

**Comments Received from Members of the SAB Committee on Valuing
the Protection of Ecological Systems and Service (C-VPES) as of
October 14, 2005,
In Response to**

*“Valuing the Protection of Ecological Systems and Services:
An Expanded and Integrated Approach” (September 27, 2005 Draft)*

TABLE OF CONTENTS

1. GREG BIDDINGER..... 3
COMMENTS RECEIVED:..... 3
 1.1.1. *October 10, 2005*..... 3
 1.1.2. *Additional Comments October 11, 2005*..... 3
 1.1.3. *Comments shown as “redline” revisions to text:* 3
RED-LINE MARKUP WITH KEY ISSUES HIGHLIGHTED IN YELLOW..... 6

2. ANN BOSTROM 35

3. ROBERT COSTANZA 37

4. TERRY DANIEL 38
COMMENTS ON SECTION: MEASURING BENEFITS 38

5. DENNIS GROSSMAN 40
COMMENTS RECEIVED AS “REDLINE” WITHIN DOCUMENT: 40

6. DOUG MACLEAN 62

7. HAL MOONEY 63

8. LOU PITELKA 64
COMMENTS RECEIVED AS “REDLINE” WITHIN DOCUMENT: 64

9. PAUL RISSER 87
COMMENTS HIGHLIGHTED IN YELLOW:..... 87

10. JOAN ROUGHGARDEN..... 110
COMMENTS RECEIVED AS “REDLINE” WITHIN DOCUMENT: 110

11. MARK SAGOFF 132

12. KERRY SMITH 139
COMMENTS RECEIVED AS “REDLINE” WITHIN DOCUMENT: 139

1. Greg Biddinger

Comments received:

1.1.1. October 10, 2005

I will continue to try to work on this between now and the meeting. In general I think what Kathy has put together is excellent so don't take all the mark-ups and comments as an indication otherwise. Mostly what I am concerned with is that our vision of what should be considered in ecological valuation and what the agency is conditioned to value or capable of considering may be worlds apart.

If we plan to expect the agency to dramatically shift its capacity to estimate impacts in alignment with ecological production functions rather than toxic response functions then we should probably draw them a better map than we are doing so far. But I am not convinced that is what we should be doing. More sophistication does not always lead to an improved outcome.

1.1.2. Additional Comments October 11, 2005

I was trying this morning to link figure 5.2 from the reports document to the level zero. I thought that maybe it would fit into section 3 of the level zero document as the missing figure 1. So I started to map the three components of the proposed framework in Paragraph 4 of sec. 3. I think maybe we need a 4th component which is "Estimate and communicate value of Agency action". Then you can take the 4 components

- A) Identify the context and scope of the Benefits assessment
- B) Identify the ecological services that will be considered in the assessment
- C) Characterize, represent or measure these impacts and
- D) Estimate and communicate value of Agency actions and map them to figure 5.2 . A simple graphical representation of this would be to draw hatched-lines (or you could use brackets) across figure 5.2 to show which portions of the flow chart are linked to the 4 framework components. To expedite getting this to you I have marked up a copy of the figure by hand and sent it to you via fax. If you want to send me a copy of the figure in powerpoint I would be glad to do it electronically.

Anyway, at a minimum I think we need to add that 4th component to paragraph 4 of section 3.

1.1.3. Comments shown as "redline" revisions to text:

In general I think the level zero document provides a good overview of what we are trying to accomplish and what challenges we have.

There are some general comments I have which I will try to identify further later in the text.

1. There are a number of places in the text where **recommendations** are made. It would help the reader if we somehow were to bring them out this could be done by making them the lead sentence in a section when that makes sense or by having a separate section which repeats the recommendations. (I will try to highlight them in **yellow** as I go through)

2. I think we should try to work the "infamous" figure 5.2 from the methods report into this overview under section 2 on Ecological Valuation at EPA

3. We need to be careful in the use of the term Ecosystem. For example I don't think we want to coin the term "Ecosystem Valuation" we would be better off using Environmental or Ecological valuation. Most of the benefits are at levels of biological complexity well below ecosystems.

4. In particular this raises a much larger issue that we will need to address in both this document and the methods report. That the mission of the Agency may be to protect the environment but its legal and regulatory foundation, as well as its technical mechanisms are focused on management of

- (1) Chemicals and products (e.g. pesticides) in the market place,
- (2) Releases of chemicals and by-products from the intentional manufacturing commercial products or the treatment of municipal waste and water systems;
- (3) the emergency response to current or historical (unintentional or otherwise) releases of chemicals to the environment;
- (5) the establishment of standards for clean air, water and drinking water and
- (6) mechanisms such as permitting and enforcement procedures to assure they are achieved.

In the end what this means is that the benefits the Agency is striving to achieve are measured in terms of reduced risk. This risk is associated with environmental concentrations that are based primarily on laboratory toxicity data systems and some field demonstration of impacts. Such benefits may be real but they are not generally considered quantifiable beyond the level of impacts to individuals and at best populations of those individuals. One clear exception might be large-scale catastrophic impacts to environment (e.g. toxic spills) which are at such high concentrations that entire habitats are eliminated. But generally the Agency is working risk decisions at levels that are within the operating "noise" of the environment. For example, some have suggested that a 20 percent lethal exposure to a population would cause harm, but generally that number was not identified

based on empirical data but on the recognition that population level impacts in the field could not be statistically discerned at lower response rates due to the natural variability in populations.

This is not to say the Agency does not have an interest in the condition of the environment at the level of the community or ecosystems, as they do measure ecological condition through status and trend monitoring programs. What they don't have (and neither does anyone else) have a strong scientific understanding of how the environment responds at the community and ecosystem level to their actions taken based on their policies, regulations and standards.

There are some significant policy and data barriers for the agency to move beyond this point in their capability to quantify ecological benefits of their actions to communities and ecosystems. From a policy point of view they need to come up with a process by which a change in ecological condition can be determined as significant to populations, communities and ecosystems. Once they have a way to establish when the ecological condition has changed to a point where ecological services are diminished or enhanced then they can

It is obvious that the Agency's actions have yielded benefits to environmental condition and we most likely have healthier individual organisms, populations, communities and ecosystems. If anything the Agency would have had an easier task in quantifying ecological benefits 30 years ago than it does today. Simply because 30 years ago you could measure impacts related to chemicals released from manufacturing and municipalities (e.g burning rivers, fishes with tumors and sterile sediments). Some of that exists but much of the focus is on or should be on non-point sources which the agency is struggling to manage.

With regards to barriers to quantification linked to data gaps, the agency toxicological data is weakly linked to insitu response except for individual species and some body of work on micro-communities (e.g. periphyton).

So I guess I am raising the concern that if we recommend that the agency estimate or project benefits which it or other agencies do not have data, evidence or models to support, we are setting them up for challenges to their credibility. We should seriously evaluate if this should be a detailed focus for R&D recommendations with possibly an interagency collaborations.

Red-line markup with key issues highlighted in yellow

Valuing the Protection of Ecological Systems and Services: An Expanded and Integrated Approach (tentative title)

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Gregory Biddinger Comments

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1. INTRODUCTION AND BACKGROUND

Scope of this Report and its Intended Audience

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The Science Advisory Board (SAB) Committee on Valuing the Protection of Ecological Systems and Services (C-VPES) began its work in 2003 on a project developed by the SAB to strengthen the Agency's analysis for protecting ecological resources. The SAB saw a need to complement the Agency's ongoing work in ecological science, ecological risk assessment, and ecological benefit assessment by offering advice on how EPA might better value the protection of ecological systems and services and how that information might better support decision making to protect ecological resources. In this project the SAB set the goals of assessing Agency needs and the state of the art and science of valuing protection of ecological systems and services and identifying key areas for improving knowledge, methodologies, practice, and research at EPA. Senior EPA managers supported the concept of this SAB project and participated in the initial background workshop that launched the work of the C-VPES. The committee is an interdisciplinary group of experts from the following areas: decision science, ecology, economics, engineering, philosophy, psychology, and social sciences with emphasis in ecosystem protection.¹ The committee sees its work as a three-year initiative.

This report is intended to provide an overview of the committee's conclusions to date.² It is aimed at providing initial advice for strengthening the Agency's approaches for valuing the protection of ecological systems and services, facilitating their use by decision makers, and identifying the key research areas needed to strengthen the science base. The committee will prepare additional reports with more detailed advice at the

¹ The SAB Staff Office published a Federal Register Notice on March 7, 2003 (68 FR 11082-11084) announcing the project and called for the public to nominate experts in the following areas: decision science; ecology; economics; engineering; psychology; and social sciences with emphasis in ecosystem protection. The SAB Staff Office published a memorandum on August 11, 2003 documenting the steps involved in forming the new committee and finalizing its membership.

² The committee developed the conclusions in this report after multiple public meetings and workshops: a) an Initial Background Workshop on October 27, 2003 to learn the range of EPA's needs for science-based information on valuing the protection of ecological systems and services from managers of EPA Headquarters and Regional Offices; b) a Workshop on Different Approaches and Methods for Valuing the Protection of Ecological Systems and Services, held on April 13-14, 2004; c) an advisory meeting focused on support documents for national rulemakings held on June 14-15, 2004; d) an advisory meeting focused on regional science needs, in EPA's Region 9 (San Francisco) Office on Sept. 13, 14, and 15, 2004; and e) advisory meetings held on January 26-26, 2005 and April 12-13, 2005 to review EPA's draft *Ecological Benefits Assessment Strategic Plan* and to discuss economic and other methods for valuing the protection of ecological systems and services. The committee discussed a draft version of this report at a public meeting on (INSERT DATE).

completion of the project.³ However, given the importance of the committee's charge, it felt that it would be useful to the Agency to issue an initial report that would indicate the direction that the committee's work is taking and serve as a prelude to the subsequent committee report(s). These subsequent reports will further develop the concepts in this initial advisory report and provide more detailed discussion of issues, methods, and application. In particular, they will describe in more detail how different methods could be used more effectively to understand the benefits of the protection of ecological systems and services and how results of analyses could be better integrated and communicated to decision-makers.

This initial report focuses on the need for an expanded and integrated approach for valuing EPA's efforts to protect ecological systems and services. It provides advice to the Administrator, EPA managers, EPA scientists and analysts, and EPA staff across the Agency concerned with ecological protection. It adopts a broad view of EPA's work, which it understands to encompass national rulemaking, regional decision making, and programs in general that protect ecological systems and services. It focuses directly on EPA's contributions and impacts, however, and not on the general question of the value of ecosystems or ecological services in themselves. It outlines a call for EPA to expand and integrate its approach in important ways.

