Comments from Members and Consultants of the SAB Committee on Valuing the Protection of Ecological Systems and Services (C-VPESS) on the 2/15/07 draft report for discussion at the 2/27/07 C-VPESS public teleconference call

Comments Received

A. General comments

Comments from Lou Pitelka

Comments from Lou Pitelka for conference call on February 27.

I do not have a lot of comments on these sections. My one over-arching comment is that the section on bio-physical ranking methods might need more detail and examples, while the section on socio-psychological approaches needs less. Even though I am ecologist, I found it hard to "visualize" the methods that are discussed. I believe than non-ecologists will find them conceptually abstract and difficult to understand. In contrast the concepts that are discussed in the section on survey methods, focus groups, and even emerging methods are not conceptually complex and are easy to follow.

While I am not sure that we want to add a lot of detail or other information to the section on bio-physical methods, maybe the report should cite more examples. For instance, the embodied energy method should cite more examples that EPA staff could obtain to help them understand the method.

I also think that the section on socio-psychological approaches is too long and repetitive. The concepts are not that complex. In particular, the Introduction (pages 204-206 could be cut drastically because almost everything that is discussed in the introduction is then repeated in somewhat more detail in the following sections on specific approaches. In

some cases almost the same sentences were used to that I had a real sense of having already read much of the information. Beyond that, the text from page 207 to 223 probably could be cut substantially without reducing losing important information or making it harder to understand.

Other comments:

Delete the text from page 191, line 9 through page 193, line 21; it repeats verbatim text on the prior three pages.

Page 199, lines 11-12. I suspect that the term "ecological footprint" is used by many people to mean something that this specific method. Thus, I might use the term to refer to the ecological impact of something. This could mean that many of the Google hits do not pertain to this specific concepts popularity. I would suggest checking on that before making this statement.

B. Comments on draft Conservation Value Method text

Comments from Terry Daniel

While there is potential for this (or a similar) method to make important contributions to EPA's ecosystems/services valuation goals, the current description of the method is very difficult to follow. Before attempting to suggest changes in the text, however, it is necessary to get a better understanding of what the method purports to do and what procedures are used to achieve that end.

Mostly from studying the tables (less so from the text), one might deduce that the input to the method is a list of "occurrences" of (for example) individual plant or animal species (at the fine level) and of vegetation types and ecosystems (at the coarse level). Coarse level instances would generally subsume multiple fine level instances. These occurrences (based on certain agreed upon definitional criteria) are mapped over the land and water area of concern. This is clearly an expert task appropriate for ecologists.

Each occurrence, e.g., an instance of a particular plant species mapped as a polygon (or point or line, as appropriate), is ranked by expert judgment based on how closely (completely) it fits within the "range of variation" (in size, condition and landscape integrity/context) that has been found for undisturbed instances of this particular plant species. This "quality ranking" of each instance ranges from A, indicating that the instance is within the range of size, condition and all other criteria for undisturbed instances, to D, indicating that the instance is outside the range for undisturbed instances on all criteria to the extent that it is "no longer restorable." Thus, each instance/polygon (of a given plant species, for example) would at this stage in the process be designated ("attributed") with a rank (A, B, C, or D). It appears that there could be overlaps among instances even at the same fineness/coarseness level (e.g., two species share the same piece of ground, but it is not clear how this would be handled in the method. Also,

because each instance would necessarily be of a particular size and be surrounded by particular biotic and abiotic features, the rank/class would be at least partially redundant information with the location, as the quality rank is determined in part by size and by surrounds ("landscape integrity"). The implications of such redundancies are not addressed in this presentation of the method. A second designation is assigned to each quality-ranked instance (e.g., of a plant species) based on how common such instances (at each quality level?) are on a local, regional or global basis, and how vulnerable the instance is to disturbance or destruction. These "global ranks" range from G1 (extremely rare and critically imperiled) to G5 (widespread, abundant and secure). It would appear that there would be some (nonlinear) correlation between the quality classes and the scarcity/vulnerability classes (e.g., As and Ds might be more scarce than intermediate quality classes and Ds would tend to be low in vulnerability). The potential for correlations between these two rankings, and the implications for the method is not addressed in the text.

The definition and mapping of an "occurrence" and the assignment of A to D quality ranks and G1 to G5 scarcity/vulnerability ranks seems an appropriate task for ecological experts. The need for explicit and standardized criteria for these ranking processes is properly acknowledged, but some mentioned criteria appear on the face to allow more objective determination (e.g., size and range extent and area of occupancy) than others (e.g., landscape integrity and intrinsic vulnerability). On the other hand, how these (and perhaps other) attributes of occurrences are aggregated into an "ecological value" designation for each instance (occurrence) is less clear. The starting assumption for this ecological valuation seems to be that biodiversity (and/or ecological integrity and/or sustainability) is an overarching goal that is generally accepted by ecologists, and largely by the agencies/decision makers using the method. This assumption (or set of assumptions) is not clearly acknowledged, even if it plausibly would be accepted by experts and the general public. More problematic is the need to more clearly rationalize the connections between this goal and the quality and scarcity/vulnerability rankings, and the less clearly specified methods by which quality ratings and scarcity/vulnerability rankings are to be combined into some "ecological value" index. For example, would an A, G1 instance always have higher ecological value (bio-diversity value) than a B, G2?

