that's just a comment.
Q: [*Rich Iovanna*] I'll keep my comment very brief. I wanted to draw upon statements that both Clive and John made, and that is I worry that where benefits transfer may be regarded as problematic or at least we have a low level of faith in it, in the context of, for example, ecosystem services or maybe ecosystems in general, I recall a list that you put up, John -- my concern is that for virtually every rule that EPA comes out with, ecosystem services or ecosystems in general are a component of the benefits that need to be assessed. So that if there is something for which a valuation or benefits transfer is effectively precluded, don't we start, aren't we forcing ourselves into a multi-criteria analysis, then? Can we really engage in benefit cost analysis if we recognize that there's this whole territory in terms of the benefits that are conceivably provided? That we don't have much faith in the benefits transfer estimate, though?
JH: Try to give the opportunity to clarify that, because I think the point I was trying to make, I didn't want to use the term validity because that tends to be viewed as zero-one, or reliability because that has certain statistical and fairly rigorous properties. I think what I'm talking about more is confidence, and we'd have a lower degree of confidence in those areas, and in an area like recreation, where we understand what the good is. And we have a number of these studies out there that value that particular good. Or in the VSL literature. Even there you see a line of discussion, but at least with the fact that occupational mortality risk, there's somewhat of a consensus about what the independent variable is. But even then there's discussion. If you read the Viscusi and Adlee article that I cited, one of their concerns is which measure of risk do you use? Because there are different compilations of risk. And so, if you use the Bureau of Labor Statistics risk measure or another risk measure, what impact does that have on your VSL estimate? But that kind of discussion, it would be really nice to have that kind of discussion with respect to ecosystems. Well, if we use this kind of ecosystem services index, what would that do to our value? We had a reset stage of development in the ecosystem area that we have in some of these other areas of evaluation. So I wasn't really trying to preclude benefits transfer in that area. Rather to say there's a lot more work that needs to be done to get us up to a higher level of confidence. My presumption was that that's an interesting area to get involved in. See some more work trying to raise the level of confidence in those estimates, because like you say, they enter into key decisions in any nation across the globe. The problem of managing ecosystems is a major issue. So in order to do that well, we need to get more confidence in these value measures that we're using to do that.

# 9. List of Attendees

**Kimberly Barry**
Economist
National Oceanic and Atmospheric Administration
1305 East-West Highway - 10th Floor
(N/ORR3 SSMC4)
Silver Spring, MD 20910
301-713-3038
Fax: 301-713-4387
Email: kim.barry@noaa.gov

**Derek Berwald**
Economist
Biological and Economic Analysis Division
Office of Pesticide Programs
U.S. Environmental Protection Agency
1200 Constitution Avenue (7053C)
Washington, DC
703-308-8115
Fax: 703-308-8090
Email: berwald.derek@epa.gov

**Elena Besedin**
Abt Associates Inc.
55 Wheeler Street
Cambridge, MA 02138
617-349-2770
Fax: 617-349-2660
Email: elena_besedin@abtassoc.com

**Richard Bishop**
University of Wisconsin
Madison, WI
Email: bishop@aae.wisc.edu

**Zbigniew Bochniarz**
Director
Center for Nations in Transition
301 19th Avenue South
Minneapolis, MN 55455
612-625-5527
Fax: 612-626-9860
Email: zbig@hhh.umn.edu

**Ayuna Borisova-Kidder**
Ph.D. Student
Ohio State University
P.O. Box 10592
Columbus, OH 43201
614-499-1588
Fax: 614-228-1862
Email: borisova.1@osu.edu

**Yves Bourassa**
Policy Manager
Environment Canada
10 Wellington Street - 24th Floor
Terrasses de la Chaudière
Gatineau, Quebec K1A 0H3
Canada
819-953-7651
Fax: 819-994-6787
Email: yves.bourassa@ec.gc.ca

**Nick Bouwes**
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (1301)
Washington, DC 20460
202-566-1002
Fax: 202-566-1053
Email: bouwes.nick@epa.gov

**John Braden**
Professor
University of Illinois
431 Mumford Hall (MC-710)
1301 West Gregory Drive
Urbana, IL 61801
217-333-5501
Fax: 217-333-2312
Email: jbb@uiuc.edu