This report appears at a time when there is lively interest internationally, nationally, and at EPA itself in the issue of valuing the protection of ecological systems and services. Since the establishment of the SAB C-VPNESS major reports have been developed focusing on how to improve the characterization of ecological resources (Millennium Ecosystem Assessment 2005; Millennium Ecosystem Assessment Board 2003; National Research Council 2004; Pagiola, von Ritter, and Bishop 2004; Silva and Pagiola 2003) The committee's work has benefited from and will build upon those recent efforts. The C-VPNESS distinguishes its work from those efforts, however, in the following ways. The C-VPNESS focuses on EPA as an audience. The committee focuses specifically on how EPA can value its own contributions to the protection of ecological systems and services, so that the agency can make better decisions in its eco-protection programs. The C-VPNESS is inter-disciplinary and does not focus solely on economic methods or values. The committee will offer advice on several benefits assessment approaches and in each case will emphasize issues relevant to EPA policy and decision-making and address how the Agency could better characterize the benefits of ecological protection.

The Importance of Valuing Ecosystems and their Services

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The Concept of Ecosystem Services

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³ The Committee has already issued a related advisory report on the Agency's draft *Ecological Benefits Assessment Strategic Plan* (EPA SAB, EPA-SAB-ADV-05-00X). This report complements the *EBASP* Advisory, and provides a discussion of an integrated framework alluded to in that report.

The term “ecosystem” describes the organisms in a given area interacting with their physical environment as a functional unit. Ecosystems can describe organism-physical environment interactions in a woodlot, a watershed, or an extensive landscape. Ecosystems encompass all organisms within the prescribed area, including humans, who are often the dominant element. Processes that link organisms with their physical environment are considered ecosystem processes and include primary productivity and the cycling of nutrients and water. These processes in total describe the functioning of ecosystems. Processes that link organisms with each other, indirectly influencing flows of energy, water and nutrients, can also be considered ecosystem processes, such as pollination, predation and parasitism.

“Ecosystem services” is an anthropocentric concept denoting the benefits that humans derive from the functioning of ecosystems. An operational categorization of ecosystem services has recently been proposed by the Millennium Ecosystem Assessment:

a) **Provisioning services** (products obtained from ecosystems). These include food, fuelwood, fiber, biochemicals, genetic resources and fresh water. Generally these services are traded in the open marketplace.

b) **Regulating services** (benefits received from regulation of ecosystem processes). This category includes a host of benefits that humans derive from the presence and functioning of ecosystems. These include flood protection, human disease regulation, water purification, air quality maintenance, pollination, pest control and climate control. These services are generally not marketed but many have clear value to society and this value will increase for many of these services as the many dimensions of global change proceed.

c) **Cultural services** (the nonmaterial benefits people obtain from ecosystems). Ecosystems provide cultural, spiritual and aesthetic values, and a sense of place.

d) **Supporting services**. These are the processes that maintain ecosystem functioning such as: soil formation, primary productivity, biogeochemistry, and provisioning of habitat. They all affect human well-being, but generally indirectly through their support of the provisioning, regulating and cultural service functions.

Although there are different ways in which ecosystem services can be categorized, the committee feels that the approach adopted in the Millennium Assessment is a useful approach for conveying the concept of ecosystem services and the broad array of functions and processes ecosystem services include. The ecosystem service concept is useful in many ways. First, it is a concept that is readily grasped by society, since it relates directly to human well-being. Secondly, it provides a tool for evaluating the impacts of human actions in terms of the resulting change in the benefits provided by the affected services. “Ecosystem health” can then be defined in terms of the output and sustainability of services. When defined this way, the concept of ecosystem health

relates directly to the benefits provided to humans. However, life on earth can be revered and protected independent of human benefit. As discussed below, the committee recognizes that ecosystems can be valued not only because of the human-based services they provide but also for other non-anthropocentric reasons, including respect for nature based on ethical, religious, or biocentric principles.

1.2.2 The Concept of Value

Because people define and assign values, all values are *anthropogenic*. However, as noted above, not all values are *anthropocentric*. When people talk about environmental values, the values of nature, or the values of ecological systems and services, they may have different things in mind. People have moral, economic, religious, aesthetic, and other values, all of which can affect their thoughts, attitudes, and actions toward nature in general or, more specifically, ecosystems and the services they provide.

The most basic distinction in values is the distinction between means and ends. To value something as a mean is to value it for its usefulness in helping to realize or bring about some thing or state of affairs that is valued in its own right or as an end. Things valued for their usefulness as means in this sense are said to have instrumental value. Of course, it would not make sense to value anything instrumentally or as a means unless there was at least one thing or state that was valued for its own sake or as an end. Things valued as ends are sometimes said to have intrinsic value.⁴ If intrinsic value applies to things other than human beings or human experiences, then this conception of value is non-anthropocentric. Some people defend a non-anthropocentric conception of value or goodness (Goodpaster 1978; Rolston III 1991; Taylor 1986). However, others argue that only human beings or human experiences have intrinsic value, thereby defending an anthropocentric conception of value (Glover 1984; Sidgwick 1901; Williams 1994).

Ecological systems have instrumental value to the extent that they provide useful services. Some people also claim, however, that an ecological system may have value independently of the services it provides, i.e., its very existence has value. This claim can mean several different things. If it means that the existence of an ecological system is valuable because people derive satisfaction from its existence, then it has what economists call "*existence value*." This concept is anthropocentric. In addition, it is a kind of instrumental value, since it is based on the premise that the existence of the species or ecological system is one of many things that generate human satisfaction, and that the various things that contribute to human satisfaction are potentially substitutable. Some people, however, claim that an ecological system may have intrinsic value of its

⁴ There is controversy over the meaning of intrinsic value that we will not try to resolve here (Korsgaard 1996). Many people take intrinsic value to mean that the value of something is inherent in that thing. Some philosophers have argued that value or goodness is a simple non-natural property of things (see Moore 1903 for the classical statement of this position), and others have argued that value or goodness is not a simple property of things but one that supervenes on the natural properties to which we appeal to explain a thing's goodness (this view is defended by, among others, contemporary moral realists; see (Brink 1989; McDowell 1985; Sayre-McCord 1988; Sturgeon 1985).

own, and that we should protect it for its own sake. If the explanation of this claim refers to reasons that are independent of the contribution that the existence of an ecological system can make to human well-being, then this claim of intrinsic value should be understood in a non-anthropocentric sense.

This committee recognizes that there are many possible sources of value derived from ecosystems and the services they provide. Thus, throughout this report, the term "value" is used broadly to include values predicated on their contributions to human society (broadly defined), as well as those based on an ethical, religious, or biocentric notion of intrinsic value.

Related to the concept of value are the concepts of "benefits" and "valuation." Both of these terms are relative to a specific change. In this report, the change of interest is the change in the state of an ecosystem or the flow of services it provides stemming from an actual or proposed action by EPA. Thus, the term "ecosystem benefits" refers to the increase in the value of the ecological system and/or its services. This assumes a positive change in value. Analogously, a reduction in value, for example from damages to an ecosystem, can be viewed as a "negative benefit" or cost.

Similarly, the term "valuation" will refer to the process of characterizing or measuring benefits or changes in value using various methods and techniques. For example, economic valuation measures benefits in terms of the amount people are willing to pay (WTP) to ensure an ecological improvement or the amount people are willing to accept (WTA) to forego the improvement.⁵ A social/psychological assessment method might present the same ecological change and ask people to rate the importance of achieving (or preventing) that change relative to a selection of changes in a number of other (potentially competing) social goals. An ecological approach might assess the value of the targeted change in terms of the magnitude of its effect on biodiversity or some other indicator of ecological health based on the consensus that ecological health is important to human/social well-being. All of these assessments are based on an anthropocentric view of values, where ecological values are assessed in terms of their contribution to human well-being. However, they differ in terms of the means by which values are expressed, and by the extent to which the value of the targeted ecological change can then be explicitly compared (traded off) against other social values. Economic assessments claim the broadest range and most explicit method for assessing tradeoffs between, for example, ecological improvements and changes in other goods or services that also contribute to human well-being. The social/psychological methods generally settle for a relative measure of the value of the targeted ecological change and largely constrain tradeoff implications to options and circumstances that are closely related to the set of alternatives explicitly presented in the assessment. Ecological assessments might restrict tradeoff implications to the biosphere. In all cases, the ultimate purpose of the valuation process is to characterize or measure the benefits (or

⁵ A large literature exists on the use of economic valuation methods to estimate the value of changes in environmental quality. For a comprehensive description of these methods, see Freeman (1993).

costs) associated with an ecological change in a way that provides useful information about these benefits to policymakers and the public at large. The committee plans to discuss these methods, what they may offer analysts and decision makers at EPA in capturing different kinds of benefits, and their limitations and related issues in a future report.

1.2.3 The Importance of Assessing Ecosystem Benefits

Given the important role that ecosystems play in supporting life on earth and providing goods and services that people value, changes in the state of these systems or the flow of services they provide can have important implications. This importance has been increasingly recognized by many, both within the U.S. and internationally. The recent study by the National Research Council (Citation w/ date?) and the Millennium Ecosystem Assessment (Citation w/ date ?) are indicative of this growing recognition.

Many EPA actions (e.g., regulations, rules, programs, policy decisions) affect the condition of the environmental and the flow of ecological services derived from it, EPA actions can either lead to changes in the conditions of ecosystems (improvement or deterioration) or prevent changes (i.e. avoid injury) that would otherwise have occurred. These impacts can occur both at a relatively small, local scale as well as more broadly at a national scale. Yet, to date, community and ecosystem impacts have received relatively limited consideration in EPA policy analyses. Failure to consider these avoided impacts as fully as possible can lead to distorted policy decisions, particularly in regulatory contexts where benefits are being compared to costs. In some cases, the result could lead to either, an under-valuation of (or failure to fully recognize) or an over-valuation (failure to recognize unintended negative consequences of actions) of the benefits of EPA actions aimed at protecting the environment. This can occur, for example, when actions are evaluated based primarily on their impacts on human health, without recognition of potentially important ecosystem impacts. Without considering the costs and benefits of agency actions at a more holistic level the agency could take actions to protect human health that actually have a cost to the environment.

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Valuing the changes in ecological systems and services and assessing the ecosystem benefits that result from EPA policies or programs is challenging for a number of reasons. Major challenges include: a) understanding the many sources of value that ecosystems generate, b) predicting the ecological impacts of alternative EPA actions, and expressing those predictions in the temporal and spatial scale most appropriate for decision-making, c) linking those impacts to changes in the dimensions of ecosystems or the service flows that people value, d) developing methods and techniques that can be used to characterize and/or measure the value of protecting ecological systems and services so that they may be incorporated or properly reflected in environmental decisions and policies, e) aggregating to a national level using local or regional studies from regions with different ecological and/or economic characteristics, and f) finding measures or means of representing ecological values or benefits that are commensurable with values of non-ecological changes caused by EPA actions, such as human health. Despite these challenges, it is imperative that EPA improve its ability to assess ecosystem

[Gregory Biddinger Comments](#)

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benefits to ensure that ecological impacts are adequately considered in the evaluation of EPA actions.

