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Measures of attitudes, preferences, and intentions

Excerpt from draft SAB Committee report, *Valuing the Protection of Ecological Systems and Services*: *Social-psychological approaches to assessing the value of ecosystems and ecosystem services employ a number of methods to identify, characterize, and measure the values people hold, express, and advocate with respect to changes in ecological states or their personal and social consequences. These methods elicit value relevant perceptions and judgments, typically expressed as choices, rankings, or ratings among presented sets of alternative ecosystems protection policies and may include comparisons with potentially competing social and economic goals. Individuals making these judgments may respond on their own behalf or on behalf of others (e.g., society at large or specified subgroups). The basis for judgments can be changes in individual well-being or in civic, ethical, or moral obligations.*

*Social-psychological value-assessment approaches have relied most strongly on survey methods. For a general discussion of the use of surveys in valuation, see [http://yosemite.epa.gov/Sab/Sabproduct.nsf/WebFiles/SurveyMethods/\\$File/Survey_methods.pdf](http://yosemite.epa.gov/Sab/Sabproduct.nsf/WebFiles/SurveyMethods/$File/Survey_methods.pdf). **Survey questions eliciting information about attitudes, preferences, and intentions** are most often presented in a verbal format, either in face-to-face or telephone interviews or in printed questionnaires. Assessments of values for ecosystems and ecosystem services can be well-conveyed in perceptual surveys (e.g., assessments based on photographs, computer visualizations, or multimedia representations of targeted ecosystem attributes) and conjoint surveys (e.g., requiring choices among alternatives that systematically combine multiple and potentially competing attributes). Quantitative analyses of survey responses are usually interpreted as ordinal rankings or rough interval-scale measures of differences in assessed values for the alternatives offered. Survey questions about social and psychological constructs may be especially useful when the values at issue are difficult to express or conceive in monetary terms, or where monetary expressions are likely to be viewed as ethically inappropriate.*

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Further reading

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- Schaeffer, N.C. and S. Presser. 2003. The science of asking questions. Annual Review of Sociology 29: 65-88. 45*
- Tourangeau, R. 2004. Survey research and societal change. Annual Review of Psychology 55: 775-801.*
- Wilson, T.D., D.J. Lisle, D. Kraft, and C.G. Wetzel, 1989. Preferences as expectation-driven inferences: Effects of affective expectations on affective experience. Journal of Personality and Social Psychology 56: 4519-530.*

Individual narratives and focus group methods have also been used in values assessments, but these methods are generally more appropriately used as formative tools for the design and testing of formal quantitative surveys. While surveys are typically based on quantitative analyses of responses from large representative samples, individual narrative methods – including mental-model analyses, ethnographic analyses,

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and other relatively unstructured individual interviews – generally employ small samples of informants and analyze responses qualitatively. For example, mental models studies seek to assess how informed people are about the consequences of specific decisions and their decision-relevant beliefs. Mental models studies of risk communication explicitly compare causal beliefs with formal decision models. How people understand relevant causal processes – that is, in this case, their mental models of ecosystems and the services they provide – can be critical to their judgment of the outcomes and effects of environmental programs and can influence their preferences among policy alternatives. Similarly, **focus groups** can be used to elicit information about values and preferences from small groups of relevant members of the public engaging in group discussion led by a facilitator. Rigorous qualitative analyses of transcripts from individual narratives (including mental models studies) or focus groups can expose subtle differences in individual beliefs and perspectives and the inferential bases of participants’ expressed values. However, the use of qualitative measures and the uncertainty of any generalizations of results from small respondent samples limit the utility of these methods for formal policy and decision making.*

Given the small number of participants, the goal of individual narratives and focus groups is rarely to assess the public’s values per se. Rather, these methods seek to identify the types and range of value perspectives, positions, and concerns of individual participants, and to use this information to identify the ecosystem effects that might be particularly important to the public. The open-ended nature of these methods can reveal perspectives and concerns that more structured methods might miss. Thus, these methods can provide useful input early in a valuation process. For example, they are often used in the early stages of designing a formal survey to elicit quantitative value information from a broader representative sample (a “probability sample”) of the relevant population.

** This comparison of causal beliefs with formal decision models entails three steps. First is the construction of an expert decision model, generally through systematic, formal decision analysis involving scientists and other topical experts, individually or in groups. Following this is the analysis of semi-structured interviews with individuals from the population of interest, and comparison of these to the decision model. Third is the design and fielding of a survey to test the reliability of findings from the interviews in a representative sample of the population of interest or the public at large. The interviews and surveys employ mixed methods, and assess both how decision makers intuitively structure and conceptualize their environmental mitigation decisions, as well as how they react to structured stimuli and questions (Morgan et al., 2002).*

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Recently, researchers have explored the use of behavioral observation methods for obtaining information about people's values. These methods elicit values information through observations of behavioral responses by individuals interacting with either actual or computer-simulated environments. Observing how the activities of people change as environmental conditions change can reveal information about the importance

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of these changes to those people. Researchers can observe changes in actual behavior (e.g., visitation rates) or virtual behavior (e.g., responses in interactive computer simulation games). Behavioral observation methods are consistent with other revealed preference methods (see the following section), but they are still relatively new and untested, particularly in the context of valuing ecosystem services. Nonetheless, they show promise for use in this context.

Further reading

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- Gimblett, H.R., T.C. Daniel, S. Cherry, and M. J. Meitner. 2001. The simulation and visualization of complex human-environment interactions. Landscape and Urban Planning 54: 63-79.*
- Wang, B. and R.E. Manning. 2001. Computer simulation modeling for recreation management: A study on carriage road use in Acadia National Park, Maine, USA. Environmental Management 23: 193-203. 46*
- Zacharias, J. 2006. Exploratory spatial behaviour in real and virtual environments. Landscape and Urban Planning 78: 1-13.*

Overview. EPA has a number of laws, regulations and guides to assure that “the Agency considers public concerns, values, and preferences when making decisions” (EPA 2003, p 1). The social-psychological methods described in this section are consistent with that goal and can also contribute to systematic quantitative assessments of the values of protecting ecosystems and ecosystem services. Survey methods are the most frequently used means for identifying public values and concerns (“what people care about”) and for measuring the degree of public preference, acceptance and support for alternative environmental outcomes and associated social consequences (see [discussion of survey methodology](#)). Surveys are also used to predict how various segments of the public are likely to respond to projected changes in environmental conditions and to alternative management means for affecting those changes. Related

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methods, such as focus groups and individual narrative interviews, can support agency decision making by elaborating and enriching understanding of the different perspectives of various stakeholders and concerned citizens.

EPA's charge to protect ecosystems and ecosystems services is consistent with widely shared public concerns and values (e.g., Dunlap et al. 2000). However, the formulation and implementation of specific ecological protection policies will often involve scientific and technical considerations which the lay public can not be expected to fully understand and appreciate. Further, some publics may have local knowledge, values or concerns not fully accounted for by specific policies, programs or involved scientists. Surveys and the other methods described in this section have proven effective in uncovering assumptions, knowledge, beliefs and feelings underlying expressed preferences and concerns so that decision makers can better understand and address conflicts between various publics and between public preferences and ecological science. Moreover, there are a number of methods for introducing relevant information into or prior to a systematic survey that can help to assure that respondents have an adequate and appropriate foundation for expressing requested preferences and other judgments (see detailed discussion of [survey methods](#)).