The aggregation process determining ecological values is determined by a weighted sum (or perhaps a weighted averaging) process that is not clearly described. The procedure allows different stakeholders (including different experts) to assign their own "weights" to the attributes (the two rankings, perhaps along with some additional attributes?) so that the "value" map for one stakeholder could be different from that of another for the same land/water area. It is not clear how (or if) these multiple value maps (customized conservation surfaces?) are consolidated or compared and contrasted to determine what environmental policies are to be implemented where over the study area.

The text asserts that ecosystem services, resource values and economic values (monetary and non-monetary) are either implicitly incorporated or can be explicitly added to the ecological values (as alternative or additional attributes of the mapped and ranked occurrences or as independent polygons?). It is not at all clear how this would be

accomplished nor how issues such as conflicts and confounds among these values would be addressed in some weighted aggregation process. A strength of the method is that values (however obtained) are explicitly mapped over the landscape, consistent with the fact that ecosystems and many services are geographical entities. At the same time, because different policies will likely produce different ecological value maps (for any given stakeholder/weighting scheme), there will be an additional level of complexity for decision makers as they seek to determine which geographic (and temporal) distribution of values is "best." As for aggregation/comparisons between value maps, the description of the method does not adequately address how values can be aggregated over space or over time to compare different policies/outcomes.

Comments from Rick Freeman

p. 175, lines 15, 16 ((also p. 176, line 1): I worry about how the term "value" is used here. It does not seem consistent with the definition laid about in Table 1, p. 15. Here the term seems to be used to refer to biophysical measures rather than norms, values, etc.

There are a lot of things in this section that are just not clear to me:

- p. 176, lines 2-3: " incorporation of economic values ..." What economic values? Where did they come from? How do they get "incorporated"?

- p. 177, line 2: How could this method be used in Step 1 of the C-VPESS Framework? See p. 34 for Step 1.

- p. 177, lines 7-9: What is meant by "the integration of intrinsic ecosystem values with social values"? How is this done? What is the "transparent methodology"? This all seems to be empty jargon to me.

- p. 177, lines 13-15: How are additional inputs incorporated? What are "secondary monetary factors"? How do they get incorporated? Some explanation and perhaps examples are needed.

- p. 178, lines 28-29: Same here: How is "social scientist input" incorporated?

p. 179, line 14: I've seen nothing over the past several years on C-VPESS to indicate that this method incorporates "best practices in the social science of stakeholder surveys." Are there references to examples?

p. 179, line 31: Can you provide some references that describe the Agency's use of this method?

p. 182, in the Table, what is "the EO"?

p. 185, line 27: There is reference to "a single benefit number;" but this does not seem to refer to how benefit is defined in Table 1. Or if it does, there is nothing in this section to indicate how what this method does is linked to human well-being.

General Comment: I think that this section should include some discussion of the relationship of what this method produces to value as we have defined it (see Table 1). As I understand it, this discussion would say something like, "It produces a measure of the contribution as defined or estimated by relevant experts of a landscape unit to the conservation of species diversity."

Comments from Bob Huggett

My comments are minimal.

1) Page 179, line 23: Change "has" to "have".

2) Page 186, line 14: Change "is" to "are".

3) Page 186, line 15: Change "does" to "do".

Comments from Lou Pitelka

See points points made in (A) General Comments

C. Comments on draft Energy and Material Flow Analysis Text

Comments from Terry Daniel

The first obvious thing about this section of the report is that pages 191 – 193 duplicate pages 188-191. The second obvious thing about this section is that it is well-written and clear.

The premise that energy flow is the most fundamental basis for comparing alternative environmental policies and actions seems very plausible—it is hard to argue with the laws of thermodynamics. Another strength of this approach is that it provides an (almost) independent means for assessing and comparing alternative ecosystems/services protection policies. Given that there is no method that uncontroversially provides the "right" assessment, an approach that is conceptually and methodologically distinct from other methods can serve important cross validation and challenging functions, as the text points out. Certainly policy makers could take considerable comfort when decisions are consistently supported by economic, ecological, social and energy assessment methods. The complexity and potential difficulties of implementing the energy-based method are adequately acknowledged and the method is appropriately offered as most suitable for larger scale, more consequential policy analyses.

I cannot comment on the "emergy" method, but accept the general conclusion that it is not quite ready (if it ever will be) for adoption in Agency policy making.

The ecological footprint method is presented mostly as an alternative metric to represent the output of an assessment based on energy flow. However, it seems that ecological demands/costs of alternative policies might be measured in terms of multiple ecological variables (including availability and flows of fresh water, biomass, carbon sequestration capacity, etc) without the reduction to fundamental energy flows. A plausible and useful "footprint" metric might be based on these intermediate factors of production.

Comments from Rick Freeman

p. 188, line 10: It is not clear in what follows that ecological and economic systems can be treated in the same conceptual framework. I think that more needs to be done to show this. There is a brief discussion (p. 195, lines 27+) of applying these methods to ecosystem services and the kind of valuation problems that the Agency faces in doing RIAs. But I think that more needs to be done with this.

p. 191 +: This repeats the previous passage.

p. 196, line 9: What is the reference to Heuttner? It is not in the reference list? Also, is Patterson (2002) the piece in Ecological Economics? Again, not in the reference list.

Comments from Bob Huggett

Page191, line 9 thru page 193, line 21: Redundant with page 188, line 28 thru page 191, line 8.

