**Material for Breakout Session C:**
**Deliberative Approaches for Modeling, Valuation, and Decision Making**
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### Conceptual Framework for the Decision Science Approach to Values

The decision science perspective on valuing the protection of ecological systems and services is, at its core, relativist. Form this perspective, the "value" surrounding ecological systems and services is not an absolute concept, despite the fact that numerical and narrative descriptions of individual components of it (absent a comparison) may be obtained using a variety of economic and non-economic (e.g., psychological, biophysical, etc.) methods. Instead, the decision sciences take the view that that the overall value that is ascribed to the environment and its services can only be fully understood in a comparative context; in other words, we can only say that a system—or indeed the suite of services provided by that system—has a high or low value in the context of:

(a) retrospective evaluations undertaken by analyzing the degree of change experienced by the system relative to some previous or unaltered state (i.e., a system is either more or less valuable because it performs either better or worse than it did before), or

(b) decision making for management undertaken by comparing predictions about how a system or its suite of services might behave—again better or worse relative to its current condition—after it has been subjected to one or more possible management or regulatory options.

The attributes across which these changes—and hence, values—are accounted for are defined by the objectives of a given decision context. These objectives tend to be diverse and simultaneously incorporate inputs from a wide variety of disciplines. It is not atypical, for example, to ascribe an overall relative value to an ecological system or service based on the extent to which it maintains some requisite level of ecological function and productivity, provides security for endangered or threatened species, facilitates the maintenance of key services such as nutrient cycling or decomposition, yields economic outputs in the form of resource extraction and tourism, lends itself to desired recreation opportunities, and supplies a sense of pride or awe (Gregory et al. 2001). In this sense, the decision sciences straddle the line between economic and non-economic approaches to valuation in that inputs for a formal comparison of options in the case of management decisions, and current and previous conditions in the case of evaluation, are required from fields such as economics, ecology, psychology, and sociology. However, absent an explicit framework for comparison across attributes, and options or alternative states, individual inputs from these sources have very little meaning—from an overall "value" standpoint—in their own right.

Thus, a decision science approach to valuing the protection of ecological systems and services is explicitly multiattribute in nature. Absent this multiattribute view of value—with the various attributes of value tied to the concerns stated by stated by technical experts and other key stakeholders—the relative values obtained often fall short of providing the requisite guidance for decision making and evaluation, and run the risk of not meeting or surpassing the threshold of relevancy (Keeney & Raiffa 1993)—defined chiefly by those who will hold decision makers and agencies accountable. Of course, a multiattribute and comparative view of value presents challenges to decision makers and evaluators. For example, those who undertake valuations geared toward the decision sciences must be prepared to work with multiple and diverse stakeholders sometimes over extended temporal periods, conduct additional decision-specific technical analyses that are linked to stated objectives, and address complex and often contentious tradeoffs (Arvai et al. 2001; Gregory et al. 2001; Hammond et al. 1999; Keeney & Gregory 2005).

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**Deliberative Approaches**

Significant interest has been devoted to multi-stakeholder, deliberative processes for environmental decision making both at EPA (e.g., EPA 2000) and elsewhere (e.g., Beierle and Cayford 2002, Beierle 2002). Much of this interest has focused on deliberative processes as a means of legitimizing resulting policy decisions. To this end, there have been several examples of both research and practice where deliberative approaches to decision making have resulted in a high degree of participant satisfaction in a variety of different management contexts (McDaniels et al. 1999, Arvai 2003). Results from these studies, and others (e.g., Kraft 1988, National Research Council 1989, Heiman 1990, Vari et al. 1993), argue that people are more likely to accept outcomes that result from decision making processes that seem fair, reasonable, and amenable to allowing the public and other stakeholders an opportunity to voice their feelings and concerns.

This argument is also in line with writing on “procedural justice”, which suggests that a higher degree of acceptance is be expected for decisions that seem fair to the affected parties from the point of view of both the decision outcome and the process that resulted in it (Lind and Tyler 1988, Kraft and Scheberle 1995). In other words, people whose individual interests are adversely affected by an outcome may be more willing to accept decisions because they perceive that they have been dealt with fairly, they understand the other participants’ positions, and they have had the opportunity—even if comes indirectly—to contribute to the debate (Syme et al. 1991, Hillier 1998).

Why does this positive relationship between deliberative processes and support for resulting decisions exist? Some have suggested greater stakeholder satisfaction results from a frame shift during decision making from one that is imposed to one that is voluntary (Slovic 1987). Others have suggested that greater stakeholder satisfaction with decisions that are the product of deliberative approaches is simply the manifestation of a halo effect (Thorndike 1920). In this latter case, people tend to judge multiple dimensions of a stimulus in much the same was as they judge the most salient dimension. In other words, when one judges a decision to be "good" in one dimension (i.e., because it was made in a deliberative fashion), they are also likely to judge the same decision to be good in other dimensions (i.e., the outcomes of that decision). Beyond these "stakeholder relations" benefits, there are other reasons—reasons that are of greater interest to this committee—for advocating the use of deliberative approaches for valuation and decision making. Foremost among these is the fact that these approaches work to foster the inclusion of differently formulated objectives, concerns, and arguments in the valuation and decision making process (NRC 1996, Chess and Purcell 1999, Renn 1999, Gregory 2000).