While public opinion is sometimes directly used to make policy decisions (see detailed information on [referenda and initiatives](#)), social-psychological assessment methods more typically are intended for decision support. These methods may be seen as addressing the psychological foundations for subsequent actions toward the measured policy and outcome alternatives. Perceptions, attitudes and beliefs are presumed to be logical antecedents to political support, direct, indirect or hypothetical monetary payments, and to acceptance of and compliance with relevant regulatory mandates. Typically, separate measures are reported for several different value dimensions (e.g., aesthetic, ethical, personal-utilitarian, civic) across designated sets of policy alternatives or for specific features of those alternatives and their outcomes. Consistent with a multi-attribute value framework, there has been little emphasis on aggregating all expressed concerns and preferences into a single, universal value scale (as required for economic cost-benefit analysis methods, for example). Respondents may be required to make

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explicit or implicit choices among competing values and concerns within the context of a particular survey, allowing an empirical assessment of value tradeoffs within the context established by the particular survey, but more universal substitutability or commensurability across the different values represented is not generally assumed. Differences between value dimensions are typically investigated and statistically quantified, but social-psychological assessment methods do not usually attempt to resolve value differences through aggregation algorithms or other calculation devices within the assessment process. Similarly, differences in expressed values across different subsets of survey respondents are also frequently identified and quantified. Resolution of differences between multiple values and value domains, and between different constituencies within survey respondents is more typically deferred to later stages of the decision making process, where information integration, deliberation and negotiation is left to authorized decision makers or is addressed in more or less formal deliberations between stakeholders/publics and decision makers (e.g., see detailed information on [decision science methods](#)).

Social-psychological approaches to assessing the value of ecosystems and ecosystem services enlist both quantitative and qualitative methods. Formal surveys and questionnaires typically rely on standardized descriptions of alternative objects/states (e.g., alternative environmental conditions, management policies, socially-relevant outcomes), with respondents recording explicit choices, rankings or ratings that are statistically analyzed to develop appropriate quantitative metrics (e.g., preference, importance or acceptance indices). Focus groups and individual narrative interview methods typically employ less restrictive representations of options, are frequently directed at specific local cases that are familiar to respondents, and collect open-ended narrative responses that are subjected to more or less rigorous qualitative analyses. These methods have often been used to support the design and pre-testing of subsequent quantitative surveys, but they are increasingly being offered as stand-alone assessments. In addition to the more established methods, some emerging methods base assessments on more direct observations of behaviors in the environments at issue. Behavioral observation and behavior trace methods have been developed and evaluated, especially in

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the context of the assessment of recreation and tourism values (e.g., Daniel & Gimblett 2000; Gimblett et al. 2001). Computer simulation (“virtual reality”) and interactive game methods are also being developed, but have mostly been applied in research settings (e.g., Bishop et al. 2001a; 2001b). These emerging methods may not yet be sufficiently proven for application in EPA policy-making contexts, but they do show considerable promise for applications in circumstances where the validity of verbal expressions of preferences and concerns in response to described hypothetical conditions may be suspect. They will only be briefly described in this section and are offered primarily as potential targets for future research and development.

Brief Description of the Methods: Surveys. Surveys encompass a broad range of methods for systematically asking people questions and recording and analyzing their answers (e.g., Dillman 1991; Krosnick 1999; Schaeffer and Presser 2003). Questions may assess knowledge, beliefs, desires and/or behavioral intentions about a virtually unlimited range of objects, processes, or states of the person, society or the world. Multiple questions/issues are typically presented and responses are reported as choices (among two or more options), rankings, or ratings. Open-ended response formats are less often used, and pose special problems for quantitative analysis. The most popular media for surveys have been face-to-face, mail or telephone communication with individually sampled respondents. Web/internet media are increasingly being used and are rapidly becoming more sophisticated, but representative sampling issues require special attention. Increased reliance on cellphones has also raised questions regarding the representativeness of landline telephone samples.

Social-psychological surveys have been extensively used to assess understanding, beliefs, attitudes, preferences, importance and acceptability of presented policies, management actions and outcomes, and/or the expected personal or social consequences thereof. Multiple value dimensions (e.g., utilitarian, aesthetic, civil, ethical) may be addressed within and between different surveys, and surveys may instruct respondents to assume individual/personal, household/family or social/civic constituencies. The indices produced by application of appropriate quantitative analyses of recorded responses usually claim to be only ordinal (ranks) or roughly interval scale measures of relative

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differences in one or more types of assessed values across offered alternatives.

Moreover, expressed preferences or other value judgments are assumed to be at least in part created in the context of the survey (Schaeffer and Presser 2003). Thus, generalization of obtained values measures (e.g., “values transfer”) beyond the objects specifically assessed within a given survey must be approached with considerable caution. A good example of survey methods is the extensive national survey conducted to support the USDA Forest Service Government Performance Results Act process (Sheilds et al. 2002), which is illustrated below.

National telephone survey

A nation-wide telephone survey was conducted to provide support to the USDA Forest Service Strategic Plan for 2000 required by the Government Performance and Results Act. The survey randomly sampled over 7000 US citizens to determine held *values* relevant to public lands, preferred *objectives* for management of public forests and grasslands, *beliefs* about what the role of the Forest Service should be with regard to these objectives, and public *attitudes* about the job the Forest Service is doing toward fulfilling the desired objectives. The items for this “VOBA” survey were developed and pre-tested through more than 80 focus groups conducted across the country. Individual respondents in the telephone survey assigned ratings on 5-point scales to each to only a balanced subset of the total 115 items/questions developed by the focus groups. The items included, *objective* statements (30 items) rated on an *importance* scale, beliefs (30 items) and values (25 items) rated on a *disagree-agree* scale and attitudes (25 items) rated on an *unfavorable-favorable* scale.

Some example items from the survey and their mean ratings over the full national sample are presented in the table below. Items are selected for potential relevance to C-VPESS interests and they are grouped to display the observed discrimination in responses. Many of the same items were rephrased and repeated in several of the value, objectives, beliefs and attitudes categories (across, but not within respondents). Only the values and objectives category formats and mean ratings (agreement and importance, respectively) are presented here, as the beliefs and attitude items were specific to the Forest Service. Some items may be reversed from the original presentation so that higher means always indicate higher agreement/importance ratings.

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Example items from the Ribe et al., survey and their mean ratings over the full national sample		
Item Examples	Values	
	<i>Mean Agreement</i>	<i>Mean Importance</i>
Wildlife, plants and humans have equal rights to live and grow.	4.28	
Future generations should be as important as the current one in the decisions about public lands.	4.52	
We should actively harvest more trees to meet the needs of a much larger human population.	2.88	
The decision to develop resources should be made mostly on economic grounds	2.92	
Protecting ecosystems and wildlife habitat		4.58
Conserving and protecting forests and grasslands that are the source of our water resources, such as streams, lakes, and watershed areas.		4.73
Expanding access for motorized off-highway vehicles on forests and grasslands (for example, snowmobiling or 4-wheel driving).		2.41
Designating more wilderness areas on public land that stops access for development and motorized uses.		3.84
Developing new paved roads on forests and grasslands for access for cars and recreational vehicles.		2.62
I am glad there are National Forests even if I never see them	4.66	
I would be willing to pay five dollars more each time I use public lands for recreational purposes (for example, hiking, camping, hunting).	3.49	

Individual item standard deviations ranged from 0.75 to 1.50. Sample sizes were not reported per item, but would be large (several hundreds of respondents each) so that standard errors of the reported means would be very small.

Respondents also answered a number of demographic questions and provided information about their use of public forests and their knowledge of and association with the forest service. These items were used to identify several sub-groups that produced different patterns of response to the items in the survey. For example, the authors report, “Metropolitan residents in both the East and West see the objective of protecting ecosystems and wildlife habitat as more important than do those in non-metropolitan areas. Within non-metropolitan areas, those in the East are more in favor of such programs than are westerners.” p 11.

Similar surveys could obviously be designed to address issues relevant to EPA efforts to protect ecosystems and services. The example Forest Service survey was targeted on broad national strategic goals and concerns, but surveys may be even more effective in assessing beliefs, preferences and attitudes about more specific management alternatives

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and outcomes. In some cases, where the relevant dimensions of outcomes may be subtle and difficult to describe in words, visualizations and other perceptual representations may be more effective in eliciting public preferences (as illustrated in the Text Box on Perceptual Surveys, later in this section).