ECOLOGICAL VALUATION AT EPA

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There are several different contexts in which EPA policy decisions have ecological impacts and hence in which the need for ecological benefits assessment will arise. In addition, when assessing benefits, EPA must operate within a set of institutional, legal, organizational and practical constraints that affect this process at the Agency. Thus, EPA has specific needs in this regard that must be recognized and addressed. These needs arise in different parts of the Agency for different purposes and for different audiences. Some of the needs present structured requirements for valuing protection of ecological systems and services, while needs in other contexts are less prescriptive.

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(Should we consider a concise statement of under what conditions and for what purposes the agency is required to do BCA or where they voluntarily apply it.)

Policy Contexts at EPA Where Ecosystem Valuation Can be Important

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The most prescriptive requirements are for national rule making. Benefit assessments are required for national rulemaking by two of EPA's governing statutes (the Toxic Substances Control Act and the Federal Insecticide, Fungicide and Rodenticide Act) and by Executive Order 12866 for "significant regulatory actions". The circular on "Regulatory Analysis" issued by the Office of Management and Budget (OMB) in September 2003, *OMB Circular A-4*, identified key elements of a regulatory analysis for such "economically significant rules." One of these elements is an evaluation of the benefits and costs of a proposed regulatory action and the main alternatives identified. The circular provided general guidance on how to provide monetized, quantitative, and qualitative information to fully characterize benefits and EPA itself has developed initial guidance for ecological benefit assessment (U.S. Environmental Protection Agency 2000). In developing its draft *Ecological Benefits Assessment Strategic Plan* and in discussions with the committee (U.S. Environmental Protection Agency Science Advisory Board 2003), EPA identified the need for improved models and methods to help implement the requirements of the circular. The Agency identified needs both to expand methods and data for economic valuation through benefit-cost or cost-effectiveness analysis and to explore other assessment methods to provide information on ecological effects that are currently un-monetized and assigned an implicit value of \$0. Managers seek approaches that are "sound, credible, and scientifically supportable" as well as flexible, affordable, and able to be implemented within the time constraints required by rulemaking (U.S. Environmental Protection Agency Science Advisory Board 2004).

EPA's regional offices, although generally not responsible for national rule-making, are responsible for several kinds of decisions and activities where the benefits of ecological protection come into question:

- Priority setting for regional action, such as targeting projects for wetland restoration and enhancement or identifying critical ecosystems or ecological resources for regional attention
- Setting Supplemental Environmental Protection (SEPs) penalties for enforcement cases where those penalties involve protection of ecological systems and services
- Choice of options for Superfund and Resource Conservation and Recovery Act (RCRA) cleanups that could take ecological benefits into account
- Review of Environmental Impact Statements prepared by other federal agencies to comply with the National Environmental Protection Act
- Assisting state and local governments and other federal Agencies with protecting lands and land uses, where assessment of the value of protection options could help decision-makers make better-informed decisions.

Regions seek low-cost methods that can be implemented quickly to inform "place-based" decisions. They seek methods that provide information on the value of ecological services; ecological diversity; conservation opportunities and threats; sustainability; and historical and cultural values associated with ecological systems or parts of ecosystems at the watershed or landscape scale. Regions experience the need to communicate the value of ecological protection as they collaborate with other federal agencies and with government partners at the local, state, and regional levels.

EPA's need to communicate the value of its ecological protection programs has two dimensions: 1) a retrospective dimension, because assessments focus on the value of EPA's current and past protection efforts and 2) a prospective dimension, because such assessments are meant to inform decisions about future EPA programs and priorities.

The need to assess the ecological benefits of policy options is woven into most of the Agency's decisions, including the assessment of ecological protection programs . Program assessments are mandated for EPA, as they are for all agencies of the executive branch, by the Government Performance and Results Act of 1993. As part of that assessment, OMB requires EPA to periodically identify its strategic goals and describe both the social costs and budget costs associated with them. EPA's Strategic Plan for 2003-2008 described the current social costs and benefits of EPA's programs and policies under each strategic goal area for the year 2002 (U.S. Environmental Protection Agency 2003). This analysis repeatedly points out that EPA lacks data and methods to quantify the ecological benefits associated with the goals in its strategic plan.

In addition, the Government Performance Results Act of 1993 established requirements for assessing the effectiveness of federal programs. Part of that assessment involves assessing the outcomes of programs intended to protect ecological resources. EPA must report annually on its progress in meeting program objectives linked to strategic plan goals and must engage periodically in an in-depth review [through the Program Assessment Rating Tool (PART)] of selected programs to identify their net

benefits and to evaluate their effectiveness in meeting meaningful, ambitious program outcomes. Characterizing ecological benefits associated with EPA programs is a necessary part of the program assessment process.

Institutional and Other Issues Affecting Benefits Assessment at EPA

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The committee recognizes that ecological benefits assessment at EPA must be conducted within a set of institutional, legal, organizational, and practical constraints that affect what is and can be done to incorporate ecosystem values into policy evaluations. In an effort to better understand these issues and their implications for the committee's charge, the committee conducted a series of interviews with Agency staff.⁶ The interviews were focused on the process of developing benefit analyses for Regulatory Impact Assessment (RIA) for rulemaking and the relationship between EPA and the Office of Management and Budget. However, many of the questions raised are equally applicable to strategic planning, performance reviews, regional analysis, and other situations in which the agency is called upon to assess the value of ecosystems. Below are some key observations made by the committee based on those interviews.

EPA Program Offices responsible for new rules initiate, finance, and administer the process for developing ecological benefit assessments. The development of a new rule – including definition of the rule itself, options to be weighed, and the assessment of impacts arising from the rule – involves much more than scientific assessment. Political negotiations and legal analysis arguably dominate the process. EPA has a formal rule-development process with several stages, each which impose demands on the Agency and the Agency also develops rules to meet court-imposed deadlines.

Several aspects of these imposed constraints deserve emphasis. First, despite the commonality of the underlying rule-development process, it is clear that there is no single way in which ecological valuation is conducted within the Agency. Practices vary considerably across program offices, reflecting differences in mission, in-house expertise, etc. Program offices have different statutory and strategic missions. The organization, financing, and skills of the program offices differ enormously. The National Center for Environmental Economics (NCEE) is the Agency's centralized reviewer of economic analysis within the agency.⁷ However, the primary expertise and development of the rules resides within the program offices.

⁶ These interviews were conducted by one Committee member, Dr. James Boyd, in conjunction with the Designated Federal Officer, Dr. Angela Nugent, over the period September 22, 2004 through November 23, 2005. In seven sets of interviews, Dr. Boyd spoke with staff from the Office of Policy, Economics and Innovation, Office of Water, Office of Air and Radiation, Office of Solid Waste and Emergency Response.

⁷ NCEE is typically brought in by the program offices to both help design and review RIAs. NCEE can be thought to provide a centralized "screening" function for rules and analysis before they go to OMB. NCEE is actively involved in discussions with OMB as rules and supporting analysis are developed and advanced.

Secondly, the timing of the process largely determines the kinds of analytical techniques that are employed. This is related to court-imposed deadlines on the rule process, as well as intervening requirements related to the collection and analysis of new data. The scientific community is used to much longer time horizons for their analyses. They are also used to the idea that a new rule should call for the collection of new kinds of data. Unfortunately, collecting new data poses a significant bureaucratic problem for the Agency. To collect original data, the Agency must submit an Information Collection Request, which is reviewed within the Agency and by OMB. This hurdle alone can add significant drag to the assessment process. With perhaps a year or two at most to conduct a study, this kind of review significantly limits the kind of analysis the Agency can conduct.

A third issue is the role of the Office of Management and Budget (OMB) in defining or directing ecosystem valuation exercises at EPA. It was difficult for the committee to ascertain the EPA-OMB relationship precisely.⁸ EPA has been given explicit guidance by OMB in the Circular A-4, which the committee views as a reasonable document on its own because of its call for a full characterization of the impacts of different policy options and inclusion of language calling for characterization of benefits that cannot be monetized or cannot be quantified (Office of Management and Budget 2003)⁹. However, the implications of some sections of the Circular, particularly relating to the treatment of benefits that cannot be readily monetized, remain somewhat ambiguous. For a benefit or cost that cannot be expressed in monetary terms, the Circular instructs Agency staff to “try to measure it in terms of its physical units,” or, if this is not possible either, to “describe the benefit or cost qualitatively.” However, little guidance is provided on how this should be done. Instead, the Circular urges regulators to “exercise professional judgment in identifying the importance of non-quantified factors and assess as best you can how they might change the ranking of alternatives based on estimated net benefits.”

It is clear that the Agency views the OMB as a kind of “court” that reviews its analysis. In front of this “court,” methods that have been accepted in the past create incentive for the use of the same or similar methods in the future. The thinking seems to be “if it made it through OMB once, it will make it through again.” There appears to be a pronounced tendency to use “off-the-shelf” methods to avoid problems with OMB. This creates a bias toward the *status quo* and a reluctance to explore new or innovative approaches. To this end, the committee sees the need to strike an appropriate balance between the use of established methods and the possible need to innovate in an effort to

⁸ OMB responded to written questions, but declined to be interviewed by Dr. Boyd. EPA staff were informed that their formal responses to all questions, including the OMB-EPA interview were to be documented as part of the Committee report and this is likely to have had a chilling effect on the discussions.

⁹ eg., see pp.27 “If monetization is impossible, explain why and present all available quantitative information” and. pp “If you are not able to quantify the effects, you should present any relevant quantitative information along with a description of the unquantified effects, such as ecological gains, improvements in quality of life, and aesthetic beauty.”

conduct more comprehensive and defensible benefit assessments for use in decision making and evaluation.

A related issue involves RIA review by external parties. The Agency does not take a standardized approach to RIA review.¹⁰ EPA staff and managers reported that peer review was focussed only on “novel” elements of an analysis. This raises the question of how the Agency (and perhaps OMB) defines “novel.” Moreover, the novelty standard actually creates a clear incentive to avoid conducting novel analyses (however defined). It is clearly cheaper and quicker to avoid review altogether. The committee advises the Agency to consider whether there is a role for a standing expert body that can bring consistency to the review of analysis, avoid duplication of review, and be sensitive to timing and resource constraints.

Finally, the committee notes the importance of organization of assessment science within the Agency. Currently, the Agency relies upon a variety of offices to develop assessments, with varying degrees of reliance on other offices (e.g., NCEE) or outside assistance.¹¹ It is not clear which work better than others. In addition, it is not clear how different programs integrate social science and biophysical science.¹²

Do we want to advocate a “ecosystem services valuation paradigm” and/or development of a set of guidelines for doing ecological valuation?

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Yes I think we do want to advocate the development of a rules-based approach to ecological valuation. The rules or guidelines would be flexible to handle data rich or data poor situations. Any paradigm would likely define benefits at a number of biological hierarchies for any given action. That is to say it would expect that a "benefits statement" at the highest level of quantification for individual species, ecological guilds, communities and measures of ecosystem performance or condition for all be attempted for any major rule, policy or action.

¹⁰ In some cases, review panels are appointed, in others not. In some cases, contractors are called upon to manage the review. In other cases, Program Offices themselves manage the review process.

