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ON VALUING ECOLOGICAL SYSTEMS AND SERVICES:

PARADIGMS, METHODS, AND A GLOSSARY

- For use by the SAB Committee on Valuing the Protection of Ecological Systems and Services -

First Draft for the Steering Group

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1. Introduction

By paradigms, we mean concepts and definitions of values.[1] By methods, we mean the sources of data, techniques of analysis, models, and so forth that are used to estimate measures of value that correspond to one of the concepts of value.

One objective of estimating values for protection of ecological systems and services (and EPA's principal reason for being interested in the question) is to provide information that can inform the Agency's decision makers as they choose among alternative policy measures. One implication of this is that what is needed is measures of the values associated with *changes* in the degree of protection offered to ecological systems and *changes* in the quantities of various services provided by ecological systems rather than estimates of the *total value* of ecological systems.

In the next section we offer a taxonomy of valuation paradigms. It is drawn from several sources including the Millennium Assessment (2003) and various memos from Theme Groups

[1] This term is used by the authors of the chapter on concepts of ecosystem value and valuation approaches in the Millennium Assessment (2003).

written during the fall. Forming a taxonomy is difficult. Some of our decisions are arbitrary. And we are aware of disagreements in the literature about the details of such taxonomies. But we suggest that this taxonomy (or something like it) provides a useful basis for organizing our discussions in the future.

In the third section, we provide brief descriptions of the available methods for estimating some forms of values. The list of methods described is undoubtedly incomplete. But time and the limits of our expertise precluded forming a more extensive list for this memo. We solicit input from the other Committee members on this.

Finally, we have started to compile a glossary of terms that have been used in our discussions. We think that it is important that we have a common understanding of the meanings of terms used in the discussion. We welcome suggestions for additional terms to be included. The glossary is in Appendix A to this paper.

2. Valuation Paradigms

The first distinction that we make is between *instrumental value* and *intrinsic value*. See Table 1. The instrumental value of an ecosystem service is a value derived from its role as a means toward an end other than the provision of the service itself. In other words, its value is derived from its usefulness in achieving a goal. In contrast, intrinsic value is the value that exists independently of any such contribution and reflects the value of something for its own sake. For example, if a tropical forest is a source of fruit and nuts for people and the goal is increased well-being of the people, the value of these services from the forest is an instrumental value. Alternatively, if it is believed that the tropical forest should be preserved independently of any contribution that it might make to human well-being, this is an assertion of intrinsic value.

Intrinsic value can be linked to a variety of religious, cultural, and ethical points of view as well as to the idea that certain types of things have "rights" to exist.

A key feature of instrumental values is the role of substitution in defining measures of value. If there is more than one thing that contributes to the achievement of a goal, the instrumental value of anything can be defined as the amount of something else that would make an equivalent contribution to the goal and could replace the thing in question if it were to be lost. Substitutability means that more of one thing can be traded off against less of something else that contributes to the same goal. In contrast, intrinsic value that is based on a right to exist implies that tradeoffs are not acceptable, that is, that it is not acceptable to substitute more of something else to compensate for the loss of the thing being valued on the basis of this right. Thus instrumental values can be defined as scalar measures, but rights-based intrinsic values may not be definable in this manner.

Instrumental Values. Within the category of instrumental values, we have identified two types of value: utilitarian values and community-based values. Utilitarian values are based on the contributions that ecological systems and services make to the well-being of individuals. Utilitarian values are based on the preferences of individuals for alternative bundles of goods and services, including environmental amenities and ecological services.

Economic measures of value are utilitarian values. Economics is the study of how societies organize themselves to provide for the sustenance and well-being of their members. Thus in economics, the goal is increased human well-being. The economic theory of value is based on the ability of things to satisfy human needs and wants or to increase the well-being or utility of individuals. The economic value of something is a measure of its contribution to

human well-being. The economic value of ecological systems resides in the contributions that the variety of ecosystem functions and services make to human well-being.

We can distinguish between those ecological services that individuals value because they make use of them in some way (use values) and those which they value independent of any kind of observable use. In the latter case, people perceive themselves to be better off (increased well-being) because of the existence of the service even though they do not make use of the service themselves. Values that are independent of people's present use of the service have been variously termed "existence," "nonuse," and, more recently, "passive use" values. These values are said to arise from a variety of motives, including a desire to bequeath certain environmental resources to one's heirs or future generations, a sense of stewardship or responsibility for pre-serving certain features of natural resources, and a desire to preserve options for future use.

Community-based values are based on the assumption that when placed in a position of making choices about public goods (goods that when made available to one person are available to all), individuals make their choices based on what they think is good for society as a whole rather than what is good for them as individuals. In other words, people base their choices on their conception of social preferences or community-based preferences rather than their individual preferences.[2] The values reflected by these preferences would be revealed through some sort of deliberative process involving open discussion. We call the values that are based on community preferences community-based values.