Source: *Shields, D. J., Martin, I.M., Martin, W.E., Haefele, M.A. 2002. Survey results of the American public's values, objectives, beliefs, and attitudes regarding forests and grasslands: A technical document supporting the 2000 USDA Forest Service RPA Assessment. General Technical Report, RMRS-GTR-95. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 111 p*

Surveys have become ubiquitous in modern society, with uses ranging from assessments of diners' satisfaction with the service at a restaurant to citizens' support for major national policies (Dillman 2002). Surveys are now frequently directed by computer programs that can select and order questions individually for each respondent, sometimes based on their specific responses to prior questions. Increasingly surveys are fully implemented by computer, allowing the respondent to control (with more or less restriction) the pace of questions and to record their responses directly into a computer database by key presses, clicks or voice commands (Tourangeau 2004). Internet-based methods offer extended possibilities for contacting respondents, presenting questions, and recording responses and their use is increasing. However, web surveys may raise representative-sampling and other issues that require special attention (e.g., Couper 2001; Tourangeau 2004; also see the web-accessible description of [survey issues](#) provided to the C-VPESS committee).

Variations on survey research methods that may be especially appropriate for assessments of ecosystems and services include perceptual and conjoint representations of assessment targets. In perceptual surveys assessment targets (e.g., existing environmental conditions and/or projected policy outcomes) are represented by photographs, videos, computer visualizations, audio recordings, or even chemical samples representing different smells or tastes (as might be used to assess drinking water, for example). As for verbal surveys, responses are typically choices, rankings or ratings of the offered alternatives. Perceptual surveys may be seen as extensions of traditional psychophysical research methods that have long been applied to assess qualities and preferences for foods and other products that are difficult or impossible to describe

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effectively with words (Daniel 1990). Relevant examples include assessments of the visual aesthetic effects of alternative forest management policies (e.g., Buyhoff et al. 1982; Daniel & Boster 1976; Ribe et al. 2002; Ribe 2006), of in-stream flow levels on scenic and recreational values (e.g., Brown et al. 1991; Heatherington et al. 1993), of visibility-reducing air pollution on visitor experience in National Parks (e.g., Malm et al. 1981), and assessment of the annoyance produced by aircraft over-flight noise in the Grand Canyon (Mace et al. 1999). An illustration of perceptual survey methods based on Ribe et al. 2002 is presented in Perceptual Surveys, below.

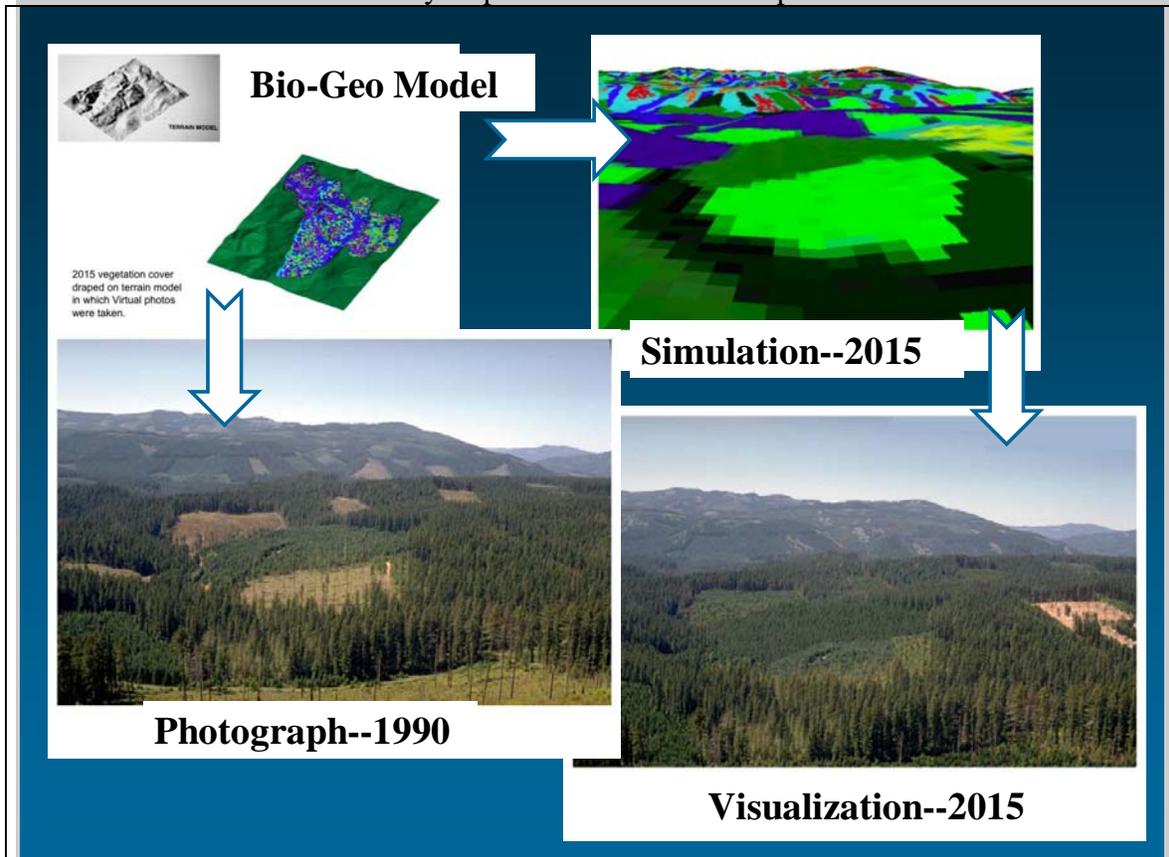
Perceptual Surveys

A study by Ribe et al. (2002) provides a good illustration of a perceptual survey employing computer visualization technology. The focus of this study was on the aesthetic effects of the shift to more ecologically motivated forest management in the Northwest US. The survey sought to determine how the Northwest Forest Plan (NFP, arising out of the spotted owl controversy) would affect the perceived scenic beauty of affected landscapes in public forests. Another study objective was to investigate the possible contributions of landscape design principles contained in the US Forest Service Scenery Management System for assessing NFP harvest prescriptions to provide better aesthetic results. The description here will focus only on the visualization and perceptual survey components, and how these methods were used to attain quantitative measures of the aesthetic affects of shifting the emphasis in forest management from economic to ecological goals.

The basic strategy of this assessment was to first select a representative set of forest areas where the NFP prescribed changes to forest management. From within these areas, 15 forest landscape scenes (“vistas”) were selected to represent a range of forest and visual conditions consistent with pre-NFP management practices. Geographic information system (GIS) technology was used to create detailed land-cover maps and 3-D terrain models of the visible area of each scene (from their respective designated viewpoints). GIS perspective view techniques were used to create a “virtual photograph” of the scene so that color-coded vegetation features (e.g., forest with different levels of thinning, clearcuts of various sizes and stages of re-growth) could be accurately located within the view. An actual photograph was also taken from each viewpoint and was compared with the virtual view to assure accuracy. Forest harvest and growth models and expert judgments of trained foresters working in the study area were then combined to create detailed projections of the expected bio-physical effects of NFP forest management plans (e.g., removal and re-growth of forest vegetation) over 20 years following the implementation of modeled NFP management actions.. GIS and terrain modeling techniques were again applied to create virtual photographs to represent the projected changes in the visible landscape encompassed within each selected forest scene. Finally, digital editing methods were used to introduce appropriate forest imagery (e.g., 5-year re-

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grown clearcut, thinned forest, etc) into the scene to create a biologically accurate and photographically realistic visualization of the projected forest conditions. The figure below illustrates some of the key steps in this visualization process.



The digital visualizations of future forest conditions and the actual digital photos for each of 15 selected study scenes were rendered to color slides. Study scene slides were randomly intermixed with slides of 90 additional scenes representing a wide range of forest conditions in the region and presented in a perceptual survey. The 608 respondents were sampled (not randomly) from 31 diverse public groups in the Cascade region affected by the NFP. Respondents recorded their judgments of the scenic beauty of each scene independently on an 11-point scale ranging from “extremely ugly” (-5) to “extremely beautiful” (+5). Because scenes were rated by the same groups of respondents in the same context, simple mean ratings were judged an appropriate index of the relative scenic beauty of the scenes. Because the study scenes were specifically selected to represent particular forest management-by-view parameters (not random samples of all possible forest scenes) statistical comparisons were restricted to the pre-NFP versus post-NFP pairs for each of the selected base scenes.