**Brad Brown**
Economist
U.S. Food and Drug Administration
5100 Paint Branch Parkway
College Park, MD 20740-3835
301-436-1551
Fax: 301-436-2626
Email: bradley.brown@cfsan.fda.gov

**Lauretta Burke**
World Resources Institute
10 G Street, NE
Washington, DC 20002
202-729-7693
Fax: 202-729-7686
Email: lburke@wri.org

**Dallas Burtraw**
Senior Fellow
Resources for the Future
1616 P Street, NW
Washington, DC 20036
202-328-5087
Fax: 202-939-3460
Email: burtraw@rff.org

**Alice Candido**
Ph.D. Student
University of Padua
via Venezia, 1
Padova 35131
Italy
39-049-8276825
Fax: 39-049-8276717
Email: alice.candido@unipd.it

**Marta Ceroni**
Gund Institute for Ecological Economics
590 Main Street
Burlington, VT 05405
802-656-2968
Fax: 802-656-2995
Email: mceroni@uvm.edu

**Joel Corona**
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (4101M)
Washington, DC 20460
202-564-0006
Fax: 202-564-0480
Email: corona.joel@epa.gov

**Katie Coughlin**
Staff Researcher
Lawrence Berkeley National Laboratory
1 Cyclotron Road (MS 90-4000)
Berkeley, CA 94720
510-486-5949
Fax: 510-486-6996
Email: kcoughlin@lbl.gov

**Kenneth Davidson**
Environmental Scientist
Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (6401A)
Washington, DC 20460
202-564-7478
Fax: 202-564-1686
Email: davidson.ken@epa.gov

**Edi Defrancesco**
Professor of Agricultural Economics
Department TeSAF
University of Padova - Italy
Agripolis Viale Universita 16
Legnaro, PD 35020
Italy
39-049-827-2721
Fax: 39-049-827-2772
Email: edi.defrancesco@unipd.it

**Willard Delavan**
Assistant Professor
Rochester Institute of Technology
8 Fairmount Street
Rochester, NY 14607
585-461-3726
Fax: 585-475-2510
Email: delavan@frontiernet.net

**Chris Dockins**
Director, Economics Forum
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (1809T)
Washington, DC 20460
202-566-2286
Fax: 202-566-2338
Email: dockins.chris@epa.gov

**Susan Durden**
Senior Economist
Institute for Water Resources
115 Turkey Trail
Statesboro, GA 30458
703-428-9089
Fax: 912-652-5787
Email: susan.e.durden@usace.army.mil

**Earl Ekstrand**
Resource Economist
U.S. Bureau of Reclamation
P.O. Box 25007 (D-8270)
Denver, CO 80225
303-445-2731
Fax: 303-445-6380
Email: eekstrand@do.usbr.gov

**Andrew Estrin**
Economist
U.S. Food and Drug Administration
5100 Paint Branch Parkway
College Park, MD 20740
301-436-1829
Fax: 301-436-2626
Email: aestrin@cfsan.fda.gov

**David Evans**
Research Associate
Resources for the Future
1616 P Street, NW
Washington, DC 20036
202-328-5172
Fax: 202-939-3460
Email: evans@rff.org

**Scott Farrow**
Chief Economist
U.S. General Accounting Office
441 G Street, NW (MS 6K17E)
Washington, DC 20548
202-512-6669
Fax: 202-512-3938
Email: farrows@gao.gov

**Amy Gautam**
Economist
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
1315 East-West Highway
Silver Spring, MD 20910
301-713-2239
Fax: 301-713-1940
Email: amy.buss.gautam@noaa.gov

**Brett Gelso**
Economist
Environmental Assessment Division
Economic and Environmental Assessment Branch
Office of Water
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (4303T)
EPA West Building
Washington, DC 20460
202-566-1077
Fax: 202-566-1053
Email: gelso.brett@epa.gov

**Brad Gentner**
Economist
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
1315 East West Highway (F/ST5)
Siliver Spring, MD 20910
301-713-2328
Email: brad.genter@noaa.gov

**Stavros Georgiou**
University of East Anglia
Earlham Road
Norwich, Norfolk NR4 7TJ
United Kingdom
44-1603-593743
Fax: 44-1603-593739
Email: s.georgiou@uea.ac.uk