Intrinsic Values. Intrinsic values stem from some assertion of an ethical principle or from some religious or cultural beliefs. For example, the assertion that all living organisms have

[2] See, for example, Jacobs (1997), Costanza and Folke (1997), or Sagoff (1998).

rights implies a *biocentric* intrinsic value to all living organisms. For further discussion of the sources and nature of intrinsic value, see Millennium Assessment (2003, pp. 139-143).

Some concepts of value that are applicable to ecological systems and services do not fir easily into either the instrumental or intrinsic categories. For example, we can see arguments for placing biodiversity in several places in the taxonomy, depending on why biodiversity is considered to be important. For example, if biodiversity is seen to contribute to the well-being of individuals, then increases in biodiversity would have instrumental utilitarian value. But a biocentric ethical position would give biodiversity intrinsic value. If biodiversity is considered to be an intrinsic value, then the value of changes in biodiversity could be defined in several different ways depending on the definition of biodiversity that has been chosen (genetic distance, species richness, and so forth).

Committee members have mentioned several other possible types of value that do not seem to fit into the category of intrinsic values but are based on objectives other than human welfare or well-being. These include ecosystem health, ecological sustainability (both mentioned by Rolston), and energetics (Odum and Odum, 2000). At this point, we think that it is not especially important to decide how to fit these concepts of value into a taxonomy. What is important is to decide which of these value paradigms to focus our attention on.

3. Measurement

Economic (Utilitarian) Values: There are two kinds of techniques for estimating economic values: revealed preference and stated preference. *Revealed preference* methods involve the analysis of choices that people make in real-world settings where they are maximizing their well-being (utility) subject to a variety of constraints, including limited

income, prices for market goods, and so forth. *Stated preference* methods rely on individuals' responses to hypothetical questions of various forms, including the simplest form, "How much would you be willing to pay for X?[3]

Revealed preference methods include hedonic price analysis, travel cost models, averting behavior models, and market price models (Freeman, 2003; Champ, et al., 2003, for example). The choice of a method will depend on the case at hand, since different techniques are designed to deal with different types of services in different settings. Models based on market prices are appropriate where the ecological service supports the production of a market good such as timber or commercially harvested fish and changes in the service flow lead to changes in market supply and price. There have been a number of applications of market price models. See, for example, the paper by Barbier, et al. (2002) which was the bases for Ivar Strand's presentation on April 13.

The question formats for stated preference studies have become increasingly sophisticated in recent years. The earliest questions involved asking people directly about the values they place on environmental services by creating, in effect, a hypothetical market. For example, people could be asked how much they are willing to pay for a specified change in environmental services. Discrete choice questions ask for a *yes* or *no* answer to a question of the form: "Would you be willing to pay $*X* for. . . ?" where $X is varied systematically across the sample of respondents. In another form of question, respondents are given a set of hypothetical

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[3] The Millennium Assessment (2003, pp. 134-136) refers to revealed preference as "Direct and Indirect Observed Behavior "methods and stated preference as "contingent valuation". But the current practice in the field of nonmarket valuation is to use the terminology we have used here.

alternatives, each depicting a different bundle of environmental attributes. They are asked to choose the most preferred alternative, to rank the alternatives in order of preference, or to rate them on some scale. Responses to these questions can then be analyzed to determine, in effect, the marginal rates of substitution between any pair of attributes that differentiate the alternatives. If one of the other characteristics has a monetary price, then it is possible to compute the respondent's willingness to pay for the attribute on the basis of the responses. Again, the choice of question format will depend on the case at hand, since different formats are designed to deal with different types of services in different settings.

Standard or neoclassical welfare economics is based in part on the assumptions that individuals know their preferences and that they are well informed about the alternatives that they face and the potential consequences of the choices that they make.. These assumptions are problematic in two respects when it comes to applying welfare economics to the valuation of ecosystem services. First, an individual might act as if he/she placed no value on an ecosystem services if he/she was ignorant of the role of that service in contributing to well-being. In that case, both the choices that are analyzed in revealed preference models and the responses to hypothetical questions that are analyzed in stated preference models will not reflect the true value of the ecosystem service. In the cases of stated preference methods, it might be possible to provide the individual with information about the ecosystem service before asking the valuation questions.

Constructing Values: As for the second problem, some researchers have argued that, at least when confronted with unfamiliar choice problems, individuals do not have well-formed preferences and that responses to simple stated preference willingness to pay questions are

therefore unreliable (Gregory, et al., 1993; Gregory and Slovic, 1997).[4] These authors have advocated using multi-attribute utility theory (MAUT) as a way of assisting respondents in learning about the ecological services to be valued and constructing their preferences and values. We are aware of only one study that has actually used multi-attribute utility methods to value an environmental resources (Russell, et al., 2001).