The mean differences between pre- and post-NFP pairs for the 15 selected forest scenes ranged from -3.05 (favoring the pre-NFP prescription) for a close-up view of a recent harvest to +2.39 favoring the NFP prescription in a larger scale vista with numerous

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partial harvest sites in the visible area. For 6 of the 8 scenes selected to have large to medium-sized view areas scenic beauty ratings were significantly higher for the post-NFP scene. Regression analyses identified several objectively measured variables affecting scenic beauty differences between pairs of scenes. The key factors were the percent of the visible area of a scene covered by recent, high-contrast clearcuts in the middle distance and in the far distance of the view (both with negative coefficients).

The NFP management prescriptions apply to public lands and were primarily driven by ecological considerations. In the most conspicuous cases (the larger views) these ecological prescriptions also produced significant improvements in scenic beauty as perceived by relevant publics in the region. While this study did not directly address the question, a similar perceptual survey, along with standard forest vegetation cover and harvest data could be used to assess tradeoffs among economic, ecological and aesthetic values for forest management alternatives (including NFP and other approaches) based on a systematic sample of viewpoints/scenes across a landscape of interest. Such tradeoff assessments and regression-based models could be used by forest planners to develop detailed harvest prescriptions and schedules for specific sites allowing NFP ecological guidelines to be met while maintaining or enhancing economic and aesthetic goals for the public landscape. In EPA contexts, similar landscape modeling and visualization techniques in combination with perceptual survey methods might be applied to assess aesthetic and other visual impacts at contaminated sites, as well as to assess the relative merits of alternative restoration and reuse options.

Source: Ribe, R.G., Armstrong, E.T., & Gobster, P.H. 2002. *Scenic vistas and the changing policy landscape: visualizing and testing the role of visual resources in ecosystem management. Landscape Journal, 21: 42–66. Image used with the permission of the author.*

Surveys most often present the individual attributes of assessment targets separately. For example, a survey to assess the effects of a proposed environmental policy might present separate questions to determine respondent's judgments about effects on air quality, water quality and local employment. Conjoint survey questions (e.g., Adamowicz et al.1998; Boxall et al. 1996) instead present options as multidimensional composites or scenarios presenting integrated/conjoined combinations of different attributes (e.g., each option presents a different combination of levels of air quality, water quality and local employment). Combinations generally reflect actual or projected variations in the attributes (e.g., specific levels of air and water quality and local employment opportunities). In the more sophisticated conjoint surveys, the particular combinations of attributes represented are specified by an experimental design that allows estimates of the separate and interacting effects of component attributes

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(Louviere 1988). Multiple regression (or similar) analyses are used to estimate the relative contributions of individual components (attributes) to the expressed preferences (or other judgments) for the conjoint alternatives.

Analyses of responses to conjoint survey questions can provide relatively direct estimates of the value tradeoffs people make when choosing among outcomes composed of multiple attributes that naturally covary and whose values potentially conflict and compete. When at least one of the attributes that forms the conjoint alternatives is (or can be) valued in monetary terms, and the relevant theoretical assumptions and methodological criteria are met, the regression equation based on expressed preferences among the conjoint alternatives can be translated so that coefficients for all attributes are expressed as monetary values (see information on [stated preference economic methods](#) provided by members of the SAB C-VPES). An illustration of conjoint survey methods is presented in the text box below.

Conjoint Surveys

Conjoint methods may be especially well-suited for gauging public preferences across sets of complex multi-dimensional alternatives, such as alternative EPA regulations or management options for ecosystems/services protection. Respondents choose among (or rank or rate) multi-dimensional “conjoint” alternatives that present specific packages of desired and less-desired attributes. Analyses of the patterns of preferences values (e.g., probability or percent choice or mean rating) among the conjoint alternatives can be used to estimate the contribution (e.g., regression coefficients) of each of the separate attributes.

Chattopadhyay, Braden and Patunru (2005) used a conjoint survey method to assess the effects on residents’ home preferences of various cleanup options for the Waukegan Harbor Superfund site in Wisconsin. This study also employed and compared results of a hedonic pricing method, but the monetary estimates of willingness-to-pay for the cleanup options evaluated were based on stated preferences in a conjoint survey, which is the subject of this illustration. Adjustments for differences in respondents’ incomes, annual costs for current housing and for the hypothetical housing options offered (based on real estate market data) and a number of composite and interaction terms involving economic variables were introduced to conform to assumptions of relevant economic theory and practices. However, the basic data are simply respondents’ choices (expressed preferences) among alternative hypothetical conjunctions of housing and environmental-condition attributes. The core features of the study nicely illustrate an application of a

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conjoint choice survey that could as (or more) easily be used to obtain an interval scale measure of the effects of cleanup options on housing preferences.

Housing market data for 47,100 transactions (1996-2001) for Waukegan and 12 similar nearby cities along with focus group sessions with homeowners were used to determine the six housing/environmental attributes that were conjoined to describe the hypothetical housing options and to describe the respondent’s own current home/environment. Housing attributes were *lot size*, *house size* and *house price*. Environmental attributes were *elementary school class size*, *public areas near the harbor*, and *extent of changes proposed in the harbor-area pollution*. Each of the 6 housing/environmental attributes was represented by four levels, so that in principle there could be $4^6 = 4096$ distinct conjoint options. A fractional factorial experimental design (with a “fold-over” to allow estimation of two-way interaction terms) was used to determine the $64 \times 2 = 128$ conjoint options that were actually assessed in the survey. The details and rationale for this complex design is beyond the scope of this illustration, but the key point is that the alternatives selected allow for statistical estimates of the separate effects of each of the housing/environmental attributes on overall preferences (or overall w-t-p estimates in the present study) across all of the options. All 128 selected options were assessed in the study, but each of the 954 respondents (from 2339 surveys mailed to the 13 targeted communities) only responded to a random subset of 16 options.

In a typical conjoint choice study, respondents would see pairs of the conjoint house/environment options and be required to choose between them. Chattopadhyay et al. instead chose to reduce the length and complexity of the task by comparing each hypothetical alternative to a standard—the respondent’s current home/environmental conditions. The difference on each of the 6 attributes between the current home and each hypothetical option was expressed as a percentage. For example, the *house size* attribute could be 15% smaller, unchanged, 15% larger or 25% larger than the respondent’s current home, and the *harbor area environmental condition* could be additional pollution, no change (from current conditions), partial cleanup or full cleanup. A facsimile of an illustrative choice question in the survey is presented in the table below.

Home #1: Imagine your home modified to fit this description.						
	Lot size	House size	School class size	Public/natural areas in harbor area	Harbor area environmental condition	House price
Compared to your current home:	Smaller by 15%	Smaller by 15%	Smaller by 2 students	Smaller by 20%	Additional pollution	Less expensive by 10%
Which do you prefer?						
<input type="checkbox"/> The home described above <input type="checkbox"/> My current home						

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The core data for the conjoint choice study is the observed probability of choice for each of the 128 hypothetical house/environment options over the current home. These probabilities can be used to derive more sophisticated quantitative value scales, but basically the worst options (least preferred) would be chosen less often and the best would be chosen more often. In conjoint studies choices for the hypothetical multi-attribute options is usually of less interest than are the estimates of the contributions of the respective house/environment attributes to those expressed preferences. There are numerous methods for attaining these estimates, most based on multiple regression analyses of one kind or another. In the Chattopadhyay et al. study a multinomial/conditional logit model was used. The details of this analysis are not relevant to this illustration, but the basic outcome of such a conjoint choice study can adequately be portrayed as a regression equation of the following form

$$P_i = w_1(A1_i) + w_2(A2_i) + w_3(A3_i) + w_4(A4_i) + w_5(A5_i) + w_6(A6_i)$$

where

P_i is probability of choice (versus current home) of conjoint alternative i
 w_1 is the regression coefficient for house/environment attribute 1 (e.g., lot size)
 $A1_i$ is the level for attribute 1 for alternative i (e.g., 15% smaller)
and so on for each of the other 5 house/environment attributes.