Comments from Lou Pitelka

See points points made in (A) General Comments

D. Comments on draft Socio-Psychological Approaches Text

Comments from Rick Freeman

p. 72-74: I think that there should be some brief discussion of the relationship between the social-psychological methods and the economic methods, especially concerning the latter's in a coherent theory of preferences and concepts of individual and social welfare.

p. 73, lines 23-24: There should be references to those examples of the "extensive use ...", or at least to the one example (apparently) cited on p. 215.

p. 204, line 17: "providing reliable and valid measures of relative value ..." Except for p. 219, lines 15-18, there doesn't seem to be any discussion of either reliability or validity in this section. I think that there needs to be an explanation of these terms, a brief

discussion of how one would assess various concepts of reliability and validity, and a review of the evidence or citations such reviews.

p. 211, line 5: mental model methods are mentioned as being discussed elsewhere. But I don't see this term in the table of contents.

p. 218, beginning at line 22: The discussion in this paragraph is out place. This is not the lace to discuss the "leave it to the experts" view.

p. 222, beginning at line 11: How does this discussion relate to the uncertainty discussion in Part 2, Section 8? I haven't had a chance to read that section yet.

General Comment: I think that there should be some discussion of how these methods can be applied specifically to valuing provisioning, regulating, and supporting services.

Comments from Lou Pitelka

See points points made in (A) General Comments

Comments from Joseph Arvai

(see markups on following pages)

to prioritize land for, for example, acquisition and conservation. Based on GIS technology, it has the capability to combine information about a variety of ecosystem characteristics and services across a given landscape, and to overlay ecological information with other spatial data. In addition, data layers can be used for multiple policy contexts. Conservation values have been used in various contexts by federal agencies (e.g., Forest Service, Fish and Wildlife, National Park Service, and Bureau of Land Management) as well as by non-governmental organizations (e.g., the Nature Conservancy, NatureServe) and regional and local planning agencies.

The second group of bio-physical methods that the committee evaluated were based on energy and material flows. Energy and material flow analysis is the quantification of the flows of energy and materials through complex ecological and/or economic systems. These analyses are based on an application of the first (conservation of mass and energy) and second (entropy) laws of thermodynamics to ecological-economic systems. Examples include embodied energy, emergy, and ecological footprints. Of these three, embodied energy and ecological footprints are based on a consistent set of principles, while emergy is not (and is hence not scientifically sound). Embodied energy measures the (available) energy cost of goods and services using input-output analysis or flow accounting methods. Ecological footprint analysis also uses input-output analysis, but measures "costs" in land units (rather than energy units) based on the biologically productive land area (rather than the amount of energy) required to meet various consumption patterns. These techniques have been used to estimate implicit costs or "shadow prices" of providing ecosystem goods and services, measured in physical rather than monetary units. While such costs can be used to rank alternatives based, for example, on an energy theory of value, they will provide a proxy for preference-based values only under limited conditions (see Part 3, section 8).

4.2. Social-Psychological Methods

Social/psychological methods seek to characterize the values that are held, about expressed, and advocated by people. They focus on individuals' judgments of the relative importance of, acceptance of, or preferences for ecological changes. Individuals making the judgments may respond on their own behalf or on behalf of others (society at their large or specified sub-groups) and the basis for judgments may be changes in individual

well-being, or civic or ethical/moral obligations relevant to ecosystems and ecosystem services. That is, people may hold, express and advocate bio-ecological values or ethical values that are unrelated or even counter to their own wants and needs.

Social/psychological methods provide scientific means for determining people's value-relevant perceptions and judgments about a wide array of objects, events and conditions. They typically focus on choices or ratings among sets of alternative policies, and may include comparisons with potentially competing social and economic goals.

Social-psychological methods elicit information about preferences and values primarily through surveys, focus groups, and individual narratives. However, recently experts in this field are also experimenting with eliciting this information through observations of behavioral responses by individuals interacting with either actual or computer simulated environments.

Survey questions are typically framed as choices (among two or more options), rankings, or ratings. Survey methods that may be especially important in the context of ecological valuation include perceptual surveys (e.g., assessment of ecosystem attributes) and conjoint survey methods (e.g., choice among different combinations of ecosystem attributes). Quantitative analysis of responses are usually interpreted as ordinal rankings or rough interval scale measures that provide relative measures of differences in assessed values. Similarities and differences among different segments of the public can also be identified and articulated. Surveys may be especially useful when the values at issue are difficult to express or conceive in monetary terms or where monetary expressions are viewed as ethically inappropriate. Surveys to elicit value-related information have been used extensively by other federal agencies, including the U.S. Department of Agriculture's Forest Service.

In contrast to surveys, which are based on large samples and are not interactive, focus group methods elicit information about values and preferences from small groups of relevant stakeholders engaging in group discussion lead by a facilitator. Collective narratives are subjected to qualitative analyses to identify and possibly to ascertain levels of consensus on relevant issues, perspectives, and positions represented by participants. Given the small number of participants, the goal of a focus group is rarely value assessment per se, but rather an articulation of all of the values that may be relevant. Use

* also typically focus on the attributes of systems (vs. policies)

? it's not really clear to me how this follows from the previous section. Maybe it's me...

This section really assumes the perspective of conjoint analysis; is it not possible to also consider surveys that focus on systems or parts of systems (vs. alternative policies aimed at managing those systems)?

Speaks to the notion of a "survey of representatives" vs. a "representative survey."

seems again to take on an artificially narrow perspective. Focus groups can (and often are) used to assign values / make tradeoffs (see SDM approaches).