**Thomas Geronikos**
Senior Real Estate Analyst
General Serfvices Administration
18th & F Streets, NW - Room 4241 (PVB)
Washington, DC 20405
202-501-3190
Fax: 202-208-1714
Email: thomas.geronikos@gsa.gov

**Robin Goldman**
Research Assistant
Quality of the Environment
Resources for the Future
1616 P Street, NW
Washington, DC 20036
202-328-5041
Fax: 202-939-3460
Email: goldman@rff.org

**Pat Hagan**
*No information provided*

**Trish Hall**
Economist
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (4607M)
Washington, DC 20007
202-564-5263
Fax: 202-564-3767
Email: hall.patricia@epa.gov

**LeRoy Hansen**
Environmental Resource Economist
Economic Research Service
U.S. Department of Agriculture
1800 M Street, SW - Suite 4011
Washington, DC 20036
202-694-5612
Fax: 202-694-5737
Email: lhansen@ers.usda.gov

**Patrice Harou**
Visiting Professor
ENGREF
14 rue Girardet
Nancy, Lorraine F-54042
France
33-3-83-39-68-60
Fax: 33-3-83-37-06-45
Email: harou@nancy-engref.inra.fr
pharou@worldbank.org

**Daniel Hellerstein**
Economise
Economic Research Service
U.S. Department of Agriculture
1800 M Street, NW - Room 4006
Washington, DC 20036
202-694-5613
Fax: 202-694-5774
Email: danielh@ers.usda.gov

**Julie Hewitt**
Economist
National Center for Environmental Economics
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (1809T)
Washington, DC 20460
202-566-2290
Fax: 202-566-2338
Email: hewitt.julie@epa.gov

**Elizabeth Hilliard**
Economist
U.S. Army Corps of Engineers
100 West Oglethorpe Avenue
Savannah, GA 31402
912-652-5837
Fax: 912-652-5787
Email:
elizabeth.j.hilliard@sas02.usace.army.mil

**Sandra Hoffmann**
Fellow
Resources for the Future
1616 P Street, NW
Washington, DC 20036
202-328-5022
Fax: 202-939-3460
Email: hoffmann@rff.org

**Mark Holliday**
Director of Policy
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
1315 East-West Highway
Silver Spring, MD 20910
301-713-2239
Fax: 301-713-1940
Email: mark.holliday@noaa.gov

**Michael Huguenin**
Principal
Industrial Economics, Inc.
2067 Massachusetts Avenue
Cambridge, MA 02140
617-354-0074
Fax: 617-354-0463
Email: mikehuguenin@indecon.com

**Richard Jensen**
Professor
University of Notre Dame
434 Flanner
Notre Dame, IN 46556-5611
574-631-7698
Fax: 574-631-4783
Email: rjensen1@nd.edu

**Amber Jessup**
Economist
U.S. Food and Drug Administration
5100 Paint Branch Parkway (HFS-726)
College Park, MD 20902
301-436-1689
Fax: 301-962-2626
Email: amber.jessup@cfsan.fda.gov

**Yong Jiang**
Ph.D. Student
Department of Environmental and Natural Resource Economics
Coastal Institute
University of Rhode Island
1 Greenhouse Road
Kingston, RI 02881
401-874-4563
Fax: 401-782-4766
Email: yjia6796@postoffice.uri.edu

**Mark Jones**
Department for Environment, Food, and Rural Affairs
London
United Kingdom
Email: mark.w.jones@defra.gsi.gov.uk

**Yoshiaki Kaoru**
Visiting Professor
Department of Agricultural and Resource Economics
University of Maryland
2200 Symons Hall
College Park, MD 20742
301-405-1293
Fax: 301-314-9091
Email: ykaoru@arec.umd.edu

**Pamela Kaval**
Waikato Management School
University of Waikato
Private Bag 3105
Hamilton
New Zealand
647-838-4045
Fax: 647-838-4331
Email: pkaval@mngt.waikato.ac.nz

**Laura Konda**
Center for Food Safety and Applied Nutrition
U.S. Food and Drug Administration
5100 Paint Branch Parkway (HFS-726)
College Park, MD 20740
301-436-1764
Fax: 301-436-2626
Email: laura.konda@cfsan.fda.gov