Chattopadhyay et al. scaled the weights in a much more complex equation (including derived economic terms and interactions) to attain monetary benefit estimates on the basis of which they offered conclusions such as

...the significant coefficient for the interaction variable *full*highinc* indicates that high-income residents prefer full cleanup more than other categories, while the insignificant coefficients on *addpol*highinc* and *part*highinc* indicate that high-income residents are no different from others (income levels) with respect to their dislike for additional pollution and their preference for partial cleanup. p 367

The authors went on to estimate aggregate monetary benefits of partial and full clean up of the Waukegan Harbor Superfund site (\$249 million and \$535 million, respectively). The validity of these monetary estimates, of course, depends upon a complex set of assumptions required by general economic theory and by specific features of the present study, which may also affect reliability of the estimates. Most of these assumptions would not be required for the more basic analysis of expressed preferences suggested in this illustration. The attribute weights (regression coefficients) in the suggested simple preference equation can be interpreted as relative (interval scale) measures of the tradeoffs the sampled respondents made between the offered changes in harbor environment cleanup (from additional pollution to full cleanup) and the other house/environmental attributes represented by the options in the study.

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Once determined, the preference-based regression equation could also be used to estimate preferences for new policy alternatives based on their respective projected changes in environmental conditions, so long as those options fit sufficiently within the range of the attributes and levels assessed and the constraints imposed by the context of the survey in which the house/environmental condition options were offered and judged. Optimization or less formal heuristics might be applied to create additional policy options for consideration and/or for direct evaluation in subsequent conjoint surveys.

Source: Chattopadhyay, S., Braden, J. B., & Patunru A. (2005) *Benefits of hazardous waste cleanup: new evidence from survey- and market-based property value approaches*. *Contemporary Economic Policy*, 23, 3: 357-375.

Brief Description of the Methods: Focus Groups. Focus group methods engage small groups of relevant stakeholders in facilitated discussion and deliberation on selected/focused topics relevant to the assessment of the effects of a policy, or alternative policies, and associated outcomes or consequences (Merton, Fiske & Kendall, 1990). Typically experts and/or trained facilitators present the context, motivation and goals for the group and open-ended narratives are collected from the participants, usually in the context of discussion and deliberation with other members of the group and the experts/facilitators. It is common for focus groups to be used in the process of designing and pre-testing more formal surveys. For example the Shields et al. 2002 survey described above employed 80 focus groups distributed across the nation to develop the USDA Forest Service survey illustrated above.

Reports of focus group results typically include numerous quotations of collected comments, along with the investigators' interpretations of the implications for the problems/policies/outcomes being addressed (e.g., Winter and Fried 2000). Less often, collected narratives are subjected to more rigorous analyses based on formal logic models or discourse analysis systems (Abell 2004; Bennett and Elman 2006). Relative to formal surveys, focus group studies typically rely on small numbers of respondents and do not employ formal probability sampling for participant recruitment. Emphasis is instead on assuring the full range of interests and perspectives relevant to the policies or outcomes at issue are represented. The goal of a focus group is rarely value assessment per se, but rather a full discovery and articulation of all of the values and concerns that are relevant, and exploration of agreements and conflicts among the stakeholder constituencies

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represented by participants. Thus, focus groups are often employed early in policy and decision making, including the identification of the problems to be addressed and the formulation of alternative policies to address those problems.

Brief Description of the Methods: Individual Narratives. Researchers using individual narrative methods contact and directly interview individual respondents. Unlike focus groups, respondents participate alone, without interaction or discussion with experts, facilitators or other respondents. Respondents are not typically selected by a random, probability sampling process. Most often individuals are specifically targeted because of their known or assumed nominal group membership or personal relationship to the problem/policy/outcome at issue. The sample may be extended by having prior respondents refer others thought to be relevant, as in “snowball” sampling (Goodman, 1961). The number of individuals to be included is quite variable, and in a relatively few cases has been determined by some formal process based on a rolling analysis of collected narratives (e.g., using a criterion of diminishing new perspectives/positions being discovered). Selected respondents are asked to comment on relatively broadly defined topics with relatively little direction from the interviewer/assessor (e.g., Brandenburg & Carroll 1995; Löfstedt 1991). Collected narratives are subjected to more or less rigorous qualitative analyses, (somewhat analogous to the analysis of focus group responses) to explore and articulate the breadth and depth of expressed understandings and concerns relevant to the assessment target. Included in this category are various ethnographic methods and mental modeling procedures.

As described above, a widely used approach is to use exploratory, open-ended research methods to understand better the target population’s conceptual landscape of the survey topic, before designing specific survey items and response scales. Focus groups are perhaps the best known of these kinds of exploratory approaches. The group dynamics of focus groups may reveal, but can also obscure, specific conceptual issues, wording choices, and individual differences in understanding of a topic or domain. Interviews designed to probe individuals’ mental models of the topic are a useful complement or alternative to focus groups. A mental models approach can inform debate

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about the best ways to elicit values, and about how people use and understand different qualitative and quantitative expressions of value, response scales and response modes.

Mental models studies aim at eliciting people's understandings of causal processes associated with the consequences from specific decisions or actions. People use their prior (pre-existing) mental models to interpret survey questions and other preference-elicitation probes and to draw inferences.

Mental models research would be an appropriate precursor (i.e., formative analysis) to any formal survey or preference elicitation method, to improve the validity and reliability of the method. Mental models research can provide insights into causal beliefs, specific terminology/wording, and the scope and focus of mental models in the decision domain of interest. A mental models approach would have to be used in conjunction with another method in order to obtain benefits numbers. The approach is qualitative, designed to elicit how an individual conceptualizes and categorizes a process, such as protecting an ecological service, and how that individual would make inferences about and decisions to influence that process. The method is appropriate for use in all identification stages (ecological modeling; what matters; ecological impacts that matter), with the possible exception of identifying EPA's objective(s). The method requires qualitative analysis of results, in order to provide effective input to survey instrument design.

Issues in implementing mental models research. Mental models research is resource-intensive, if carried out carefully, but can be used effectively as a starting point for any survey or broader scale research on values. The method assumes that a fairly small sample will characterize the distribution of basic beliefs about the hazard/risk to be found in the population of interest, and that a larger representative sample can be drawn and will respond to surveys. A follow-up survey is generally necessary before drawing conclusions about the distribution of particular beliefs and mental models. As with most methods, to some extent the effort invested will correspond to the quality of the product the method produces. A casual application of the method could be carried out by a single researcher, with sufficient time and training in decision analysis, interview and survey

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research methods, and the focal domain. A team of 3-4 researchers working together fulltime could probably carry out an entire mental models study in a month, if they had access to domain experts and members of the target population to interview/survey.

Potential obstacles to the effective use of the method include the following: institutional review board clearances, Information Collection Request Clearances under the Paperwork Reduction Act, lack of training in interview and survey research, and qualitative research methods more generally, difficulty obtaining responses from randomly sampled members of the population, and lack of familiarity with decision analysis are probably the largest obstacles to effective use of the method.

Mental models research assumes some homogeneity in how people conceptualize the world, and requires an underlying theory of culture and meaning (e.g. Romney, Weller, and Batchelder 1986; Romney et al. 2000 on the theory of culture as consensus), but no more so – and possibly less so - than other survey or interview research. Variability in beliefs is captured, as well as qualitative statements of certainty or uncertainty. The method could be adapted to assess beliefs about system dynamics.