¹¹ Another issue that relates to the organization of science within the Agency is the availability and location of data to support ecosystem valuation. The choice of methods is clearly related to the practical availability of data across the Agency. It is important that data that are housed within individual program offices are made public and readily shared with other offices. (Does data drive the method or method drive the collection of data. As mentioned in my initial comments, I question if the Agency can verify the link between its actions and changes in the environment)

¹² One anecdote is that Dr Boyd was able to speak with only one ecologist during the interviews designed (in part) to interview a set of ecologists. Economists in the agency were not able to identify ecologists to interview, for example. It also became clear that simple “counts” of professional background can be deceptive. What the agency terms an “ecologist” is not necessarily what the scientific community would call an ecologist.

Relationship to risk assessment paradigm/guidelines??? See more on this in footnote below. I think the agency holds the risk assessment framework as one of its technical cornerstones or maybe a better metaphor is its backbone. So to that degree it would need to be linked the Risk Assessment framework. But as I implied my preliminary notes that risk is often a poor surrogate for performance and the agency does not have a strong data set to bridge estimates of risk and measures of benefits captured from mitigating those risks. Therefore what we need is a ecological valuation framework that can help the Agency see a way to create a technical bridge between Risk And Performance. This is likely going to require a significant R&D effort.

An Illustrative Example of Ecosystem Benefit Assessment at EPA

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In an effort to better understand the current state of ecosystem valuation at EPA, the committee examined in detail one specific case where benefit assessment was undertaken, namely, the *Environmental and Economic Benefits Analysis* that EPA prepared in support of new regulations for Concentrated Animal Feeding Operations (CAFOs) (U.S. Environmental Protection Agency 2002).^{13,14} The Agency indicated that this analysis was typical of other EPA regulatory analyses of ecological benefits in form and general content.

Because the proposed new CAFO rule constituted a “significant regulatory action” under Executive Order 12866, EPA was required to assess the costs and benefits of the rule.¹⁵ EPA identified a wide variety of potential “use” and “non-use” benefits as

¹³ The Committee reviewed and critically evaluated the Environmental and Economic Benefits Analysis at its June 15, 2004 meeting. As stated in the Background Document for SAB Committee on Valuing the Protection of Ecological Systems and Services for its Session on June 15, 2004, the purpose of this exercise was “to provide a vehicle to help the Committee identify approaches, methods, and data for characterizing the full suite of ecological ‘values’ affected by key types of Agency actions and appropriate assumptions regarding those approaches, methods, and data for these types of decisions.” The Committee based its review on EPA’s final benefits report (EPA 2002) and a briefing provided by the EPA Office of Water staff. During the June meeting, members of the Committee divided into two workgroups. The workgroups each worked independently and reported their findings to the combined Committee. The leaders of the two working groups then prepared a consolidated summary of comments from the two workgroups.

¹⁴ In December 2000, EPA proposed a new CAFO rule under the federal Clean Water Act to replace 25-year-old technology requirements and permit regulations (66FR 2959). EPA published its final rule in December 2003 (68 FR 7176). The new CAFO regulations, which cover over 15,000 large CAFO operations, reduce manure and wastewater pollutants from feedlots and land applications of manure and remove exemptions for stormwater-only discharges.

¹⁵ Prior to publishing the draft CAFO rule in December 2000, EPA spent two years preparing an initial assessment of the costs and benefits of the major options. After releasing the draft rule, EPA spent another year collecting data, taking public comments, and preparing assessments of new options. EPA published its final assessment in 2003. An intra-agency team at EPA, including economists and environmental scientists in the Office of Water, Office of Air and Radiation, Office of Policy Economics and Innovation, and Office of Research and Development, worked on the benefit assessment. EPA also worked with the U.S. Department of Agriculture in developing the assessment. Dr. Christopher Miller of EPA’s Office of

part of its analysis.¹⁶ Using various economic valuation methods, EPA provided monetary quantifications in its CAFO report for seven environmental benefits.¹⁷ Approximately eighty-five percent of the monetary benefits quantified by EPA were attributed to recreational use and non-use of affected waterways. According to Agency staff, EPA's analysis was driven by what it could monetize. EPA focused on those benefits for which data were known as available for quantification of both the baseline condition and the likely changes from the proposed rule, and translation of those changes into monetary equivalents. EPA's final benefits assessment provides only a brief discussion of the benefits that it could not monetize. The benefits table in the Executive Summary listed a variety of non-monetized benefits¹⁸ but designated them only as "not monetized." EPA represented the aggregate effect of these "substantial additional environmental benefits" simply by attaching a "+B" place-holder to the estimated range of total monetized benefits. Although the Executive Summary gave a brief description of these "non-monetized" benefits, the remainder of the report devotes little attention to them.

Although much effort was invested in the CAFO benefits assessment, the assessment illustrates a number of limitations in the current state of ecosystem valuation at EPA.

First, EPA's analysis and report focused nearly exclusively on meeting the requirements as described in Executive Order 12866. This may not be surprising since the Executive Order provided the reason for preparing the analysis and report. However, when EPA prepares a benefit assessment specifically to comply with Executive Order 12866, the Agency need not limit itself to the goals and requirements of the Executive Order. The Executive Order does not preclude EPA from adopting broader goals. The Executive Order provides merely that EPA shall conduct an "analysis" and "assessment"

Water estimated that EPA spent approximately \$1 million in overall contract support to develop the benefit assessment. EPA spent approximately \$250,000-\$300,000 on water quality modeling as part of the assessment.

¹⁶ The potential "use" benefits included in-stream uses (commercial fisheries, navigation, recreation, subsistence, and human health risk), near-stream uses (non-contact recreation, such as camping, and nonconsumptive, such as wildlife viewing), off-stream consumptive uses (drinking water, agricultural/irrigation uses, and industrial/commercial uses), aesthetic value (for people residing, working, or traveling near water), and the option value of future services. The potential "non-use" values included ecological values (reduced mortality/morbidity of certain species, improved reproductive success, increased diversity, and improved habitat/sustainability), bequest values, and existence values.

¹⁷ These benefits were recreational use and non-use of affected waterways, protection of drinking water wells, protection of animal water supplies, avoidance of public water treatment, improved shellfish harvest, improved recreational fishing in estuaries, and reduced fish kills.

¹⁸ These include eutrophication of estuaries; reduced pathogen contamination of drinking water supplies; reduced human and ecological risks from hormones, antibiotics, metals, and salts; improved soil properties from reduced over-application of manure; and "other benefits".

of the “benefits anticipated from the regulatory action” and, “to the extent feasible, a quantification of those benefits.” By adopting a narrow focus, the report failed to consider or reflect the broader purposes that a benefit assessment can serve. Environmental benefit assessments, such as the CAFO study, can serve a variety of important purposes, including helping to educate policy-makers and the public more generally about the benefits that stem from EPA regulations.

Second, as noted above, in implementing the Executive Order, the CAFO analysis did not provide the full characterization of ecological benefits using quantitative and qualitative information, as required by the OMB Circular A-4. Instead, the report focused on a limited set of environmental benefits, driven primarily by the ability to monetize these benefits using generally accepted models and existing value measures (benefit transfer).¹⁹ These benefits did not include all of the major environmental benefits that the new CAFO rule would likely generate, nor all of the benefits that generated public support for the new rule.²⁰ The Circular requires that a benefit assessment identify and characterize all the important benefits of the proposed rule, not simply those that can be monetized. By focusing only on a narrow set of benefits, the CAFO analysis and report understates the benefits of the rule change and distorts the rationale supporting the final rule.²¹ An unfortunate effect of this presentation is to suggest to readers that the monetized benefits constitute the principal justification for the CAFO rule.²² Although in this case the focus on monetized benefits did not affect the outcome of the regulatory review, it is certainly possible that in a different context, this conservative approach to benefits assessment (based only on easily monetized benefits) could inadvertently undermine support for a rule that would be justified based on a more inclusive characterization of benefits.

¹⁹ EPA apparently conducted no new economic valuation studies (although a limited amount of new ecological research was conducted) and did not consider the possible benefits of developing new information where important benefits could not be valued in monetary terms based on existing data. The CAFO report emphasizes EPA’s predisposition toward conservative benefits estimates and identifies the lack of adequate data and/or models meeting EPA standards of quality as a basis for truncating the CAFO analysis.

²⁰ For example, while the report notes the potential effects of discharging hormones and other pharmaceuticals commonly used in CAFOs into drinking water sources and aquatic ecosystems, the nature and possible ecological significance of these effects is not adequately developed or presented. Similarly, the report does not adequately address the well-known consequences of discharging TMC precursors into drinking-water sources.

²¹ One of the benefits of monetary benefit estimates obviously is the ease of aggregating them by simple arithmetic. However, the Committee does not believe that reporting that a rule produced a total of “218.9 million dollars in annual benefits” is necessarily more useful, meaningful, or defensible for environmental policy than reporting, for example, the achievement of a “10% reduction in the pollution of over 129,000 miles of streams and rivers, 3.2 million acres of lakes and ponds, and 2,800 square miles of estuaries.”

²² In the case of this CAFO rule, 97% of the monetized benefits arise from recreation (boating, swimming and fishing) and from private well owners’ willingness to pay for water quality, estimated using contingent valuation or travel cost methods.

Third, the monetary values for many of the emphasized benefits were estimated through highly leveraged benefit transfers that were generally based on dated studies conducted in contexts quite different from the CAFO rule application.²³ This was undoubtedly driven to a large extent by time, data, and resource constraints, which make it very difficult for the Agency to conduct new surveys or studies and virtually force the Agency to monetize benefits using existing value estimates. However, **reliance on dated studies in quite different contexts raises questions about the credibility or validity of the monetary benefit estimates.** **(This is more a flaw than a recommendation but could be turned around to be stated positively as a recommendation)** This is particularly true when values are presented as point estimates, without adequate recognition of the underlying limitations, due to uncertainty and data quality.

Fourth, EPA apparently did not engage in a detailed and systematic effort at the outset to model the rule's ecological impacts. The report presents only a simple conceptual model that traces outputs (a list of pollutants in manure – Exhibit 2-2 in the CAFO report) through pathways (Exhibit 2-1) to environmental and human health effects.²⁴ This model provided useful guidance, but was not sufficiently detailed to assure an adequately comprehensive and balanced analysis of the rule's ecological impacts. As a consequence the analysis was unduly directed by Agency presumptions (or discoveries) about the availability of relevant data and the likely opportunities to quantify effects precisely and to link and monetize associated benefits. This was undoubtedly driven in part by the time pressures of putting together the regulatory impact analysis. However, without a detailed and comprehensive modeling effort at the outset, EPA had insufficient insight into the potential benefits that needed to be analyzed and valued. **Developing integrated models of relevant ecosystems at the outset of a valuation project would also help in identifying important secondary effects, which frequently may be of even greater consequence or value than the primary effects.**²⁵

²³ EPA used estimates based on a variety of public surveys in its benefit transfer efforts, including: a national survey (1983) that determined individuals' willingness to pay for changes in surface water quality relating to water-based recreational activities (Section 4 of the CAFO Report); a series of surveys (1992, 1995, 1997) of willingness to pay for reduced/avoided nitrate (or unspecified) contamination of drinking water supplies (Section 7); and several studies (1988, 1995) of recreational fishers' values (travel cost, random utility model) for improved/protected fishing success related to nitrate pollution levels in a North Carolina estuary (Section 9).