3. SOCIO-PSYCHOLOGICAL APPROACHES

3.1. Introduction

That "we the people" should have a say in the policies and actions of our public agencies is inherent to a democratic society. Along with other public agencies EPA has a number of laws, regulations and guides that acknowledge and implement public input into agency policies and decision making. For EPA, public involvement "... means that the Agency considers public concerns, values, and preferences when making decisions" (EPA 2003, p 1). The social-psychological methods for assessing the value of protecting ecosystems and ecosystem services described in this section can be viewed as an important component of the broader public involvement ~~program for~~ goals of EPA. Surveys are proven, effective methods for identifying public values and concerns ("what people care about"), for determining what environmental outcomes and associated social consequences the public prefers, accepts and supports, and for predicting how various publics are likely to respond to particular changes in environmental conditions and to alternative management means for achieving those ends. Along with focus groups and individual narrative interviews, surveys can provide important inputs to and supports for agency decision making, including providing reliable and valid measures of the relative value to society of alternative ecosystem protection policies and outcomes.

While the need to consider public concerns, values and intentions is uncontroversial, accomplishing this goal can be complicated. Different segments of society may disagree on what matters most, and there can be substantial differences in people's opportunities and abilities to make their concerns and desires known (especially those yet unborn). EPA's charge to protect ecosystems and ecosystems services reflects widely shared public concerns and values (e.g., Dunlap et al. 2000), but the formulation and implementation of specific ecological protection policies involves substantial scientific and technical considerations which the lay public may not always fully appreciate. Social-psychological surveys and the other methods described in this section have proven effective in identifying and measuring people's concerns, preferences and intentions and at uncovering underlying assumptions, knowledge, beliefs and feelings allowing conflicts between various publics and between

public preferences and ecological science to be better articulated and addressed by decision makers.

Many social-psychological methods were primarily developed and are frequently used for the purpose of determining characteristics and traits of people. For example, differences in the patterns of responses across a standard set of items in a questionnaire are used to ascertain and measure the intelligence, personality, religious beliefs, political leanings, and world views of individuals and groups. By shifting the focus from differences between persons (across items) to differences between items (across persons) the same basic instruments can be used to ascertain beliefs, attitudes, preferences, and behavioral intentions for a wide range of objects, events, states of the world and personal or social circumstances. For example, marketing surveys analyze responses to alternative goods and services to ascertain consumer preferences and purchasing intentions. Political polls collect responses to candidates and policy initiatives before elections to determine preferences and voting intentions. Social-psychological methods for assessing the value of ecosystems and ecosystem services focus on changes in environmental conditions, the associated social consequences of those changes, and on alternative means of achieving (or preventing) such changes. These assessments may also include measures of persons/groups, however, as when expressed ecosystems values are found to differ consistently between people with different beliefs, political leanings, or world views.

While public opinion is sometimes directly used to make policy decisions, as in elections and referenda, social-psychological assessment methods more typically are explicitly intended for decision support. Thus there has been little emphasis on mapping all expressed concerns and preferences onto a single metric scale (as in economic cost-benefit analysis methods, for example).* More often separate indices are developed on several different value dimensions (e.g., aesthetic, ethical, utilitarian, personal, civic) for each policy alternative. Where alternative policies/outcomes fall on these psychological value scales may be seen as a precursor of resolving tradeoffs among competing values, for making choices between or for actually or hypothetically making monetary payments for them. Consistencies and conflicts between coherent sub-sets of the public (e.g., urban-rural, young-old, conservative-liberal, local-regional-national) in the relative orderings of alternatives on one or more value dimensions may also be estimated and reported. Differences among value

?? * This strikes me as a little confusing; the preceding discussion and the one that follows deals with items across alternatives (vs. within alternatives or indeed systems themselves which seems to be the focus here). Clarify?

dimensions or between public groups are not typically resolved through aggregation or other calculation devices within the assessment process. Instead, such resolution is deferred to subsequent stages in the decision making process, where information integration, deliberation and negotiation may be applied in more or less formal procedures.

The social-psychological approach ~~to~~ for assessing the value of ecosystems and ecosystem services enlists a number of different quantitative and qualitative methods. Formal surveys and questionnaires are the most frequently used and the most thoroughly researched set of quantitative methods. Surveys typically rely on standardized verbal descriptions of alternative objects/states (e.g., alternative environmental conditions or policies), with respondents recording explicit choices, rankings or ratings that can be quantitatively analyzed. Focus groups and individual narrative interview methods place more emphasis on qualitative analyses and have historically been used primarily in preliminary studies to support the design and pre-testing of quantitative surveys. These methods are less thoroughly researched than quantitative surveys, but they are being used with increasing frequency as stand-alone assessment methods. These qualitative methods typically employ less restrictive representations of options, are frequently directed at specific local cases that are familiar to respondents, and collect open narrative responses that are subjected to more or less rigorous qualitative analyses. In addition to these 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 the context of the assessment of recreation and tourism values. Computer simulation ("virtual reality") and interactive game methods are also being developed, but have mostly been applied in research settings. These emerging methods are not yet sufficiently proven for immediate application in EPA policy-making contexts, but they do show considerable promise in areas where more traditional methods have been found lacking. They will only be briefly described in this section and are offered primarily as potential targets for future research and development.

such as? A little cryptic.

3.2. Brief Description of the Methods

3.2.1 Surveys

Surveys encompass a broad range of methods for systematically asking people questions and recording and analyzing their answers (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. The most popular survey formats have involved face-to-face, mail or telephone contacts with individually sampled respondents. Multiple questions/issues are presented and responses are typically reported as choices (among two or more options), rankings, or ratings (Dillman 1991; Krosnick 1999). Open-ended response formats are less often used, and pose special problems for quantitative analysis.