The output of mental models studies is generally easy to communicate, understandable, and of interest to intended audiences. Even simple analyses of the data, including frequencies of beliefs and co-occurrences of beliefs, can go a long way toward clarifying how people respond to messages/statements/questions about the focal topic. In those few comparisons that have been made to date (e.g., mental models of global climate change), results from a mental models approach have been consistent with results from other exploratory analyses and cognitive maps (e.g., studies by cognitive anthropologists, such as Kempton (1991), and results from the surveys have been consistent with the interview results, within the method. A possible point of sensitivity is the choice of expert decision model(s) to be used as the basis for the coding of the interviews.

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Mental Models of global climate change

Several studies have examined mental models of climate change, including a pair of studies by Bostrom et al (1994) and Read et al (1994). Bostrom et al use a semi-structured interview protocol to interview two small convenience samples of respondents (N=44), opening with “Tell me all about the issue of climate change... “ The structure of the interview protocol itself follows roughly the causal model for risk processes outlined in Hohenemser et al (1985) and described by Morgan (e.g., Morgan, 1993). Increasingly structured questions probe the respondent to assess reactions to standard questions in addition to how the respondent structures the domain, as assessed by responses to the open-ended questions. Following verbatim transcription of the taped interviews, the transcripts are coded by comparison with an expert decision model. For the climate change study, the expert decision model used for coding transcripts of interviews was a high-level, qualitative abstraction of ICAM, an integrated climate assessment model developed at Carnegie Mellon University. The follow-on survey study (Read et al, 1994) implements a survey instrument built on the findings from the mental models interviews in Bostrom et al. The survey systematically assesses beliefs regarding climate change risk exposure, effects and mitigation beliefs (mitigation defined broadly to include avoidance, abatement, and adaptation). Conclusions from these studies, such as the common confusion of the greenhouse effect and stratospheric ozone depletion, and the prevalence of a general “pollution” model as a cause of global warming, have also been found in other studies (e.g., Böhm and Pfister, 2001; Kempton et al 1995).

Mental models for the valuation of Tampa Bay Estuary changes

As part of a workshop sponsored jointly by EPA and EPA’s Science Advisory Board, Christel, Kempton, and Harris developed a prototype research proposal involving mental models research. The research proposal lays out a clear ethnographic approach to assessing mental models for valuation purposes. The study includes three interviews of disparate stakeholders, to illustrate the potential of ethnographic interview methods (as applied by cognitive anthropologists in this case) for revealing differences in patterns of causal beliefs, awareness and values. One of the findings demonstrated in this paper is lack of awareness of how tailpipes contribute to estuary pollution, except among experts.

Source: Christel, Douglas, Willett D., Kempton, and Jennifer Harris, *The Effect of Values and Cultural Models on Policy: An Anthropological Approach to Environmental Policy in Tampa Bay*. 2001. In *EPA Science Advisory Board Understanding Public Values And Attitudes Related To Ecological Risk Management: An SAB Workshop Report Of An EPA/SAB Workshop Prepared by The EPA Science Advisory Board*. Appendix D.4. EPA-SAB-EC-WKSP-01-001.

Brief Description of Emerging Methods. The assessment methods described in this section are relatively new and untested. They are characterized by more direct observation of responses to policies, outcomes and consequences in situ, avoiding

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problems of relying on hypothetical responses to described conditions. In that context, these methods parallel the revealed preference methods used in economic value assessments. Observed environmental behavior is often not consistent with what people say they would do in the specified circumstances (Cole and Daniel 2004) and people are often incorrect at identifying, or are unaware of the environmental factors that affect their behavior (e.g., Nesbitt and Wilson 1977; Wilson 2002). In the context of ecosystems and services, *behavioral observation* methods monitor the activities of people in a particular environmental context and observe changes in behavior as relevant conditions change over time within a site or over sites with differing characteristics. *Behavior trace* methods are based on indirect evidence of people's behavior in specific environmental contexts. For example, the number of visitors to recreation sites might be estimated by counting the number of autos parked at access points, by the number of passers-by recorded by automated trail counters, by the number of fire rings in dispersed camping areas or by the amount of trampling and disturbance of vegetation along trails and at destination points. Direct observations or traces of visitors' activities can be correlated geographically with relevant environmental/ecological conditions or monitored over time as changes in conditions occur at the same sites, revealing the effects of these changes on environmental preferences and reactions (e.g., Gimblett et al. 2001; Wang et al. 2001; Zacharias 2006).

These methods do not seem to have been applied in the context of assessments of the effects of changes in ecosystems and services. However, changes in human use of rivers, lakes and estuaries are often important indicators of the need for and the value of EPA interventions to protect water quality and associated aquatic systems, and the travel cost methods employed by economists in these contexts are fundamentally similar. Behavioral observation and trace methods might be effectively employed to attain quantitative measures of human use levels that could be used in conjunction with economic measures or as separate measures to be correlated with changes in ecological conditions. Numbers and durations of users, their geographic distribution and the activities that they engage in might be correlated with relevant bio-physical measures of

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ecological conditions to develop useful assessments of the effects of ecological degradation or the effectiveness of ecological protection efforts.

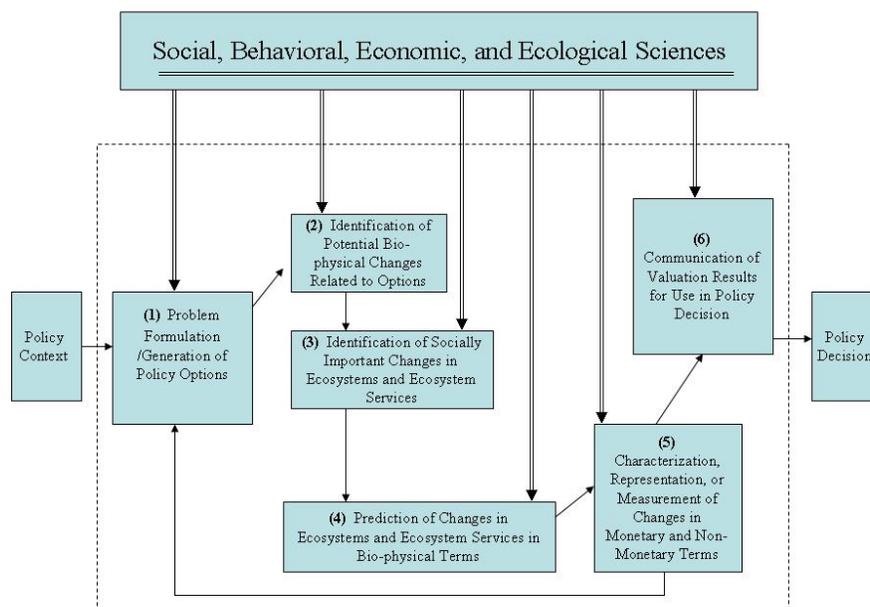
Interactive environmental simulation systems provide means to overcome some of the limitations and difficulties of conducting direct behavioral observations or interpreting behavior traces. Direct observation methods are necessarily limited to existing conditions and are potentially confounded by uncontrolled or unrecognized irrelevant variables. Most policy decisions hinge on people's responses to specific changes to not-yet-existing, projected environmental conditions. Rapidly advancing computer technology has enabled effective and economical simulation of complex dynamic environments at high levels of realism (e.g., Bishop and Rohrmann 2003; Bishop et al. 2001a; 2001b). The emphasis has been on visual presentations, but the technology can readily include auditory features and in some systems tactile, proprioceptive, olfactory, and other senses can also be effectively simulated to achieve very compelling, immersive environmental experiences. Moreover, expanding response options, ranging from the computer mouse to video-game controllers to gloves to full-body movement enable increasingly natural interactions with simulated environments. In the context of assessing the effects of changes in ecosystems and services, interactive computer simulation systems offer the opportunity to conduct virtual in situ experiments to determine how persons respond to specific investigator-controlled changes in environmental conditions. Thus the effects of manipulated conditions on environmental preferences and other reactions can be revealed in a context closely approximating "real world" circumstances.