Indeed, EPA itself has acknowledged this point, stating in the past that the American people are the agency's primary "customer" and to this end issued the following policy statement (EPA 2000, p. 1): "We are committed to providing the best customer service possible. We aim to achieve this through increased public participation, increased access to information, and more effectively responding to customer needs." This is a sweeping statement that applies to a wide variety of valuation contexts, including both those that involve single valuation metrics (e.g., dollar responses obtained via contingent valuation) and multiattribute inputs obtained via multi-stakeholder approaches (e.g., such as mediated modeling and structured decision approaches).

For example, in the context of contingent valuation, a commitment to deliberative approaches implies that EPA will seek input from stakeholders regarding such things as:

- the ecological systems or services that will be the subject of valuations,
- the aspects of these ecological systems or services to be valued (e.g., the attributes by which an object such as aesthetic quality might be defined),
- appropriate measures (e.g., dollars for economic valuations; indices of quality for environmental attributes) for valuation outputs, and
- appropriate ways to frame and implement valuation questions.

Likewise, in the context of multiattribute approaches, this commitment guides EPA to seek input regarding:

- problem identification and framing,
- stakeholders' objectives as they relate to a given decision or evaluation context,
- the range of options that may be considered as part of a management decision,
- valuation inputs to consider during decision making or evaluation; these include results from valuation processes that include, but are not limited to CV, deliberative value elicitations, and the results from (non-monetized) surveys, and
- information about the tradeoffs that must be addressed when selecting one option over another.


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**Mediated Modeling**

Brief Description of Method. Computer models of complex systems are frequently used to support decisions concerning environmental problems. To effectively use these models, (i.e. to foster consensus about the appropriateness of their assumptions and results and thus to promote a high degree of compliance with the policies derived from the models) it is not enough for groups of academic "experts" to build and run the models. What is required is a different role for modeling - as a tool in building a broad consensus not only across academic disciplines, but also between science and policy. Mediated modeling is the involvement of stakeholders (parties interested in or affected by the decisions the model addresses) as active participants in all stages of the modeling process, from initial problem scoping to model development, implementation and use (Costanza and Matthias 1998; van den Belt 2004). Integrated modeling of large systems, from individual companies to industries to entire economies or from watersheds to continental scale systems and ultimately to the global scale, requires input from a very broad range of people. We need to see the modeling process as one that involves not only the technical aspects, but also the sociological aspects involved with using the process to help build consensus about the way the system works and which management options are most effective. This consensus needs to extend both across the gulf separating the relevant academic disciplines and across the even broader gulf separating the science and policy communities, and the public. Appropriately designed and appropriately used mediated modeling exercises can help to bridge these gulfs. The process of mediated modeling can help to build mutual understanding, solicit input from a broad range of stakeholder groups, and maintain a substantive dialogue between members of these groups. Mediated modeling and consensus building are also essential components in the process of adaptive management (Gunderson, Holling, and Light 1995).

Mediated Modeling and Value. Mediated models can contain explicit valuation components. In fact, if the goal of the modeling exercise is to consider trade-offs, then valuation of some kind becomes an essential ingredient. How these trade-offs and valuations get incorporated into the model, varies, of course, from exercise to exercise. Perhaps the best way to describe this process is with an example. The South African fynbos ecological economic model described by Higgins et al. (1997) is an illustrative example.

The area of study for this example was the Cape Floristic Region—one of the world's smallest and, for its size, richest floral kingdoms. This tiny area, occupying a mere 90,000 km2, supports 8,500 plant species of which 68% are endemic, 193 endemic genera and six endemic families (Bond and Goldblatt 1984). Because of the many threats to this region's spectacular flora, it has earned the distinction of being the world's "hottest" hot-spot of biodiversity (Myers 1990).

The predominant vegetation in the Cape Floristic Region is fynbos, a hard-leafed and fire-prone shrubland which grows on the highly infertile soils associated with the

ancient, quartzitic mountains (mountain fynbos) and the wind-blown sands of the coastal margin (lowland fynbos) (Cowling 1992). Owing to the prevalent climate of cool, wet winters and warm, dry summers, fynbos is superficially similar to California chaparral and other Mediterranean climate shrublands of the world (Hobbs, Richardson, and Davis 1995). Fynbos landscapes are extremely rich in plant species (the Cape Peninsula has 2,554 species in 470 km2) and plant species endemism ranks amongst the highest in the world (Cowling 1992).

In order to adequately manage these ecosystems several questions had to be answered, including, what services do these species-rich fynbos ecosystems provide and what is their value to society? A two-week workshop was held at the University of Cape Town (UCT) with a group of faculty and students from different disciplines along with parks managers, business people, and environmentalists. The primary goal of the workshop was to produce a series of consensus-based research papers which critically assessed the practical and theoretical issues surrounding ecosystem valuation as well as assessing the value of services derived by local and regional communities from fynbos systems.