Social-psychological surveys have been extensively used to assess preferences, liking, acceptability and importance of presented policies, actions, outcomes and/or the expected personal or social consequences thereof. Multiple value dimensions (e.g., utilitarian, aesthetic, ethical) may be addressed within and between different surveys, and surveys may specify 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, providing relative measures of differences in the assessed values among the offered alternatives. Thus, generalization of obtained value measures (e.g., "values transfer") beyond the objects specifically assessed within the survey must be approached with caution. 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).

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 2003). Surveys are now frequently directed by computer programs that can select and order questions individually for each respondent, sometimes based on 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 still have a number of hurdles to cross before being fully accepted in survey research (Couper 2001; Tourangeau 2004).

Variations on survey research methods that may be especially important to assessments of ecosystems and services include perceptual and conjoint survey methods. 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. 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 and environmental conditions that are difficult or impossible to describe effectively with words (Daniel 1990). Relevant examples include assessments of the visual aesthetic effects of alternative forest management policies in the northwestern US (Ribe et al. 2002, Ribe 2006), of in-stream flow levels on scenic and recreational values (e.g., 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). Perceptual surveys commonly also include more traditional verbal survey questions.

Surveys have most often presented the 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 methods (e.g., Adamowicz et al.1998; Boxall et al. 1996) instead present options as multidimensional composites or scenarios presenting integrated combinations of different attributes (e.g., different levels of air quality, water quality and local employment, as illustrated in the accompanying box). Combinations generally reflect the actual or projected correlations among the combined attributes (e.g., air and water quality may be positively correlated, and both might be negatively correlated with local employment opportunities). In some cases, hypothetical combinations of attributes may be included, as specified by an experimental design to allow estimates of the separate and interacting effects of component attributes (Louviere 1988). Multiple regression analyses are used to estimate the relative contributions of individual components (attributes) to the expressed preferences (or other judgments) for the conjoint alternatives.

Conjoint survey methods 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 compete. When at least one of the attributes that forms the conjoint alternatives is (or can be) valued in monetary terms, 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 (e.g., Chattopadhyay et al. 2006, and see the discussion under economic assessment methods in this report).

Text Box 9: What Are Conjoint Surveys of Attitudes?

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 can be required to choose among (or rank or rate) compound alternatives that present specific packages of desired and less-desired attributes. For example, a policy that produces cleaner air and water in a region, but constrains employment opportunities in local communities might be pitted against alternatives that allow various levels of degradation in air and water quality, coupled with different levels of expanded employment opportunities. A simplified example of alternatives that might be presented to a respondent in a conjoint survey might be:

Which option do you think would be the best policy for public agencies in your area

Policy A: Resulting in a 10% improvement (from current conditions) in air quality, a 15% improvement in water quality, and a 15% decrease in local employment opportunities;

or

Policy B: Resulting in a 5% improvement (from current conditions) in air quality, a 10% improvement in water quality, and a 10% decrease in local employment opportunities.

Choices (or rankings or ratings) among a carefully constructed array of such alternatives can provide quantitative measures of relative public preferences for each policy option compared, as well as provide estimates of the contributions of each individual component or attribute to the conjoint preferences expressed. Following the simple example above, preferences for conjoint options might be represented by

$$\text{Preference for option } j = w1(WQj) + w2(AQj) + w3(Jobsj),$$

where option j is a particular policy that produces specific changes in the levels of water and air quality (WQj and AQj) and jobs (Jobsj). The relative contribution of each component/attribute is estimated by the derived coefficients (the wi) in the multiple regression equation for preferences among conjoint alternatives. Once determined, the regression equation can also be used to estimate preferences for new policy alternatives

(based on their respective projected measures of water and air quality and jobs), so long as those options fit within the range of the attributes assessed and the constraints imposed by the context of the survey in which the policy options were offered and judged. Optimization or less formal heuristics may be applied to create additional policy options for consideration and/or for direct evaluation in subsequent conjoint surveys.

3.2.2 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, outcomes and/or consequences. 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. Collected narratives are subjected to qualitative analyses to identify and possibly to ascertain levels of consensus on relevant issues, perspectives and positions represented by the participants. 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 groups use small numbers of respondents and do not typically attempt formal probability sampling to select participants. Emphasis is instead on assuring that at least one representative from the full range of interests and perspectives relevant to the policies or outcomes at issue are included. The goal of a focus group is rarely value assessment per se, but a full discovery and articulation of all of the values that are relevant, and exploration of agreements and conflicts among the stakeholder constituencies 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. It is common for focus groups to be used in the process of designing and pre-testing more formal surveys (e.g., Shields et al. 2002).

But, focus groups can be used for this purpose. Work nothing? (see SDM approaches).

* Mental models are only mentioned in passing – on pages 37, 133, and 150. pp 37 and 133 seem to deal with MMs more formally while the reference to MM on pg. 150 is unclear.

3.2.3 Individual Narratives

The individual narrative method is distinguished from the focus group method in that individual respondents are contacted and participate alone, without interaction or discussion with experts, facilitators or other respondents. Included in this category are various ethnographic methods and the* mental model methods described elsewhere in this report. Individuals nominally representing possible stakeholder perspectives are contacted and asked to comment on relatively broadly defined topics with relatively little direction from the interviewer/assessor (e.g., Brandenburg & Carroll 1995). Respondents are not typically selected by a random, probability sampling process. Instead, particular 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, as in the "snowball" technique. 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). Collected narratives are subjected to more or less rigorous qualitative analyses, essentially similar 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.