²⁴ Although EPA later prepared more detailed conceptual models of the CAFO rule's impact on various ecological systems and services, EPA did not prepare these models until after the Agency finished its analysis.

²⁵ Contamination of estuaries, for example, might negatively affect fisheries in the estuary (a primary effect) but might have an even greater impact on offshore fisheries that have their nurseries in the estuary (a secondary effect).

Fifth, the CAFO analysis clearly demonstrates the challenges of conducting ecological benefit assessments at the national level.²⁶ National rule-makings inevitably require EPA to generalize away from geographic specifics, both in terms of ecological impacts and associated values. However, it is possible (and desirable) to **make use of intensive case studies** (e.g., individual watersheds, lakes, streams, estuaries) in support of the national-scale analyses. **Existing and ongoing research at local and regional scales offers more detailed data and models that could be better exploited, both to fill in gaps and to systematically validate the national-scale analyses.** Systematically performing and documenting comparisons to intensive study sites could indicate the extent to which the national model needs to be adjusted for local/regional conditions and could provide data for estimating the range of error and uncertainty in the projected national-scale effects.

Sixth, although EPA invited public comment on the draft CAFO analysis as required by Executive Order 12866, there is no indication in the draft CAFO report that EPA consulted with the public during its analysis to help it identify, assess, and prioritize the effects and values addressed in its analysis, nor is there discussion in the final CAFO analysis of any comments received on the draft CAFO analysis. **Early public involvement could play a valuable role in helping the Agency both a) identify all of the systems and services impacted by the proposed regulations and b) determine the regulatory effects that are likely to be of greatest value.** This would ensure that the benefits assessment includes the most important impacts.

Finally, while EPA in its analysis and report appropriately emphasized the importance of using outside peer-reviewed data, methods, and models, EPA did not seek to peer review its application of them or its integration of these components in deriving benefit values for the CAFO rule. Once again, this is undoubtedly due in part to time and resource constraints. **However, peer review, especially early in the process, would help EPA staff identify relevant and available data, models, and methods to support its analysis, and provide encouragement, direction, and sanction for more vigorous and effective pursuit of ecological and human wellbeing effects associated with the proposed rule.** The general idea is to have individual components of the analysis (e.g., watershed modeling, air dispersal, human health, recreation, aesthetics) each reviewed, as well as a more general review of the overall analytic scheme.

Could we be helping the agency to build a "design" checklist or set of rules for assessing data, models and methods? Are they looking to us to do that?

²⁶ The goal of EPA's analysis was a national level assessment of the effects of the CAFO rule. This involved the effects of approximately 15,000 individual facilities, each contributing pollutants across local watersheds into local and regional aquatic ecosystems. A few intensive case studies were mentioned in the report and used to calibrate the national scale models (e.g., NWPCAM, GLEAMS), but there was no indication that these more intensive data sets were strategically selected or used systematically for formal sensitivity tests or validations of the national-scale model results.

AN INTEGRATED AND EXPANDED APPROACH TO ECOSYSTEM VALUATION

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The CAFO example discussed above highlights a number of limitations to the current state of ecosystem valuation at EPA. The committee's analysis points to the need for a comprehensive, integrated approach to valuing the ecological impacts of EPA actions, one that focuses on the impacts of most concern to people and integrates ecological analysis with valuation. This section describes a proposed framework, based on the committee's deliberations to date. A more detailed discussion of the methods that could be used to implement this framework and the issues that arise in doing so will be provided in a subsequent committee report. The goal in this report is simply to provide an organizing framework to guide the more detailed discussion regarding implementation.

A key feature of the framework outlined here is that it integrates ecological analysis with valuation. This integration needs to occur both at an early stage (in the identification of the impacts that matter) and at a later stage (when estimating the value of impacts). Thus, instead of having ecologists work independently initially to estimate ecological impacts and then "pass the baton" on to economists or other social scientists to value those impacts, it envisions collaborative work across disciplines to ensure that the analysis focuses on the impacts that are of greatest concern and that the ways in which these impacts are defined and measured are informative during the selection and, if necessary, design of the valuation techniques/methods. Such a framework requires a committed dialog among the relevant bio-physical, ecological, and social/economic scientists and analysts. The various disciplines must reach out to establish useful and credible links to each other. This interaction should commence at the beginning of the process and continue until the completion of the analysis. Ecological models need to be developed, modified, or extended to provide usable inputs for value assessments. Likewise, valuation methods and models need to be developed, modified, or extended to address important ecological/bio-physical effects that are currently underrepresented in value assessments.

In addition, the framework envisions the use of a variety of methods to characterize and measure benefits or values, including economic methods, social/psychological assessments, and ecological approaches. The suite of methods to be used will vary with the specific policy or valuation context, due to differences across contexts in: a) information needs, b) the underlying sources of value being captured; c) data availability; and d) methodological limitations. The framework should serve as a guide to EPA staff as they conduct RIAs and seek to implement the provisions of Circular A-4 (including the provisions relating to benefits that are not readily quantified or monetized), as well as in regional decision-making and program assessment.

The proposed framework has three main components: a) identify the context and scope of the benefit assessment, b) identify the ecological services that will be considered in the assessment, and c) characterize, represent or measure those impacts in bio-

physical, human, and/or monetary terms. This proposed framework would parallel the Agency's Framework for Ecological Risk Assessment (U.S. Environmental Protection Agency Risk Assessment Forum 1992) and ultimately be merged with it as part of a broader framework for ecological assessment.

Seems like we ought to have a figure here !

Context and Scope

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As noted above, ecological benefit assessment can play a key role in a number of different decision contexts, including (1) national rule-making, (2) local/regional decision-making, and (3) program evaluation. There is a need to formulate the benefit assessment problem within the specific EPA context. These contexts differ not only in the required scale for the analysis (e.g., national vs. local) but possibly also in the type of valuation information that is needed, i.e., whether it requires that benefits be characterized or measured in terms of bio-physical impacts, or the resulting impacts on humans, or both. Therefore the context in which the assessment is made is a key influence on the appropriateness of data, models and methods.

The information needed for a given policy decision will in turn depend on the decision approach to be used in evaluating alternatives. The rule to be used could be dictated by statute, regulation, or executive order, or could be determined by the EPA staff. Possible approaches include (1) maximization of (expected) net present value (based on cost-benefit analysis), (2) minimization of the (expected) cost of meeting a given goal (cost-effectiveness), (3) use of a safe minimum standard, use of the precautionary principle, or (4) use of a moral or rights-based rule based on intrinsic value. For example, the Endangered Species Act is based on an underlying presumption that species should be preserved (either because of high existence value or high intrinsic value), and hence the value information necessary to support decisions in this context can be expressed solely in bio-physical terms. In contrast, if a strict cost-benefit rule is to be used in a rule-making context, aggregate dollar values of benefits (and costs) are needed. Under a broader interpretation (e.g., OMB Circular A-4), use of cost-benefit analysis would require that ecological benefits be a) measured in dollar terms when possible, b) measured using other metrics for impacts on humans (e.g., population affected) when monetary valuation is not possible, and c) fully described in qualitative terms, when quantitative information is not available.

Ecological Services to be Included

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Decisions about the ecological services to be included in the analysis should be based on an assessment of the impacts that are likely to be most important, depending on both the magnitude and bio-physical importance of the effect and the resulting impact on humans.

3.2.1 Identifying Potentially Important Bio-Physical Impacts. The bio-physical impacts of a given EPA action can be identified at different levels. These

include the individual level, the population level, the community level, the ecosystem level (union of biological populations with their surrounding physical environment), and the level of the global biosphere. Ecological science is organized according to these scales. For the purposes of ecological benefits assessment, ecological impacts correspond to changes in functions or services provided by the ecosystem, as described above. Living organisms supply goods and services that differ across all levels of organization, from the individual to the ecosystem or global biosphere. For example, the service provided by an individual animal unit is different from the service provided by a given animal population.

Many types of ecological models exist at various levels (e.g., population, community, ecosystem, biosphere) to predict impacts of perturbations on ecosystems. Some have been developed for specific contexts (species, geographic locations) while others are more general. In some cases “off-the-shelf” models may be available, while in others existing models may need to be modified or new models developed. **(what should we say about the current state of ecological modeling???) We need the committee to discuss and come to some agreement about this.)**

Agree we need to discuss. We will need to parse this out a bit to be specific about what type of ecological models we are talking about. The Agency has developed some very complex modeling systems that focus on linking the fate of a chemical in the environment with potential routes of exposure and data on toxic response functions to estimate risk. But as I said in the preliminary comments this is focus on death of individuals or groups of individuals as a population. Most of the standard ecosystem models would need to be adapted to address impacts of chemicals. This could lead to a request for Agency to clarify their capabilities and likely an R&D recommendation.

In identifying possible impacts, it is important to consider their full range, including both primary and secondary effects, adequately accounting for uncertainty (incomplete information), (in)stability of the system (including the effect of random shocks or management errors and the system’s resilience), heterogeneity within a population or ecosystem, heterogeneity across populations or ecosystems, and dynamic changes in the ecosystem over time. **(Great recommendation but in my estimation well out of the reach of current agency toolkit and staff)** Ecosystems are complex, highly variable systems with many interacting parts. They are subject to both natural and anthropogenic disturbances that can propagate through the system in ways that are difficult to predict. The complexity, variability, and potential instability of the systems need to be considered when identifying impacts with the greatest ecological significance.

3.2.2 Identifying What Matters to People. For benefit assessments based on anthropocentric values, it is important to identify early in the process what people care about, i.e., which ecological services or functions are important to them. For example, are individuals likely to value the re-introduction of native grasses into a marshland, or would they be just as happy with non-native grasses that perform similar ecological functions and aesthetic appeal? Is animal waste disposal a concern to people primarily

because of the recreational opportunities lost due to the resulting deterioration in water quality, or are they primarily concerned about other impacts? The range of services that are the focus of the benefits assessment needs to include the services people care most about, not just what can be measured. Previous benefit assessments have often focused on what can be measured relatively easily rather than what is most important to people. This diminishes the relevance, usefulness and impact of the assessment.