To achieve the goals, an 'atelier' approach was used to form multidisciplinary, multicultural teams, breaking down the traditional hierarchical approach to problem-solving. Open space (Rao 1994) techniques were used to identify critical questions and allow participants to form working groups to tackle those questions. Open space meetings are loosely-organized affairs which give all participants an opportunity to raise issues and participate in finding solutions.

The working groups of this workshop met several times during the first week of the course and almost continuously during the second week. The groups convened together periodically to hear updates of group projects and to offer feedback to other groups. Some group members floated to other groups at times to offer specific knowledge or technical advice.

Despite some initial misgivings on the part of the group, the structure of the course was remarkably successful, and by the end of the two weeks, seven working groups had worked feverishly to draft papers. These papers were eventually published as a special issue of *Ecological Economics* (Cowling and Costanza 1997). One group focused on producing an initial scoping (or mediated) model of the fynbos. This modeling group produced perhaps the most developed and implementable product from the workshop: a general dynamic model integrating ecological and economic processes in fynbos ecosystems (Higgins et al. 1997). The model was developed in STELLA and designed to assess potential values of ecosystem services given ecosystem controls, management options, and feedbacks within and between the ecosystem and human sectors. The model helped to address questions about how the ecosystem services provided by the fynbos ecosystem at both a local and international scale are influenced by alien invasion and management strategies. The model consists of five interactive sub-models: a) hydrology; b) fire; c) plant; d) management; and (e) economic valuation. Parameter estimates for each sub-model were either derived from the published literature

or established by workshop participants and consultants (they are described in detail in Higgins et al. 1997). The plant sub-model included both native and alien plants. Simulation of the model produced a realistic description of alien plant invasions and their impacts on river flow and runoff.

This model drew in part on the findings of the other working groups, and incorporates a broad range of research by workshop participants. Benefits and costs of management scenarios were addressed by estimating values for harvested products, tourism, water yield and biodiversity. Costs included direct management costs and indirect costs. The model showed that the ecosystem services derived from the Western Cape mountains are far more valuable when vegetated by fynbos than by alien trees (a result consistent with other studies in North America and the Canary Islands). The difference in water production alone was sufficient to favor spending significant amounts of money to maintain fynbos in mountain catchments.

The model was designed to be user-friendly and interactive, allowing the user to set such features as area of alien clearing, fire management strategy, levels of wildflower harvesting, and park visitation rates. The model has proven to be a valuable tool in demonstrating to decision makers the benefits of investing now in tackling the alien plant problem, since delays have serious cost implications. Parks managers have implemented many of the recommendations flowing from the model.

There are several other case studies in the literature of various applications of mediated modeling to environmental decision-making, including valuation. Van den Belt (2004) is the best recent summary and synthesis.

Decision contexts where this method can be used. As described above, the method is fairly general and could be used to assess any value (means toward and ends) that a group of stakeholders could identify and build into a model. Any decision context that requires the estimation of the values of ecosystem goods or services could employ this method, although to the committee's knowledge no EPA decisions have as yet employed this technique. The method covers all elements of the diagram after the initial identification of EPA needs, and could be used in conjunction with the full range of decision models. Prior applications have been at a broad range of scales, from watersheds or specific ecosystems to large regions and the global scale. The method is in principle broadly applicable to the full range of time and space scales.

Resource Inputs/Limitations. Resources needed to implement the method vary from application to application. The method can deal with a broad range of available data and resources, probably better that most other methods, since the model can adapt to the resources available across different levels of data, detail, scope and complexity. As a rule of thumb, one can produce a credible mediated model in 30-40 hours of workshops; about 300-400 hours of organizing/modeling. Cost: about $40,000 - $100,000 depending on side activities. The most serious obstacle seems to be the fact that this method is very different from the top-down approach most frequently used in government. It requires that consensus building be put at the center of the process, which can be very scary for

institutions accustomed to controlling the outcome of decision processes. The final outcome of this process cannot be predetermined.

Uncertainty: In terms of uncertainty, there are all the usual sources, but the difference is that the stakeholders are exposed to these sources as they go, and learn to understand and accommodate them as part of the process. The method is compatible with formal or informal characterizing of uncertainty, producing probability distributions in addition to point estimates.

Other important dimensions:

- The method is inherently dynamic – that is what it does best
- The results can be aggregated to get a single benefits number as needed.
- Participants in the mediated modeling process gain deep understanding of the process and products. Those who have not participated can easily view and understand the results if they invest the effort. Usually the results can (with some additional effort) be made accessible to a broad audience.
- Since the method explicitly discusses and incorporates subjective or "framing" issues, it is at least open and transparent to users. No research has yet been done on whether application of the process to exactly the same problem by two independent groups would yield "consistent and invariant" results. One would expect general consistency, but some variation between applications. This is an area for further research.

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