In my view, Mental models are intended for valuation purposes. If a case is being made for making use of mental models in valuation, then someone needs to articulate clearly how the method can be used for this purpose. Otherwise, MM reference to MMs is a little misleading.

3.2.4 Emerging Methods.

The social-psychological methods described in this section are relatively new and untested, but do show increasing potential for addressing value assessment issues not well handled by other methods. These methods are characterized by their attempt to more directly observe responses to policies, outcomes and consequences in situ, avoiding problems of relying* on hypothetical responses to described hypothetical conditions. Moreover, observed environmental behavior is often not consistent with what people say they would do in the specified circumstances (or even with what they say they did) and people are often incorrect at identifying, or are unaware of the environmental factors that affect their behavior (Cole and Daniel 2004). 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

Such as?

It's not clear how survey methods are different in this respect. Are people not responding to hypothetical options/outcomes here too? (e.g., in the case of conjoint analysis).

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).

Interactive environmental simulation systems (sometimes approaching "virtual reality") 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). The emphasis has been on visual presentations (now including high resolutions over full spherical view angles), but the technology can readily include auditory features and in some systems tactile, proprioceptive, olfactory, vestibular and other senses can also be effectively simulated to achieve very compelling, emersive 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.

In many regards interactive simulation systems come full circle back to the hypothetical responses to hypothetical environments that have challenged the validity of

verbal survey methods. However, as environmental simulations come into closer perceptual correspondence with actual environments and the available responses to simulated environments more closely approximate natural in situ responses, confidence in the validity of assessments based on these systems is increased. As for all other assessment methods, the gold standard is the empirical correspondence with the behavior of people in the actual environment of interest, if and when that environment is achieved.

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. Environmental 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 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 achieve some acceptable balance among desired and undesired outcomes.

3.3. Relation of Methods to the CVPESS Expanded and Integrated Assessment Framework

Survey methods have useful roles to play throughout the valuation process envisioned by C-VPESS. Surveys could contribute to initial problem formulation by identifying ecological services and impacts that most concern citizens and/or identified stakeholders, as well as by uncovering assumptions, beliefs and values that underlie that concern.

Importantly, similarities and differences in concerns among different segments of the public can also be identified and articulated. Once relevant ecological endpoints have been identified surveys could be very useful for determining the personal and social consequences of policy outcomes, and for exploring public understanding of the links between chains of ecological effects and the policy options under consideration (Box 2). Given a set of potential policy options, with their respective ecological endpoints (from Step 3), surveys could be used to assess relative public preferences (and/or other judgments, such as importance or acceptability) for those options (Step 4). Quantitative indices of public/stakeholder preferences (or judgments of importance or acceptability) from surveys could be combined with bio-ecological and economic/monetary measures of the value of the same alternatives to provide cross validation of all measures, or to identify possible limitations of either set of measures. Surveys may be especially useful when the values at issue are difficult to express or conceive in monetary terms or where monetary expressions/valuations are viewed as ethically inappropriate. In those cases social-psychological surveys could provide quantitative measures of public preferences among the policy alternatives or ecological endpoints that are under consideration, improving the basis for Agency decision making.

Surveys could make an additional contribution after Step 4 in the C-VPESS model. The values of ecosystems/services coming out of Step 4 must inevitably be represented by multiple economic/monetary, bio-ecological and social-psychological 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, perhaps including material to inform respondents about relevant ecological and social effects and other considerations affecting the policy/decision at issue, could effectively involve citizen stakeholders in this value integration and tradeoff process, providing an additional relevant input to the policy decision, and adding to the political validity and social acceptability of the final action.

what is meant here by "properly structured"?

Focus groups and individual narrative methods would be most appropriate and most useful at the earliest and latest stages of the decision making process. While focus groups and individual interview methods do not generally provide quantitative assessments for alternative policies or outcomes, they can make important contributions to improving the

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design, development and pre-testing of more formal surveys that can provide reliable and valid quantitative assessments of public concerns and values. 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 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 the methods. Social-psychological surveys are the longest 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 ascertain citizen desires, concerns and preferences, by commercial marketers to determine the attractiveness of a wide array of goods and services, and by social and political scientists to measure and monitor shifting values and desires in the electorate. Economists have lately adapted survey methods to develop expressed preference methods for estimating monetary values for non-market goods and services, and surveys are often relied upon to collect the data needed to exercise other economic valuation efforts. Environmental management agencies have made extensive use of surveys, either directly or indirectly, in setting policy and in making and monitoring the effects of management decisions.

For a recent example of the application of survey methods in environmental management, the USDA Forest Service conducted a nationwide telephone survey to inform the Forest Service Strategic Plan, 2000 Revision, as required by the Government Performance and Results Act (Shields et al. 2002). By the authors' description, "approximately 7000 randomly selected members of the American public were asked about their *values* with respect to public lands, *objectives* for the management of forests and grasslands, *beliefs* about the role the USDA Forest Service should play in fulfilling those *objectives*, and *attitudes* about the job the USDA Forest Service has been doing in fulfilling their *objectives*" (p 1). This survey provided useful information about public values and concerns relevant to Forest Service management mandates, as well as quantitative measures of the relative importance to the public of particular policies (e.g., roadless areas, wilderness, timber harvesting, recreation opportunities, ecosystem health). Results were reported collectively and separately for different regions of the country, different demographic groups

and for groups evidencing in one section of the survey different levels of familiarity with the Forest Service and its management mandates.