**Rosemary Kosaka**
Economist
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
1315 East-West Highway (SSMC 3/ST5)
Silver Spring, MD 20910
301-713-2328
Fax: 301-713-1875

**Randall Kramer**
Professor
Nicholas School of the Environment
Duke University
Box 90328
Durham, NC 27708
919-613-8072
Fax: 919-684-8741
Email: kramer@duke.edu

**Alan Krupnick**
Senior Fellow
Resources for the Future
1616 P Street, NW
Washington, DC 20036
202-328-5107
Fax: 202-939-3460
Email: krupnick@rff.org

**Sarah Kruse**
Ohio State University
5799 Clear Stream Way
Westerville, OH 43081
614-891-1188
Fax: 614-247-7066
Email: kruse.22@osu.edu

**Alessandra La Notte**
Assistant Researcher
Department TeSAF
University of Padova - Italy
Agripolis Viale Universita 16
Legnaro, PD 35020
Italy
39-049-827-2721
Fax: 39-049-827-2772
Email: alessandra.lanotte@unipd.it

**Drew Laughland**
Senior Economist
ERG
110 Hartwell Avenue
Lexington, MA 02421
781-674-7359
Fax: 781-674-2851
Email: drew.laughland@erg.com

**Andrew Lee**
Economist
Office of Pesticide Programs
Biological and Economical Analysis Division
Office of Prevention, Pesticides and
Toxic Substances
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (7503C)
Washington, DC 20460
703-308-7226
Fax: 703-308-8091
Email: lee.andrew@epa.gov

**Joseph Lewis**
Economist
Forest Service
U.S. Department of Agriculture
1601 North Kent Street - 7th floor
Arlington, VA 22209
703-605-5339
Fax: 703-605-5353
Email: jlewis02@fs.fed.us

**R. Jeffrey Lewis**
Scientific Associate
ExxonMobil Biomedical Sciences, Inc.
1545 Route 22 East - Room LF 264
P.O. Box 971
Annandale, NJ 08801-0971
908-730-1107
Fax: 262-313-9333
Email: r.jeffrey.lewis@exxonmobil.com

**Igor Linkov**
Senior Scientist
Cambridge Environmental
58 Charles Street
Cambridge, MA 02141
617-225-0812
Fax: 617-225-0813
Email: linkov@cambridgeenvironmental.com

**Bruce Lippke**
Director, Rural Technology Initiative
College of Forest Resources
University of Washington
123 Anderson
Box 352100
Seattle, WA 98195
206-543-8684
Fax: 206-685-0790
Email: blippke@u.washington.edu

**Lyn Luben**
Economist
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (5307W)
Washington, DC 20460
703-308-0508
Fax: 703-308-0509
Email: luben.lyn@epa.gov

**Carol Mansfield**
Research Triangle Institute
3040 Cornwallis Road
Durham, NC 27713
919-541-8053
Fax: 919-541-6683
Email: carolm@rti.org

**William Mates**
Research Scientist
New Jersey Department of Environmental
Protection
P.O. Box 409
Trenton, NJ 08625-0409
609-292-7692
Fax: 609-984-9383
Email: william.mates@dep.state.nj.us

**Cristina McLaughlin**
Economist
U.S. Food and Drug Administration
5100 Paint Branch Parkway (HFS-726)
College Park, MD 20740
301-436-1978
Fax: 310-436-2626
Email: cmclaugh@cfsan.fda.gov

**Walter Milon**
Professor
College of Business Administration
Department of Economics
University of Central Florida
Box 161400
Orlando, FL 32816-1400
407-823-1881
Fax: 407-823-3269
Email: wmilon@bus.ucf.edu

**Scott Miner**
Ecosystem Restoration Specialist
U.S. Army Corps of Engineers
1325 J Street (CESPK-PD)
Sacramento, CA 95814
916-557-6695
Fax: 916-557-7856
Email: scott.p.miner@usace.army.mil

**Klaus Moeltner**
Department of Resource Economics
University of Nevada, Reno
(MS 204)
Reno, NV 89557-0105
775-784-4803
Fax: 775-784-1342
Email: moeltner@unr.edu

**Sian Mooney**
Assistant Professor
University of Wyoming
1000 East University Avenue - Department 3354
Laramie, WY 82071
307-766-2389
Fax: 307-766-5544
Email: smooney@uwyo.edu