Community Preferences: As mentioned above, a number of authors have advocated using some form of structured deliberative process to elicit community preferences and values for environmental changes (as distinct from individual preferences). As we learned from Joe Arvai's presentation on April 13, such structured processes have been used in an effort to reach consensus among stakeholders regarding plans for dealing with certain types of resource management and environmental problems. But we are not aware of any efforts to use these processes to reach consensus on the values to be applied to environmental changes. And although the tradeoffs made in reaching an agreement on a resource management plan imply the values placed on those environmental attributes involved, we are not aware of any efforts to analyze the results of these structured process to estimate the values revealed by the choices made by the stakeholders.

Others. [I have written about those measurement methods that I have some knowledge about. Others will have to fill out the rest of this section. RF]

[4]This criticism is not directed at values estimated using revealed preference methods, since the data there come from actual choices made by individuals who experience the consequences of their actions.

TABLE 1

VALUATION PARADIGMS

I. **INSTRUMENTAL**

A. Utilitarian: Based on individual preferences that are assumed to be known to individuals and fixed or unchanging.

Includes use values as well as nonuse or passive use values

B. Community Preferences

II. **INTRINSIC**

A.. Biocentric

B. Cultural-Religious

III. **OTHER**

A. Ecosystem health

B. Energetics

C. Ecological sustainability

D. Biodiversity

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APPENDIX A

Glossary:

benefit-cost analysis: (same as cost-benefit analysis) a policy assessment method that quantifies in monetary terms the economic value of all of the consequences of a policy or project (both costs and benefits) to all of the members of society.

benefits: the economic value in money units of improvements in the environment, increases in the levels of ecological services, etc.; defined as the aggregate of the willingness to pay of all the affected individuals.

contingent valuation methods: a stated preference method of eliciting economic values by asking respondents simple hypothetical questions of the form "How much would you be willing to pay for (a specified environmental improvement)?" or Would you be willing to pay $X for (a specified environmental improvement)?"

cost-effectiveness analysis: a comparison of mutually exclusive alternatives using the ratios of their economic costs in money units to a single quantified measure of the beneficial effect of a policy or project, for example, dollar cost per acre of wetland protected.

costs: the economic value in money units of what is given up or used up in carrying out a policy or program, valued in terms of the opportunities forgone.

choice experiments: a stated preference method of economic valuation based on asking respondents to rank, rate, score, or select the most preferred of a set of alternatives described on the basis of several relevant attributes, usually including a price attribute. Also referred to as **conjoint analysis**.

conjoint analysis: See **choice experiments**

ecological production function: an expression describing the behavior of a population over time (dN/dt), for example, as the logistic equation gives dN/dt as a function of the intrinsic growth rate, carrying capacity and the present population.

ecological system: a biotic community and its abiotic environment functioning as a system.

economic production function: a relationship between the output of some valuable good or service (e.g.., the harvest of fish) and the inputs used to produce it, both human or economic in origin and environmental or ecological, e.g.., stock of harvestable fish. For example, the economic production function for a commercial fishery could be represented as:

Catch = k * b(t) * E(t)

where b(t) is biomass at time t, which might be given by an ecological production function; and E(t) is some standardized measure of fishing effort.

economic value: a utilitarian value. See **benefit**.

ecosystem services: the processes through which ecosystems, and the species that make them up, sustain and fulfill human life (Daily, 1997, p. 3) ; the things that ecosystems do (including providing flows of valuable materials) that enhance human well-being (see Millennium Assessment, 2003, pp. 8-9).

existence value: the economic value an individual places on knowing that a resource will continue to exist even though he/she does not intend to visit or otherwise use the resource. Also know as nonuse value or passive use value.

instrumental value: the value of something derived from its role as a means toward an end other

than the provision of the service itself, in other words, a value derived from its usefulness in achieving a goal.

intrinsic value: value of something that exists independently of any such contribution and reflects the value of something for its own sake.

nonuse value: see existence value

passive use value: see existence value

production function approach: a revealed preference method of economic valuation that uses the economic production function to estimate the effect of the ecological service on the market supply of a good.

revealed preference methods: methods for estimating economic values based on the analysis of choices that people make in real-world settings where they are maximizing their well-being (utility) subject to a variety of constraints, including limited income, prices for market goods, and so forth.

stated preference methods: methods for estimating economic values that rely on individuals' responses to hypothetical questions of various forms. See **contingent valuation methods**, **choice experiments**.

utilitarian value: a form of instrumental value based on the contribution that something makes to human well-being.

valuation: act of determining value; estimation of worth, merit, etc. (Webster's New World, 3rd ed.).

value: a fair or proper equivalent in money; that quality of a thing that makes it more or less

desirable (Webster's New World, 3rd ed.).

valuing: estimating the value of or setting the worth of something (Webster's New World, 3rd ed.).