Information about what matters to people can be obtained in a variety of ways. Examples include survey information (from past surveys or surveys conducted specifically for the benefit assessment) or the results of previous valuation studies. In addition, early public involvement²⁷ or use of focus groups or workshops comprised of representative individuals from the affected population and relevant scientific experts can help to identify relevant or potentially important ecological services for the specific context of interest. **(Add something about group processes here?)**

In eliciting information about what matters to people, it is important to bear in mind that what people say they care about depends on both their preferences and their information, i.e., the extent to which they are informed about an ecological system and the services it provides. Survey respondents or even members of a focus group may have preferences that are representative of the general population but may not be fully informed. Expressions of what is important (e.g., in surveys) can change with the amount of information provided. Collaborative interaction between analysts and public representatives can ensure that respondents have sufficient information when expressing preferences. **(Add something about constructed preferences here?)**

The information about those ecosystem functions and services that are important to people and potentially impacted significantly should then be integrated to select the services to include in the assessment. As noted above, this requires a collaborative effort and dialogue among analysts from a variety of disciplines early on in the valuation process.

Measuring Benefits

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Given the services to be included in the assessment, the impact of the EPA action on those services needs to be characterized and, when possible, measured or quantified. To measure impact on humans, the bio-physical measures of ecological impact need to be translated into their effects on the goods and services provided by those ecosystems to humans. These impacts can be measured in non-monetary terms (e.g., population affected, duration of effect, etc.) or, in contexts where benefits are to be compared

²⁷ This could include either a robust public involvement process following Administrative Procedures Act requirements (e.g., FR publication), or some other public involvement process [see EPA's public involvement policy, (U.S. Environmental Protection Agency Office of Policy 2003) and the SAB report on science and stakeholder involvement (U.S. Environmental Protection Agency Science Advisory Board 2001)].

directly to costs, in monetary terms if possible. (Some how we will need to find a way to scope this out for them in an example later on.)

Estimating bio-physical impacts requires information about the ecological production function for the services being considered. (Note: Most of the Agencies science is based on toxic impacts to individuals, so unless the endpoint is reproduction the agency does not generally deal with production functions for the ecosystem). This allows an estimation of the *change* in the level of services that could result from a given EPA action or policy. (e.g., percent reductions/avoidances of pollution in streams and lakes, reduced/avoided eutrophication of estuaries, reduced risk from the introduction of hormones and antibiotics into aquatic systems (Question: Is a reduction in risk a benefit? It may or may not be an avoided injury. Where this is problematic is when the agency is trying to regulate at or near to the border between impact and the assimilative capacity of the environment. Is it possible to over regulate and do harm to the environment? If so we need to factor that into any framework.)), improved/protected quality of community drinking water sources). As when selecting the services to be considered, in estimating the effect of a given action on those services, it is crucial to account for the complexity of ecosystems. In particular, predicted changes need to account for the interconnectedness of ecosystems, uncertainty about how the systems operate, possible instability of the system (including the effect of random shocks or management errors and the system's resilience), heterogeneity within a population or ecosystem, heterogeneity across populations or ecosystems, and dynamic changes in the ecosystem over time. This complexity and the associated uncertainty underscore the importance of presenting ranges rather than point estimates of values when possible. (Note: All of the proceeding may be true but the Agency is not an organization rich in Ecologists they will need help in creating this capacity)

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In some contexts (e.g., endangered species) where bio-physical impacts are the primary concern, the benefit assessment can end with quantification of the impact of the EPA action on these bio-physical indicators. However, when EPA policies are to be evaluated in terms of impact on humans, the bio-physical effects must be translated into the corresponding impacts on the flow of goods and services that humans value. First and foremost, this requires that the output from the ecological impact assessment be in a form that can be used as an input in estimating the value of the change in ecosystem services. Again, this requires that ecologists work closely with other disciplines to ensure that the ecological assessment is designed from the start with this requirement in mind.

To translate bio-physical impacts into human benefits, it is necessary to project how ecosystem changes will affect humans through changes in the flow of the goods and services they provide. The extent of the impact on humans can be measured in non-monetary terms using a variety of metrics, such as the number and characteristics of the people/communities affected, the number significantly affected, the likely symptoms avoided or reduced, and the duration of the impact. Care will be needed in efforts to scope the extent and direction of such impacts to human services. For example reducing Nitrogen or Phosphate in large lake system may reduce eutrophication but it may also

Gregory Biddinger Comments

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impact the current fisheries, which may have commercial value. Which is preferred and by whom? (Note I believe this actually happened in the great lakes with the switch to low/no phosphate detergents. Over time the commercial fisheries had to adapt to a different catch.)

Estimation of impact on humans in terms of the extent of exposure or similar measures is crucial in three possible ways. First, in some contexts, decisions based on social expectations, (e.g., protection of children's health) may look directly to these measures as indicators of the appropriate policy choice. Second, even in contexts where monetary measures of value are sought, the human benefits captured by information on exposure or symptoms need to be translated into their monetary equivalents. This requires an understanding of those impacts on humans before this translation can occur. Third, in some cases where monetary values are sought, it may not be possible to monetize all benefits due to data or methodological constraints. In these cases, there may be a tendency simply to "ignore" the benefits that cannot be monetized. Using methods that defensibly report the magnitude and human significance of such effects, rather than ignoring them, would allow the policymakers to draw their own conclusions regarding the associated potential value or benefit. Thus, in all of these cases, estimates of the impact of the ecosystem change on human populations are needed.

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In contexts where monetary metrics are sought and the necessary data and methods exist, the impact of the ecosystem change on the provision of services to human populations can be translated into a monetary equivalent of that change using standard economic valuation techniques to determine the tradeoffs that people are willing to make. Economic or monetary methods for valuing changes are relatively well-developed. They are designed to estimate the benefit or cost of a given change in ecological services using a willingness-to-pay or willingness-to-accept measure of the utility equivalent of that change. These methods have been applied to the valuation of ecosystem services in a number of studies that have produced results that are useful for policy evaluation. However, as in the CAFO study, monetary valuation methods have generally been applied to a relatively narrow set of services. In some cases, these might not have been the services that people are most concerned about protecting. **There is a need to expand the range of services to which economic valuation is applied.**

As with ecological impacts, in estimating the values of impact on humans in either monetary or non-monetary terms, it is necessary to address cross-cutting issues such as uncertainty (randomness, level of information), dynamics, scale (temporal, geographic), and heterogeneity (spatial variability, heterogeneity across people). In subsequent reports, the committee will assess the challenges of uncertainty arising out of data limitations, theory limitations, and randomness, and will recommend approaches for reducing uncertainty and conveying the magnitude and nature of uncertainty to policymakers.

[Gregory Biddinger Comments](#)

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CONCLUSIONS AND RECOMMENDATIONS

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[to be added]

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Gregory Biddinger Comments

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2. Ann Bostrom

Page 4 lines 1-2: “given area” and “functional unit” are ambiguous, as is “extensive landscape.” Might reference in a footnote as an example the ways in which the US has been divided into ecosystems – e.g. Bailey’s ecoregions - http://www.fs.fed.us/land/ecosysmgmt/ecoreg1_home.html or refer to Omernik and Bailey 1997, as is done at [/www.epa.gov/bioindicators/html/ecoregions.html](http://www.epa.gov/bioindicators/html/ecoregions.html))

Page 6 lines 36-38: The Social/psychological methods generally settle forelicit a relative measure of the value of the targeted ecological change and largely constrain tradeoff implications to options and circumstances that are closely related to the set of alternatives explicitly presented in the assessment

Page 7, line 9- delete “by many”

Page 10 line 20 – insert “of” into “each which”

Page 12 line 2- footnote 10 – say something about the importance of (and variability in?) how such contracts are made and managed?

Page 12 lines 17-19 – yes - as well as explicit guidance on the relationship between ecosystem services valuation and risk assessment paradigm/guidelines

Page 14 line 14 – insert “proximate” between “provided the” and “reason for”

Page 14 lines 12-24 – might this be edited to suggest that the narrow interpretation adopted by EPA in its analysis and report is not likely to meet even the broader goals of Executive Order 12866?

Page 14 line 32 – “would like generated” should be “would likely generate”?

Page 18 lines 43 on and Page 19 lines 1-2. The framework should include an explicit procedural component – here “identify” and “characterize” are attributed implicitly to the economists and ecologists in the previous discussion, whereas there are many reasons why other stakeholders/parties should be involved in these processes. Benefits assessments should involve at least an early option for involvement of other interested parties.

Page 19 lines 15-31 – add something like (?): “It behooves EPA to understand and take into account the potential differences in impacts of communicating these different measures, which are not equally accessible to public and policy audiences. “

Page 20 lines 12-13 –such a discussion might reference the importance of recent developments in participative modeling of ecosystems?

Page 20 section 3.2.2 – say something about which people?

Page 20 lines 40-41. Edit as follows: “Examples range from in depth studies of people’s mental models, and how their preferences are shaped by their conceptualization of ecosystems and ecoservices, to more standard survey responses, from prior or purpose-specific studies.”

Page 20 line 42 and Page 21 lines 1-3 – this should refer specifically to the fourth component of the framework – involvement not only of ecologists and economists, but of representative interested parties and/or people from the affected population, and of other scientists. (pull from Paul Slovic’s drafts, both here and in the next paragraph)

Page 21 lines 5-13: rewrite along these lines (it’s not just an issue of “sufficient” information – it is also contingent on how people conceptualize the problem and which information they consider focal, etc – of other contextual and cognitive factors – pull from Paul’s writing on constructed preferences): In eliciting people’s values and preferences, it is important to bear in mind that people’s preferences depend on their mental models (their understandings of causal processes and relations), and what information is at hand to influence their understanding, and how. Expressions of what is important (e.g., in surveys) can change with the amount and kind of information provided, as well as how it is provided. Collaborative interaction between analysts and public representatives can ensure that respondents have sufficient information when expressing preferences.

3. Robert Costanza

1. Page 6 and elsewhere. The value (or benefits) of ecosystem services are defined as related ONLY to a specific CHANGE. Someone in the group is obviously really pushing this idea, but it's absurd. Things can obviously have value in a particular state and that value can change as the state changes. Would be more accurate to say value is always RELATIVE - can be relative in time (i.e. a change) or relative to other things at the same time.

2. I still don't like the way "intrinsic value" is handled. It's not terrible or outright wrong, but still confusing. Just too many different meanings for the term "value."

4. Terry Daniel

Comments on Section: Measuring Benefits

Given the services to be included in the assessment, the impact of the EPA action on those services needs to be characterized and, when possible, measured or quantified. To measure impact on humans, the bio-physical measures of ecological impact need to be translated into their effects on the goods and services [and other values](#) provided by those ecosystems to humans. These impacts can be measured in non-monetary terms (e.g., population affected, duration of effect, [social expressions of importance](#), etc.) or, in contexts where benefits are to be compared directly to costs, in monetary terms. ~~if possible.~~

Estimating bio-physical impacts requires information about the ecological production function for the services being considered. This ~~allows an~~ [provides a basis for the](#) estimation of the *change* in the level of services [and other benefits](#) that could result from a given EPA action or policy (e.g., percent reductions/avoidances of pollution in streams and lakes, reduced/avoided eutrophication of estuaries, reduced risk from the introduction of hormones and antibiotics into aquatic systems, improved/protected quality of community drinking water sources, [protection of aesthetic and other social values](#)). As when selecting the services to be considered, in estimating the effect of a given action on those services, it is crucial to account for the complexity of ecosystems. In particular, predicted changes need to account for the interconnectedness of ecosystems, uncertainty about how the systems operate, possible instability of the system (including the effect of random shocks or management errors and the system's resilience), heterogeneity within a population or ecosystem, heterogeneity across populations or ecosystems, and dynamic changes in the ecosystem over time. [\[The preceding sentence is a repeat of a sentence in an earlier section.\]](#) This complexity and the associated uncertainty underscore the importance of presenting ranges rather than point estimates of values when possible.