The largest barriers to greater use of survey methods in the EPA are institutional. First, while the EPA seems to have embraced economic surveys (e.g., CVM, or at least "transfers" from prior CVM surveys) as a valuation method, there is a noticeable reluctance to use the larger class of systematic surveys, 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 survey 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 very 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, and the proliferation of surveys and pseudo-surveys has dampened citizen's willingness to participate, but many significant surveys continue to be conducted by a number of government agencies.

It is not clear the extent to which focus groups or individual 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 and the US Forest Service national survey by Shields et al (2002) described above reported that "over 80 focus groups conducted around the continental United States" (p. 1) were used in the design and development of the survey, as well as to support the interpretations and conclusions from the survey. "Public meetings" and on-site demonstrations are frequently cited as playing a public involvement role in EPA policy decisions, and a formal "Multi-Stakeholder Group" was assembled and used in the Avtex Fibers Superfund Site decision and implementation process (cite), 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 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-VPESS.

Limitations. Surveys have proven very effective for determining 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 have a sufficient basis for the opinions and preferences offered in a general population survey. First, limitations on length and complexity of content (especially for telephone surveys) make it unlikely that the full complexity, including uncertainties of policies and their outcomes can be effectively communicated to respondents within the survey. Second, the general public is unlikely to have the breadth and depth of ecological knowledge that is often required to understand and evaluate a given policy, its bio-physical outcomes or the implications of outcomes for the respondent or for society more generally. Finally, even when the respondent fully understands these aspects of a proposed policy he/she may still be uncertain (or incorrect in his/her projection) regarding how well (or badly) the respondent will feel about the outcomes/implications when they are actually encountered.

SDM? Mediated Modeling?

Approaches to the problems of insufficient communication of the options within the survey, and insufficient relevant prior knowledge/experience of the respondents include increasing considerably the information provided within the survey, requiring respondents to complete some workshop, training exercises or participate in guided visits to actual demonstration sites before responding, or shifting to a much more intensive interactive "deliberative group" format (see section X in this report) that includes input of relevant experts and extended discussions among respondents. While these approaches may be successful in informing and educating respondents, they may also invalidate generalizations to the population from which respondents were originally sampled—i.e., the responses of informed, educated respondents can only represent the population of similarly informed and educated publics. This presents something of a dilemma for survey research (and for public involvement more generally) in the context of public agency policy and decision making. If public beliefs, preferences and intentions regarding a proposed policy are important—as in predicting the level of public acceptance and support the policy will encounter, what objections might be raised against it, and how likely are desired responses (e.g., compliance with regulations, behavior changes needed to affect the policy, voting for political candidates that will help to sustain the policy, etc)—then, given that the preponderance of the public will be less well-informed and less educated about the policy and its implications than the survey respondents, the results of the enhanced survey may not be very useful. On the other ~~horn~~ hand, the opinions and preferences of uninformed and uneducated (in the specific issues relevant to the policy) respondents would seem a poor basis for deciding ecological protection policies. Some might argue that ~~Perhaps~~ it would be better to leave the public out of the process altogether and have experts (e.g., ecologists, biologists, toxicologists) determine ecosystem and ecosystem service protection policies. However, it is not always clear what the necessary normative principles are for such decisions, or who should decide among competing principles. In some cases, there may be high levels of agreement among experts about the bio-physical outcomes of proposed policies, and even about the implications of those outcomes for individual and social well-being. However, when expert judgments on these matters are incongruent with the beliefs, preferences or intentions of the public, there is a problem. The involvement of citizens in decisions about their future environments and what would best serve their individual and collective well-being seems a basic tenant of democratic societies.

This does not require that complex environmental policies and actions be determined by a public opinion poll (and surveys consistently show that the public does not expect or want this), but certainly public opinion always matters to public policy. In this context, surveys of the less intensive type can be very helpful in identifying where publics and experts disagree and why, and what information, deliberations or other interventions might be needed to achieve better congruence of expert and public opinion.

Research has shown that survey respondents faced with questions that imply the need for answers will usually respond as best they can under the circumstances. This often means that respondents will "grasp at straws" provided by the survey itself (e.g., who is conducting the survey, the apparent goals/intentions, the content of other/prior questions, what answers they have already recorded) to "construct" their answers (and perhaps the presumed underlying values) on the spot. For this and other reasons it is very important that surveys are carefully designed to present an unbiased representation of policy options in a context that is as close as possible to the actual contexts in which the policies/outcomes/implications being assessed will be encountered in the "real world." The ultimate test of the validity of a survey is how closely the responses collected in the survey correlate with responses made by the population of interest when the policy is actually implemented—e.g., the policy most favored in the survey should be the policy most favored in the "real world."

cite a preference construction article or two.

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 (i.e., the respondents). The integrity of generalizations to the population of interest is assured if the respondents are a formal "representative sample" of the population (i.e., classically, every member of the population has an equal chance of being a respondent, or in contemporary survey research terminology, a "probability sample" is used). Because every element of the population of interest may not be available or even in principle known, the first step in attaining a probability sample is to establish a sampling frame, or an accessible list from which a smaller number of individuals (or households) will be randomly selected and contacted. At this stage errors or "biases" may enter to the extent that the

sampling frame does not properly represent the entire population of interest (e.g., if the sampling frame is telephone numbers listed in directories, otherwise qualified individuals/households with unlisted numbers will not have an equal chance to participate in the survey).