Interactive computer simulation systems may be viewed as games, in which human respondents attempt to (virtually) navigate through and perhaps alter virtual environments to accomplish desired goals. There may be no particular outcome that can be defined as "winning" such a game, but the behavior of the player and the outcome on which s/he settles can reveal the values that motivate and guide the player's responses. *Interactive games* can be informative in this regard, even if they are played in substantially less than virtual environments. Indeed, more limited and/or more abstract games may have important advantages in some circumstances. For example, it may not

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be possible to project the explicit and detailed outcomes of a proposed policy that are required for a realistic environmental simulation, and the specific implications of particular responses to changing environmental conditions may not be known. In many situations only changes in some particular ecological component may be known and relevant (e.g., a reduction in a particular contaminant or an increase in survival rates of a particular wildlife or plant species). Still, a game-like context may be an effective and engaging way to communicate with public audiences about what outcomes they would prefer, and what policies are required to achieve those outcomes. A major advantage of games over surveys, for example, is the opportunity for respondents to learn through experience about how the ecosystem of interest responds to various policies or policy aspects and to progressively modify their expressed policy preferences to converge on some acceptable balance among desired and undesired outcomes.

Relation of Methods to the C-VPESSE Expanded and Integrated Assessment Framework. Surveys, focus groups and individual narrative methods all have useful roles to play throughout the valuation process envisioned by C-VPESSE (see figure below).



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Focus groups and individual interviews, for example, could contribute to initial problem formulation by identifying ecological services and impacts that most concern specific stakeholders or citizens more generally, as well as by uncovering assumptions, beliefs and values that underlie that concern, as in the mental modeling methods. Similarities and differences in assessed concerns, attitudes and beliefs toward proposed policies among different segments of the public can also be identified and articulated. Once relevant ecological endpoints have been defined and the personal and social consequences of those outcomes identified, focus groups and individual interview methods could be very useful for exploring public understanding of the links between chains of ecological processes and effects and the policy options under consideration (Box 3). Given a set of potential policy options, with their respective ecological endpoints (Box 4), systematic surveys based on probability samples could be used to assess relative public preferences (and/or importance or acceptability) for those options (Box 4). Quantitative indices of citizen/stakeholder preferences (importance or acceptability) from surveys could be considered along with bio-ecological and economic/monetary measures of the value of the same alternatives to cross validate and extend value measures, thus strengthening the foundation for policy decisions. Surveys may be especially useful when the values at issue are difficult to express or to conceive in monetary terms or where monetary expressions of values are viewed as ethically inappropriate. Properly designed and implemented surveys can provide reliable quantitative measures of public preferences among the policy alternatives or ecological endpoints that are under consideration, improving the basis for Agency decision making.

Surveys and focus group methods could make additional contributions after Box 5 in the C-VPESS model. The values of ecosystems/services coming out of Box 5 must inevitably be represented by multiple economic/monetary, bio-ecological and social-psychological value indicators. EPA administrators can be left with the difficult task of integrating these diverse and potentially conflicting measures, along with legal, budgetary and other constraints to make and rationalize policy decisions. Properly structured surveys, and/or focus groups, including material to inform respondents about relevant ecological and social effects, legal restrictions and other considerations affecting the

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policy/decision at issue, could effectively involve citizen stakeholders in this value integration and negotiation process, providing an additional relevant input to the policy decision, and adding to the political validity and social acceptability of the final action.

Individual narrative methods, such as the mental models method, would be most appropriate and most useful at the earliest and latest stages of the decision making process. While individual interview methods do not generally provide quantitative assessments for alternative policies or outcomes, they can make important contributions to improving the design, development and pre-testing of more formal surveys that can provide reliable and valid quantitative assessments of public concerns and values. Mental models methods are appropriate for use in all identification stages (ecological modeling; what matters; ecological impacts that matter), with the possible exception of identifying EPA's objective(s). Genuine probing interactions with individuals or groups representing key stakeholders and including divergent views and concerns should be a central part of problem definition and identification of significant ecological and associated social effects components of the policy making process. Such interactions with key stakeholders and with citizens could also inform the values integration and negotiation in the final decision process and guide and pre-test the communication of that decision.

Status of Methods. Survey questions measuring social-psychological constructs are the oldest and most frequently used methods for determining public beliefs, concerns, and preferences. Surveys have been and continue to be used effectively by all levels of government to measure citizen desires concerns and preferences. Economists have lately adapted survey methods to measure stated willingness-to-pay for non-market goods and services (Contingent Value Methods, CVM), and surveys are often relied upon to collect the data needed to exercise other economic valuation efforts, such as travel cost and hedonic pricing methods. Environmental management agencies have made use of surveys, either directly or indirectly, in setting policy and in making and monitoring the effects of management decisions (e.g., Shields et al. 2002, illustrated in Text Box 12 and the many surveys listed in Endnote 29 of the SAB draft report, *Valuing the Protection of Ecological Systems and Services.*)

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It is not clear the extent to which focus groups or individual narrative interviews are systematically used in EPA policy making, nor do the OMB and other guidelines clearly specify the criteria for using these methods. Focus groups are widely used in marketing and political polling contexts. Public meetings (following EIS prescriptions) and on-site demonstrations are frequently cited as playing a public involvement role in EPA policy decisions, but it is not clear whether any of these activities can be construed as using a focus group, nor is it clear how often such methods have been used to systematically compare alternative policies/actions. The use of focus groups would seem to be completely consistent with previous advice of the EPA Science Advisory Board (US EPA 2001) recommending increased use of “stakeholder processes” in Agency decision making. Stakeholder processes were defined as “...group processes in which the participants include non-expert and semi-expert citizens, and/or representatives of environmental non-governmental organizations, corporations and other private parties in which the group is asked to work together to: define or frame a problem; develop feedback in order to better inform decisionmakers about proposed alternative courses of action; develop and elaborate a range of options and/or criteria for good decision-making which a decision-maker might employ; or, either explicitly or implicitly, actually make environmental decisions.” (p 8) Still, the term “focus group” was not used anywhere in this document.

While no specific evidence has been found either way, it seems reasonable to assume that individual narrative interviews have not been important components of formal EPA decision making processes. Certainly the qualitative nature of the information provided by both focus groups and individual interviews, and the general disinterest in representative sampling makes them poor candidates for formal policy evaluation exercises, but that does not preclude their having a role in earlier stages of the decision making process as envisioned by the C-VPES. Mental models research could in theory be applied as a first step to investigate either “means” or “ends” values. This method would be an appropriate precursor (i.e., formative analysis) to any formal survey or preference elicitation method, to improve the validity and reliability of the method.

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Limitations. The largest barriers to greater use of survey methods in ecosystems and services valuation and decision making by the EPA are institutional. First, while the EPA seems to have embraced economic surveys (e.g., contingent valuation methods, or at least “transfers” from prior contingent valuation method surveys) as a valuation method, there is a noticeable reluctance to use the larger class of systematic surveys using attitude, preference and intention questions, relative to the practices of other federal agencies with similar environmental protection mandates and valuation needs. This predisposition may in part be due to specific legal requirements for formal monetary benefit-cost analyses (which also apply to other agencies), but none of the currently applicable laws preclude using a fuller range of value measures and methods, and the most prominent laws and guides explicitly urge a broadly based evaluation effort not limited to monetary measures. Aside from this agency-level barrier, survey methods in general are discouraged by federal rules implementing the Paperwork Reduction Act. Over the past several decades it has been difficult for federal agencies to attain required clearances (e.g., from the OMB) for surveying the public in a manner and in a time frame that effectively addresses policy evaluation needs. This institutional barrier is formidable. In addition, the proliferation of surveys and pseudo-surveys for commercial and political purposes has dampened citizen’s willingness to participate. Still, many significant surveys continue to be conducted and used effectively by a number of government agencies.