In some contexts (e.g., endangered species) where bio-physical impacts are the primary concern, the benefit assessment can end with quantification of the impact of the EPA action on these bio-physical indicators. However, when EPA policies are to be evaluated in terms of impact on humans, the bio-physical effects must be translated into the corresponding impacts on the flow of goods and services [and other aspects of ecosystems](#) that humans value. First and foremost, this requires that the output from the ecological impact assessment be in a form that can be used as an input in estimating the value of the change in [ecosystems and/or](#) ecosystem services. Again, this requires that ecologists work closely with other disciplines to ensure that the ecological assessment is designed from the start with this requirement in mind.

To translate bio-physical impacts into human benefits, it is necessary to project how ecosystem changes will affect humans and [the things that humans value](#). ~~through~~

~~changes in the flow of the goods and services they provide.~~ The extent of the impact on humans can be measured in non-monetary terms using a variety of metrics, such as the number and characteristics of the people/communities affected, [judged importance of the impact in a public survey](#), the number of people significantly affected, the likely symptoms avoided or reduced, and the duration of the impact.

Estimation of impact on humans in terms of the extent of exposure, [expressions of concern in survey or political venues](#) or similar measures is crucial in three possible ways. First, in some contexts, decisions based on moral or religious principles (e.g., protection of children's health) may look directly to these measures as indicators of the appropriate policy choice. Second, [even](#) in contexts where monetary measures of value are sought, the human benefits captured by information on exposure or symptoms [may help in translating benefits into need-to-be-translated](#) into their monetary equivalents. This requires an understanding of those impacts on humans before this translation can occur. Third, in some cases [even](#) where monetary values are ~~sought~~ required by regulations or executive orders, ~~it may not be possible to monetize all benefits due to data or methodological constraints. In these cases, there may be a tendency simply to "ignore" the benefits that cannot be monetized.~~ ^U using methods that defensibly report the magnitude and human significance of such effects, rather than ignoring them, would allow the policymakers to draw their own conclusions regarding the associated potential value or benefit. Thus, in all of these cases, estimates of the impact of the ecosystem change on human populations are needed.

In contexts where monetary metrics are [sought required](#) and the necessary data and methods exist, the impact of the ecosystem change on the provision of [some](#) services to human populations ~~can~~ [may](#) be translated into a monetary equivalent of that change using standard economic valuation techniques. ~~to determine the tradeoffs that people are willing to make.~~ [For some benefits assessment contexts](#) economic or monetary methods for valuing changes are relatively well-developed. They are designed to estimate the benefit or cost of a given change in ecological services using a willingness-to-pay or willingness-to-accept measure of the utility equivalent of that change. These methods have been applied to the valuation of ecosystem services in a number of studies that have produced results that are useful for policy evaluation. However, as in the CAFO study, monetary valuation methods have generally been applied to a relatively narrow set of services. In some cases, these might not have been the services that people are most concerned about protecting. There is a need to expand the range of services to which economic valuation [is](#) can be applied.

As with ecological impacts, in estimating the values of impact on humans in either monetary or non-monetary terms, it is necessary to address cross-cutting issues such as uncertainty (randomness, level of information), dynamics, scale (temporal, geographic), and heterogeneity (spatial variability, heterogeneity across people). In subsequent reports, the committee will assess the challenges of uncertainty arising out of data limitations, theory limitations, and randomness, and will recommend approaches for reducing uncertainty and conveying the magnitude and nature of uncertainty to policymakers.

5. Dennis Grossman

Comments received as “redline” within document:

1. INTRODUCTION AND BACKGROUND

Scope of this Report and its Intended Audience

The Science Advisory Board (SAB) Committee on Valuing the Protection of Ecological Systems and Services (C-VPSS) began its work in 2003 on a project developed by the SAB to strengthen the Agency's analysis for protecting ecological resources. The SAB saw a need to complement the Agency's ongoing work in ecological science, ecological risk assessment, and ecological benefit assessment by offering advice on how EPA might better value the protection of ecological systems and services and how that information might better support decision making to protect ecological resources. In this project the SAB set the goals of assessing Agency needs and the state of the art and science of valuing protection of ecological systems and services and identifying key areas for improving knowledge, methodologies, practice, and research at EPA. Senior EPA managers supported the concept of this SAB project and participated in the initial background workshop that launched the work of the C-VPSS. The committee is an interdisciplinary group of experts from the following areas: decision science, ecology, economics, engineering, philosophy, psychology, and social sciences with emphasis in ecosystem protection.²⁸ The committee sees its work as a three-year initiative.

This report is intended to provide an overview of the committee's conclusions to date.²⁹ It is aimed at providing initial advice for strengthening the Agency's approaches for valuing the protection of ecological systems and services, facilitating their use by decision makers, and identifying the key research areas needed to strengthen the science

²⁸ The SAB Staff Office published a Federal Register Notice on March 7, 2003 (68 FR 11082-11084) announcing the project and called for the public to nominate experts in the following areas: decision science; ecology; economics; engineering; psychology; and social sciences with emphasis in ecosystem protection. The SAB Staff Office published a memorandum on August 11, 2003 documenting the steps involved in forming the new committee and finalizing its membership.

²⁹ The committee developed the conclusions in this report after multiple public meetings and workshops: a) an Initial Background Workshop on October 27, 2003 to learn the range of EPA's needs for science-based information on valuing the protection of ecological systems and services from managers of EPA Headquarters and Regional Offices; b) a Workshop on Different Approaches and Methods for Valuing the Protection of Ecological Systems and Services, held on April 13-14, 2004; c) an advisory meeting focused on support documents for national rulemakings held on June 14-15, 2004; d) an advisory meeting focused on regional science needs, in EPA's Region 9 (San Francisco) Office on Sept. 13, 14, and 15, 2004; and e) advisory meetings held on January 26-26, 2005 and April 12-13, 2005 to review EPA's draft *Ecological Benefits Assessment Strategic Plan* and to discuss economic and other methods for valuing the protection of ecological systems and services. The committee discussed a draft version of this report at a public meeting on (INSERT DATE).

base. The committee will prepare additional reports with more detailed advice at the completion of the project.³⁰ However, given the importance of the committee's charge, it felt that it would be useful to the Agency to issue an initial report that would indicate the direction that the committee's work is taking and serve as a prelude to the subsequent committee report(s). These subsequent reports will further develop the concepts in this initial advisory report and provide more detailed discussion of issues, methods, and application. In particular, they will describe in more detail how different methods could be used more effectively to understand the benefits of the protection of ecological systems and services and how results of analyses could be better integrated and communicated to decision-makers.

This initial report focuses on the need for an expanded and integrated approach for valuing EPA's efforts to protect ecological systems and services. It provides advice to the Administrator, EPA managers, EPA scientists and analysts, and EPA staff across the Agency concerned with ecological protection. It adopts a broad view of EPA's work, which it understands to encompass national rulemaking, regional decision making, and programs in general that protect ecological systems and services. It focuses directly on EPA's contributions and impacts, however, and not on the general question of the value of ecosystems or ecological services in themselves. It outlines a call for EPA to expand and integrate its approach in important ways.

This report appears at a time when there is lively interest internationally, nationally, and at EPA itself in the issue of valuing the protection of ecological systems and services. Since the establishment of the SAB C-VPES major reports have been developed focusing on how to improve the characterization of ecological resources (Millennium Ecosystem Assessment 2005; Millennium Ecosystem Assessment Board 2003; National Research Council 2004; Pagiola, von Ritter, and Bishop 2004; Silva and Pagiola 2003) The committee's work has benefited from and will build upon those recent efforts. The C-VPES distinguishes its work from those efforts, however, in the following ways. The C-VPES focuses on EPA as an audience. The committee focuses specifically on how EPA can value its own contributions to the protection of ecological systems and services, so that the agency can make better decisions in its eco-protection programs. The C-VPES is inter-disciplinary and does not focus solely on economic methods or values. The committee will offer advice on several benefits assessment approaches and in each case will emphasize issues relevant to EPA policy and decision-making and address how the Agency could better characterize the benefits of ecological protection.

The Importance of Valuing Ecosystems and their Services

The Concept of Ecosystem Services

³⁰ The Committee has already issued a related advisory report on the Agency's draft *Ecological Benefits Assessment Strategic Plan* (EPA SAB, EPA-SAB-ADV-05-00X). This report complements the *EBASP* Advisory, and provides a discussion of an integrated framework alluded to in that report.

The term “ecosystem” describes the organisms in a given area interacting with their physical environment as a functional unit. Ecosystems can describe organism-physical environment interactions in a woodlot, a watershed, or an extensive landscape. Ecosystems encompass all organisms within the prescribed area, including humans, who are often the dominant element. Processes that link organisms with their physical environment are considered ecosystem processes and include primary productivity and the cycling of nutrients and water. These processes in total describe the functioning of ecosystems. Processes that link organisms with each other, indirectly influencing flows of energy, water and nutrients, can also be considered ecosystem processes, such as pollination, predation and parasitism.

“Ecosystem services” is an anthropocentric concept denoting the benefits that humans derive from the functioning of ecosystems. An operational categorization of ecosystem services has recently been proposed by the Millennium Ecosystem Assessment:

a) **Provisioning services** (products obtained from ecosystems). These include food, fuelwood, fiber, biochemicals, genetic resources and fresh water. Generally these services are traded in the open marketplace.

b) **Regulating services** (benefits received from regulation of ecosystem processes). This category includes a host of benefits that humans derive from the presence and functioning of ecosystems. These include flood protection, human disease regulation, water purification, air quality maintenance, pollination, pest control and climate control. These services are generally not marketed but many have clear value to society and this value will increase for many of these services as the many dimensions of global change proceed.

c) **Cultural services** (the nonmaterial benefits people obtain from ecosystems). Ecosystems provide cultural, spiritual and aesthetic values, and a sense of place.

d) **Supporting services**. These are the processes that maintain ecosystem functioning such as: soil formation, primary productivity, biogeochemistry, and provisioning of habitat. They all affect human well-being, but generally indirectly through their support of the provisioning, regulating and cultural service functions.