Because not all individuals/households selected from the sampling frame will successfully be contacted, and some who are contacted will choose not to actually participate in the survey, there is an opportunity for "non-response error" to degrade or bias the generalization of results to the population represented by the sampling frame. In spite of the attention paid to non-response errors in surveys, research shows that the biasing effects of non-response are typically negligible. That is, the results of surveys with low response rates (e.g., on the order of 20%) usually provide a sufficient basis for valid inferences about the population represented by the sampling frame. In part this can be attributed to the fact that the reasons for non-participation are usually not systematically related to the subjects addressed in the survey. 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 appendix to this report).

Social-psychological surveys do not meet the requirements of conventional economic cost-benefit or cost-effectiveness analyses because they do not achieve a unidimensional, transituational measure of value. That is, the scale values computed for the ecosystem and service options addressed in a survey can not be directly compared to values for extra-survey options, or to values and costs in other domains of the respondents' lives. However, given the identification of a feasible set of alternative regulatory/protection actions, these survey methods would be appropriate for assessing public preferences among offered sets of policy/outcome options, and for estimating relationships among the multiple component attributes (costs and benefits, biological and social effects, means and ends) of those actions. Properly designed conjoint methods may be ~~especially~~ well-suited for gauging public preferences across sets of complex multi-dimensional alternatives, such as alternative EPA regulations for ecosystems/services protection.

letter

what is meant by this?

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 contact costs may be high, are generally the most expensive, but costs for mail, telephone and/or computer resources can be significant in large surveys using those formats. All of these costs are usually quite low relative to the physical, biological and/or ecological science and field study required to create adequate projections/representations of value-relevant means and outcomes for a suitable range of alternative regulatory or protection actions. In many ways, the quality of evaluations of ecosystem and ecosystem service protections most depends upon the quality of the relevant projections and specifications of ecological endpoints and their social consequences. In some cases considerable resources may have to be devoted to translating targeted ecological outcomes into understandable representations of socially relevant effects. Thus, once these essential factors have been accomplished, the cost of the actual survey can be comparatively quite small.

Would it be worth noting that the state of the digital survey world is improving (with respect to sampling, technical sophistication, etc.)? See knowledge Networks.

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 them less useful for systematic evaluations or comparisons of alternative policies and outcomes. These methods can very useful and important for designing and pre-testing more formal 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.

Treatment of Uncertainty. There are two broad levels of uncertainty in any evaluation of changes in ecosystems and ecosystem services. At the bio-physical level any characterization of current (or past) ecological conditions will have numerous interrelated uncertainties, and these uncertainties will be magnified and added to by the need to project future conditions, with or without some postulated management action. At the social level existing and projected ecological conditions and their socially relevant consequences must be

represented to people so that they can express their preferences for current and/or alternative future conditions, providing the basis for analysts to derive valid measures of the value of the targeted changes. Within the social level, survey methods specifically must address sampling errors (e.g., representative sampling, non-response), specification errors (e.g., adequate description/representation 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, Tourtangau 2004, and the appendix attached to this report).

* While the currently available methods for dealing with uncertainty may be sufficient for some simple evaluation problems, the valuation of changes in ecosystems and ecosystem services raises issues not well addressed by any existing methods. For example, at the bio-physical level it is extremely difficult or completely unclear how to calculate the uncertainty (error) in the projection of even a single outcome (endpoint) from a complex ecological system composed of multiple interacting variables that may be separately non-linear and collectively subject to the influence of unpredictable external stochastic events. Modeling methods, such as Monte Carlo and other sensitivity analyses may be used to estimate the distribution of possible outcomes (or at least best-case, worst-case extremes) for a single endpoint, but even this approach becomes unwieldy when the outcomes relevant to the value assessment are themselves composed of multiple interrelated variables. While highly trained and experienced experts may find ways to calculate a relevant measure of uncertainty for some complex ecological outcomes, it is problematic how to meaningfully communicate this level of uncertainty to concerned lay citizens in a survey. Yet such communication can be crucial, as often the level of uncertainty in outcomes is a key factor affecting preferences for the alternative policies under consideration.

* This paragraph seems to miss the boat (for me anyway). The issue to me, is how do people respond to uncertainty when responding to surveys? Surveys seem ideally suited for the kind of broad sensitivity analysis that decision analysts dream of. Perhaps this could be noted here (?).

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 cohesiveness of survey responses can be calculated per individual respondent, but more often the focus is on the mean response 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 individual-item responses, and there are several conventional statistical indices of the internal consistency and coherence of those derived factors. More complete analyses calculate and quantitatively assess the internal consistency and distinctiveness of latent variables, based on the patterns of responses across the multiple respondents, as well as classifying sub-groups of respondents, based on patterns of individual's responses to the multiple items in the survey.

The detailed results of a complex attitude 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 mean 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., the sampling 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 exercised over the entire biological-social evaluation system. The most sophisticated communication devices 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 evaluation outcomes.

Research needs (still to be completed, but roughly addressing the following items)

- How can social-psychological surveys 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?
- How can social-psychological value indices be used to cross-validate estimates of monetary values (e.g., from CBA) for alternative policies/outcomes?

- How can social-psychological, economic and bio-ecological evaluations of changes in ecosystems and ecosystems services for alternative policies/outcomes 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 emerging methods (behavior observation, behavior trace, interactive computer simulations and games) be shaped to effectively contribute to Agency policy and decision making needs?

– It strikes me that the answers to many of these questions are answered in this very nicely written text.

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