**Georgina Moreno**
Assistant Professor
Scripps College
1030 Columbia Avenue
Claremont, CA 91711
909-607-3368
Fax: 909-621-8323
Email: gmoreno@scrippscollege.edu

**Brian Morrison**
President
Industrial Economics, Inc.
2067 Massachusetts Avenue
Cambridge, MA 02140
617-354-0074
Fax: 617-354-0463
Email: bgm@indecon.com

**Tammy Murphy**
AAAS Fellow/Economist
Office of Ground Water & Drinking Water
U.S. Environmental Protection Agency
1200 Constitution Avenue (4607M)
EPA East
Washington, DC 20004
202-564-9896
Fax: 202-564-3767
Email: tammy.murphy@umb.edu

**Clark Nardinelli**
Supervisory Economist
U.S. Food and Drug Administration
5100 Paint Branch Parkway (HFS-726)
College Park, MD 20740
301-436-1820
Fax: 301-436-2626
Email: clark.nardinelli@cfsan.fda.gov

**Steve Newbold**
Economist
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (1809T)
Washington, DC 20460
202-566-2293
Fax: 202-566-2338
Email: newbold.steve@epa.gov

**Clay Ogg**
Economist
National Center for Environmental Economics
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (1809T)
Washington, DC 20460
202-566-2315
Fax: 202-566-2339
Email: ogg.clay@epa.gov

**Linwood Pendleton**
Associate Professor
Environmental Science and Engineering Program
Department of Environmental Health Sciences
University of California, Los Angeles
Los Angeles, CA 90095-1772
805-794-8206
Fax: 310-206-3358
Email: linwoodp@ucla.edu

**Gregory L. Poe**
Associate Professor
Department of Applied Economics
Cornell University
422 Warren Hall
Ithaca, NY 14853
607-255-4707
Fax: 607-255-9984
Email: glp2@cornell.edu

**Sarah Porter**
Independent Consultant
10434 Kardwright Court
Montgomery Village, MD 20886
301-840-0377
Email: portersarah@hotmail.com

**Ellen Post**
Senior Economist
Abt Associates, Inc.
4800 Montgomery Lane - Suite 600
Bethesda, MD 20814
301-941-0287
Fax: 301-652-7530
Email: ellen_post@abtassoc.com

**John Powers**
Senior Economist
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (4101M)
Washington, DC 20460
202-564-5776
Fax: 202-564-0500
Email: powers.john@epa.gov

**Kyna Powers**
Analyst in Energy and Environmental Policy
Congressional Research Service
101 Independence Avenue, SE
Washington, DC 20001
202-707-6881
Fax: 202-707-7000
Email: kpowers@crs.loc.gov

**Shannon Price**
Economist
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (1809T)
Washington, DC 20460
202-566-2301
Fax: 202-566-2336
Email: price.shannon@epa.gov

**Lewis Queirolo**
Senior Regional Economist
Alaska Region
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
440 Eagle Crest Road
Camano Island, WA 98282
360-387-4652
Fax: 360-285-6471
Email: lew.queirolo@noaa.gov

**Matthew Ranson**
Associate Analyst
Abt Associates, Inc.
4800 Montgomery Lane - Suite 600
Bethesda, MD 20814
301-347-5622
Fax: 301-652-7530
Email: matthew_ranson@abtassoc.com

**Wha-Joon Rho**
Professor
Seoul National University (NCEE)
3015 Regents Tower Street - Apartment #435
Fairfax, VA 22031-1282
202-566-2349
Fax: 202-566-2336
Email: wjrho@hotmail.com

**David Riposo**
Consultant
Booz Allen Hamilton
8283 Greensboro Drive
McLean, VA
703-902-5905
Email: risposo_david@bah.com

**Angela Ritzert**
Economist
Center for Food Safety and Applied Nutrition
U.S. Food and Drug Administration
5100 Paint Branch Parkway
College Park, MD 20902
301-436-1763
Fax: 301-436-2626
Email: angela.ritzert@cfsan.fda.gov

**Keith Sargent**
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (1809T)
EPA West, Cube 4305-H
Washington, DC 20460
202-566-2276
Fax: 202-566-2373
Email: sargent.keith@epa.gov