Survey questions have proven effective for measuring public knowledge, beliefs, attitudes, and intentions. However, especially in the context of the complex processes of selecting alternative policies and actions to protect ecosystems and services it is important to recognize that the responding public may not a priori have a great deal of information or knowledge about the issues or policies about which they are asked. In particular, the general public is unlikely to have the breadth and depth of ecological knowledge that is often required to understand and evaluate a given environmental policy, its bio-physical outcomes or the implications of those outcomes for the respondent or for society more generally. Limitations on length and intricacy of content (especially for telephone surveys) make it unlikely that the full complexity, including uncertainties of policies and of their outcomes can be effectively communicated to

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respondents within the limits of a typical survey. Finally, even when the respondent fully understands the relevant aspects of a proposed policy he/she may still be uncertain (or incorrect) about his/her projection of how well (or badly) s/he will feel about the outcomes when they are actually encountered (Wilson et al. 1989). Some approaches to addressing these problems in surveys are presented in the document [Survey issues for ecological valuation: Current best practices and recommendations for research](#). The technical issues that have been of the greatest concern to users of survey information, to quality control agents (e.g., OMB) and to survey researchers have been associated with the sampling of respondents. The results of a survey are typically intended to be generalized to some specified population (e.g., adult citizens of the US) that includes many members that will not be included in the sample of individuals who actually respond to the survey (the respondents). The integrity of generalizations to the population of interest is assured if the respondents are a formal representative sample (“probability sample”) of the population. However, recent research shows that departures from strict sampling rules, such as the loss of intended participants by non-response or failed contacts, may not have as strong an effect on the representativeness of survey outcomes as some have thought. More difficult and potentially more potent errors are in survey design, including the crafting, selection and ordering of questions/items to be included in the survey, the form of the response options offered (e.g., the type of ratings scales) and uncontrolled events that occur during the time of survey implementation (see Krosnick 1999 and the [discussion of survey issues](#)).

Social-psychological surveys do not meet the requirements of economic cost-benefit or cost-effectiveness analyses because they do not typically attain (or even strive for) a unidimensional, transsituational measure of value. That is, the scale values computed for the ecosystem and service options addressed in a survey do not claim to be directly comparable to (commensurate with) other values or for other policy options not specifically addressed in the survey, including values and costs in other domains of the respondents’ lives. It is arguable whether any value assessment method fully meets these requirements. However, given a feasible set of alternative regulatory/protection actions and outcomes in a specified environmental-social context, surveys of public attitudes,

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preferences and intentions would be appropriate for quantitatively measuring public preferences among offered sets of policy/outcome options, for estimating the relative importance to people of the multiple attributes of those policies and outcomes, and for gauging the acceptability of alternative management means for achieving them.

Properly designed conjoint methods may be especially well-suited for gauging public preferences across sets of complex multi-dimensional alternatives, such as will likely be involved in many EPA regulations and actions for ecosystems/services protection.

In practical use, the human resources required to implement surveys range from a sufficient cadre of technically competent survey designers and analysts to temporary hourly wage employees to perform the mailing, phoning or interviewing tasks. Material needs may be very low (“paper and pencils”) or quite high, as when sophisticated computer simulations/visualizations or interactive response formats are employed. Face-to-face surveys, where trained interviewers are required and participant-contact costs may be high, are generally the most expensive, but costs for mail, telephone and/or computer resources can also be significant in large surveys using those formats. All of these costs are usually quite low relative to the physical, biological and ecological science and field study required to create adequate projections and credible characterizations of value-relevant outcomes for a suitable range of alternative regulatory or protection actions. In many ways, the quality of evaluations of ecosystems and ecosystem services protections most depends upon the quality of the relevant projections and specifications of ecological endpoints and their social consequences. Consistent with that fact, considerable resources may have to be devoted to translating targeted ecological outcomes into representations of socially relevant effects that are understandable to and that elicit valid reactions from samples of the relevant publics. Once these essential factors have been accomplished, the cost of a systematic public value assessment survey can be comparatively quite small.

Focus groups and individual interviews can have important and useful roles to play in Agency policy and decision making. However, their emphasis on qualitative analyses and their typical disregard for representative sampling can make these methods less useful for formal evaluations or comparisons of alternative policies and outcomes. These

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methods can very useful and important for designing and pre-testing more structured surveys that do provide quantitative assessments of values for alternative policies and outcomes. Qualitative methods may also contribute to the design of more effective communications and rationalizations of Agency decisions to stakeholders and to the general public. In mental models research, values may be expressed qualitatively, sometimes in ordinal terms (e.g., lexicographic or comparative statements), and sometimes using quantitative scales. The approach is designed to explore the conceptual landscape for risks and benefits, including underlying causal beliefs, specific terminology/wording, and the scope and focus of mental models in the decision domain of interest. A mental models approach would best be used in conjunction with a formal survey or another method in order to obtain quantitative measures of values. The approach is qualitative, designed to elicit how an individual conceptualizes and categorizes a process, such as protecting an ecological service, and how that individual would make inferences about and decisions to influence that process.

Treatment of Uncertainty. Survey methods specifically address the uncertainty introduced by sampling errors (e.g., representative sampling, non-response), specification errors (e.g., adequate descriptions or representations of alternatives, clear and understandable response system) and the effects of a variety of contextual and external factors that may affect (bias) participant responses. Methods for reducing and quantifying the magnitude of most of these sources of uncertainty and error in surveys are part of the well-documented technology and the accumulated lore of survey research (e.g., Dillman 1991, Krosnick 1999, and Tourangeau 2004)

Accepted methods are available and are commonly used for calculating confidence intervals or complete probability distributions for individual survey responses over respondents (e.g., the importance ratings assigned to a particular item). The internal reliability and consistency of survey responses can be calculated per individual respondent, but more often the focus is on the mean response (and standard error) of homogeneous groups of respondents. Multiple items are frequently combined, as by cluster or factor analysis, into latent variables (factors) implied by the inter-correlations among responses to related individual-items, and there are several conventional statistical

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indices of the internal consistency of such derived factors. More complete analyses also calculate and quantitatively assess the coherence and distinctiveness of identified sub-groups of respondents, based on patterns of individual's responses to the multiple items in the survey.

The detailed results and uncertainty (reliability) indices derived from a substantial survey are unlikely to be fully appreciated by anyone without relevant training and experience. On the other hand, results can be, and routinely are simplified for communication to lay audiences. Most people would find reports such as “alternative A was preferred over all others offered in the survey by 75% of respondents” to be clear and intuitively understandable. A table or graph showing means and standard deviations of preference ratings on a 10-point scale for all alternatives evaluated would be clear to many members of the public, as well as to experts from other scientific and managerial disciplines that are involved in EPA rule and decision making. Some of the uncertainty associated with these indices (e.g., sampling and measurement error) could be displayed by conventional confidence intervals or error bars. The potential effects of more complex sources of uncertainty might be revealed by bracketing mean estimates for each alternative assessed with 25th and 75th percentile estimates derived from sensitivity analyses or Markov modeling exercised over the entire biological-social evaluation system. The most sophisticated devices for communicating uncertainty might be based on interactive game systems, where the audience is allowed to alter input variables and assumptions about functional relations and stochastic events and observe and learn for themselves how these changes affect projected evaluation outcomes

Research needs. Issues that should be addressed in future research relevant to social-psychological value assessment methods include:

- How can structured surveys of public/stakeholder attitudes, preferences and intentions best be used in EPA policy and decision making, including how decision makers can and should use the relative quantitative (non-monetary) value indices provided?

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- How can social-psychological value indices best be used to cross-validate and extend estimates of monetary values (e.g., w-t-p, w-t-a) and ecological indices (e.g., biodiversity, energy flow) to strengthen the basis for Agency decisions about alternative ecosystems/services policies?
- How, and when in the decision process, can social-psychological, economic and bio-ecological evaluations of changes in ecosystems and ecosystems services most effectively be integrated to support Agency policy and decision making?
- What productive roles can focus groups, individual interviews and other qualitative methods play in Agency policy and decision making?
- How might the development of emerging methods (behavior observation, behavior trace, interactive computer simulations and games) be shaped to effectively contribute to Agency policy and decision making needs?

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