**Anne Sergeant**
Environmental Scientist
National Center for Environmental Assessment
Office of Research and Development
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (8623N)
Washignton, DC 20460
202-564-3249
Fax: 202-564-2018
Email: sergeant.anne@epa.gov

**Gina Shamshak**
Knauss Sea Grant Fellow
Office of Constituent Services
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
1315 East-West Highway - Room 9535 (SSMC 3)
Silver Spring, MD 20910
301-713-9501
Fax: 301-713-2384
Email: gina.shamshak@noaa.gov

**Keith Silverman**
Senior Project Engineer
NJIT & Merck
2 Merck Drive (WS2W-13)
Somerset, NJ 08889
908-423-4102
Fax: 908-735-1496
Email: keith_silverman@merck.com

**David Simpson**
Economist
National Center for Environmental Economics
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (180)
Washington, DC 20460
202-566-2356
Fax: 202-566-2373
Email: simpson.david@epa.gov

**Steven Stewart**
Research Associate
University of Arizona, Hydrology and Water Resources
P.O. Box 210158-B
Tucson, AZ 85721-0158
520-626-3892
Fax: 520-626-4601
Email: sstewart@hwr.arizona.edu

**Andrew Stocking**
Vice President Business Development
Care2.com
623 Hillsborough Street
Oakland, CA 94606
650-622-0869
Fax: 208-723-9149
Email: astocking@earth.care2.com

**Ivar Strand**
Professor Emeritus
University of Maryland
421 Jeffersons Trace
Amherst, VA 24521
434-277-9039
Fax: 434-277-5298
Email: ivarst@arec.umd.edu

**Gene Sturm**
Senior Economist
U.S. Army Corps of Engineers Omaha District
106 South 15 Street (CENWO-PM-AE)
Omaha, NE 68102
402-221-4629
Fax: 402-221-4886
Email: gene.a.sturm@usace.army.mil

**Terri Suomi**
E Squared, Inc.
P.O. Box 669
Crestone, CO 81131
719-256-4674
Fax: 434-975-6701
Email: tsuomi@e2inc.com

**Jennifer Thacher**
Assistant Professor
University of New Mexico
(MSC05 3060)
Albuquerque, NM 87131
505-277-1965
Fax: 505-277-9445
Email: jthacher@unm.edu

**Steve Thur**
Economist
National Oceanic and Atmospheric Administration
1305 East-West Highway - Room 10324
(SSMC4)
Silver Spring, MD 20910
301-713-3038
Fax: 301-713-4387
Email: steven.thur@noaa.gov

**George Van Houtven**
Program Director
RTI International
3060 Cornwallis Road
Hobbs Building
Research Triangle Park, NC 27709
919-541-7150
Fax: 919-541-6883
Email: gvh@rti.org

**Ferdinando Villa**
Gund Institute for Ecological Economics
University of Vermont
590 Main Street
Burlington, VT 05405
802-656-2968
Fax: 802-656-2995
Email: fvilla@uvm.edu

**Ann Watkins**
Economist
Office of Atmospheric Programs
Clean Air Markets Division
Office of Air and Radiation
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (6204J)
Washington, DC 20460
202-343-9113
Fax: 202-343-2360
Email: watkins.ann@epa.gov

**Thomas Wegge**
Principal Economist
TCW Economics
2756 9th Avenue
Sacramento, CA 95818
916-451-3372
Fax: 916-451-1920
Email: twegge@tcwecon.com

**Will Wheeler**
Economist
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (8722F)
Washington, DC 20460
202-343-9828
Fax: 202-233-0678
Email: wheeler.william@epa.gov

**James Williamson**
U.S. Environmental Protection Agency
26 West Martin Luther King Drive (498)
Cincinnati, OH 45268
513-569-7501
Fax: 513-487-2511
Email: williamson.james@epa.gov

**Sid Wolf**
Economist
EMS, Inc.
8601 Georgia Avenue
Silver Spring, MD 20910
301-585-5015
Fax: 301-589-8487
Email: swolf@emsus.com

**Wei Zhang**
Michigan State University
108 Cook Hall
East Lansing, MI 48824
517-214-7810
Fax: 517-432-1800
Email: zhangwe9@msu.edu