Although there are different ways in which ecosystem services can be categorized, the committee feels that the approach adopted in the Millennium Assessment is a useful approach for conveying the concept of ecosystem services and the broad array of functions and processes ecosystem services include. The ecosystem service concept is useful in many ways. First, it is a concept that is readily grasped by society, since it relates directly to human well-being. Secondly, it provides a tool for evaluating the impacts of human actions in terms of the resulting change in the benefits provided by the affected services. “Ecosystem health” can then be defined in terms of the output and sustainability of services. When defined this way, the concept of ecosystem health relates directly to the benefits provided to humans. However, life on earth can be revered

Comment: We say here that the Committee feels this is a useful approach, but it is not clear whether and how we are using this structure as we proceed.

and protected independent of human benefit. As discussed below, the committee recognizes that ecosystems can and should be valued not only because of the human-based services they provide but also for other non-anthropocentric reasons, including respect for nature based on ethical, religious, or biocentric principles.

1.2.2 The Concept of Value

Because people define and assign values, all values are *anthropogenic*. However, as noted above, not all values are *anthropocentric*. When people talk about environmental values, the values of nature, or the values of ecological systems and services, they may have different things in mind. People have moral, economic, religious, aesthetic, and other values, all of which can affect their thoughts, attitudes, and actions toward nature in general or, more specifically, ecosystems and the services they provide.

Comment: I find these first 3 paragraphs to be excessively in the conceptual/philosophical realm, and it takes the reader off track. I would boil this down to a paragraph and perhaps put it somewhere other than the intro to this section. Paragraph 4 in this section lays out the crux of the issue concisely.

The most basic distinction in values is the distinction between means and ends. To value something as a mean is to value it for its usefulness in helping to realize or bring about some thing or state of affairs that is valued in its own right or as an end. Things valued for their usefulness as means in this sense are said to have instrumental value. Of course, it would not make sense to value anything instrumentally or as a means unless there was at least one thing or state that was valued for its own sake or as an end. Things valued as ends are sometimes said to have intrinsic value.³¹ If intrinsic value applies to things other than human beings or human experiences, then this conception of value is non-anthropocentric. Some people defend a non-anthropocentric conception of value or goodness (Goodpaster 1978; Rolston III 1991; Taylor 1986). However, others argue that only human beings or human experiences have intrinsic value, thereby defending an anthropocentric conception of value (Glover 1984; Sidgwick 1901; Williams 1994).

Ecological systems have instrumental value to the extent that they provide useful services. Some people also claim, however, that an ecological system may have value independently of the services it provides, i.e., its very existence has value. This claim can mean several different things. If it means that the existence of an ecological system is valuable because people derive satisfaction from its existence, then it has what economists call “*existence value*.” This concept is anthropocentric. In addition, it is a kind of instrumental value, since it is based on the premise that the existence of the species or ecological system is one of many things that generate human satisfaction, and that the various things that contribute to human satisfaction are potentially substitutable. Some people, however, claim that an ecological system may have intrinsic value of its own, and that we should protect it for its own sake. If the explanation of this claim refers to reasons that are independent of the contribution that the existence of an ecological system can make to human well-being, then this claim of intrinsic value should be understood in a non-anthropocentric sense.

³¹ There is controversy over the meaning of intrinsic value that we will not try to resolve here (Korsgaard 1996). Many people take intrinsic value to mean that the value of something is inherent in that thing. Some philosophers have argued that value or goodness is a simple non-natural property of things (see Moore 1903 for the classical statement of this position), and others have argued that value or goodness is not a simple property of things but one that supervenes on the natural properties to which we appeal to explain a thing’s goodness (this view is defended by, among others, contemporary moral realists; see (Brink 1989; McDowell 1985; Sayre-McCord 1988; Sturgeon 1985).

This committee recognizes that there are many possible sources of value derived from ecosystems and the services they provide. Thus, throughout this report, the term "value" is used broadly to include values predicated on their contributions to human society (broadly defined), as well as those based on an ethical, religious, or biocentric notion of intrinsic value.

Related to the concept of value are the concepts of "benefits" and "valuation." Both of these terms are relative to a specific change. In this report, the change of interest is the change in the state of an ecosystem or the flow of services it provides stemming from an actual or proposed action by EPA. Thus, the term "ecosystem benefits" refers to the increase in the value of the ecological system and/or its services. This assumes a positive change in value. Analogously, a reduction in value, for example from damages to an ecosystem, can be viewed as a "negative benefit" or cost.

Comment: The term 'ecosystem benefits' is not value laden - it does not refer to an increase or decrease in value.

Similarly, the term "valuation" will refer to the process of characterizing or measuring benefits or changes in value using various methods and techniques. For example, economic valuation measures benefits in terms of the amount people are willing to pay (WTP) to ensure an ecological improvement or the amount people are willing to accept (WTA) to forego the improvement.³² A social/psychological assessment method might present the same ecological change and ask people to rate the importance of achieving (or preventing) that change relative to a selection of changes in a number of other (potentially competing) social goals. An ecological approach might assess the value of the targeted change in terms of the magnitude of its effect on biodiversity or some other indicator of ecological health based on the consensus that ecological health is important to human/social well-being. All of these assessments are based on an anthropocentric view of values, where ecological values are assessed in terms of their contribution to human well-being. However, they differ in terms of the means by which values are expressed, and by the extent to which the value of the targeted ecological change can then be explicitly compared (traded off) against other social values. Economic assessments claim the broadest range and most explicit method for assessing tradeoffs between, for example, ecological improvements and changes in other goods or services that also contribute to human well-being. The social/psychological methods generally settle for a relative measure of the value of the targeted ecological change and largely constrain tradeoff implications to options and circumstances that are closely related to the set of alternatives explicitly presented in the assessment. Ecological assessments evaluate the direct impact of change scenarios to biodiversity and ecological health. These address not only intrinsic values, but also the capacity to sustain ecological benefits and services. In all cases, the ultimate purpose of the valuation process is to characterize or measure the change in benefits (positive or negative) associated with an ecological change in a way that provides useful information about these benefits to policymakers and the public at large. The committee plans to review these methods for what they may offer analysts and decision makers at EPA in capturing different kinds of benefits, and their limitations and related issues in a future report.

³² A large literature exists on the use of economic valuation methods to estimate the value of changes in environmental quality. For a comprehensive description of these methods, see Freeman (1993).

1.2.3 The Importance of Assessing Ecosystem Benefits

Given the important role that ecosystems play in supporting life on earth and providing goods and services that people value, changes in the state of these systems or the flow of services they provide can have important implications. This importance has been increasingly recognized by many, both within the U.S. and internationally. The recent study by the National Research Council and the Millennium Ecosystem Assessment are indicative of this growing recognition.

Many EPA actions (e.g., regulations, rules, programs, policy decisions) affect the state of ecosystems and the flow of services derived from them. EPA actions can either lead to changes in the conditions of ecosystems (improvement or deterioration) or prevent changes that would otherwise have occurred. These impacts can occur both at a relatively small, local scale as well as more broadly at a national scale. Yet, to date, ecosystem impacts have received relatively limited consideration in EPA policy analyses. Failure to consider these impacts as fully as possible can lead to distorted policy decisions, particularly in regulatory contexts where benefits are being compared to costs. In many cases, the result will be an under-valuation of (or failure to fully recognize) the benefits of EPA actions aimed at protecting the environment. This can occur, for example, when actions are evaluated based primarily on their short term impacts on human health, without a recognition of long term change to ecosystem function.

Valuing the changes in ecological systems and services and assessing the ecosystem benefits that result from EPA policies or programs is challenging for a number of reasons. Major challenges include: a) understanding the many sources of value that ecosystems generate, b) predicting the ecological impacts of alternative EPA actions, and expressing those predictions in the temporal and spatial scale most appropriate for decision-making, c) linking those impacts to changes in the dimensions of ecosystems or the service flows that people value, d) developing methods and techniques that can be used to characterize and/or measure the value of protecting ecological systems and services so that they may be incorporated or properly reflected in environmental decisions and policies, e) aggregating to a national level using local or regional studies from regions with different ecological and/or economic characteristics, and f) finding measures or means of representing ecological values or benefits that are commensurable with values of non-ecological changes caused by EPA actions, such as human health. Despite these challenges, it is imperative that EPA improve its ability to assess ecosystem benefits to ensure that ecological impacts are adequately considered in the evaluation of EPA actions.

Comment: I find this very confusing, so would suggest a rewording to make the meaning clearer.

ECOSYSTEM VALUATION AT EPA

There are several different contexts in which EPA policy decisions have ecological impacts and hence in which the need for ecosystem benefits assessment will arise. In addition, when assessing benefits, EPA must operate within a set of institutional, legal, organizational and practical constraints that affect this process at the Agency. Thus, EPA has specific needs in this regard that must be recognized and addressed. These needs arise in different parts of the Agency for different purposes and for different audiences. Some of the needs present structured requirements for valuing protection of ecological systems and services, while needs in other contexts are less prescriptive.

Policy Contexts at EPA Where Ecosystem Valuation Can be Important

The most prescriptive requirements are for national rule making. Benefit assessments are required for national rulemaking by two of EPA's governing statutes (the Toxic Substances Control Act and the Federal Insecticide, Fungicide and Rodenticide Act) and by Executive Order 12866 for "significant regulatory actions". The circular on "Regulatory Analysis" issued by the Office of Management and Budget (OMB) in September 2003, *OMB Circular A-4*, identified key elements of a regulatory analysis for such "economically significant rules." One of these elements is an evaluation of the benefits and costs of a proposed regulatory action and the main alternatives identified. The circular provided general guidance on how to provide monetized, quantitative, and qualitative information to fully characterize benefits and EPA itself has developed initial guidance for ecological benefit assessment (U.S. Environmental Protection Agency 2000). In developing its draft *Ecological Benefits Assessment Strategic Plan* and in discussions with the committee (U.S. Environmental Protection Agency Science Advisory Board 2003), EPA identified the need for improved models and methods to help implement the requirements of the circular. The Agency identified needs both to expand methods and data for economic valuation through benefit-cost or cost-effectiveness analysis and to explore other assessment methods to provide information on ecological effects that are currently un-monetized and assigned an implicit value of \$0. Managers seek approaches that are "sound, credible, and scientifically supportable" as well as flexible, affordable, and able to be implemented within the time constraints required by rulemaking (U.S. Environmental Protection Agency Science Advisory Board 2004).

EPA's regional offices, although generally not responsible for national rule-making, are responsible for several kinds of decisions and activities where the benefits of ecological protection come into question:

- Priority setting for regional action, such as targeting projects for wetland restoration and enhancement or identifying critical ecosystems or ecological resources for regional attention
- Setting Supplemental Environmental Protection (SEPs) penalties for enforcement cases where those penalties involve protection of ecological systems and services

- Choice of options for Superfund and Resource Conservation and Recovery Act (RCRA) cleanups that could take ecological benefits into account
- Review of Environmental Impact Statements prepared by other federal agencies to comply with the National Environmental Protection Act
- Assisting state and local governments and other federal Agencies with protecting lands and land uses, where assessment of the value of protection options could help decision-makers make better-informed decisions.

Regions seek low-cost methods that can be implemented quickly to inform "place-based" decisions. They seek methods that provide information on the value of ecological services; ecological diversity; conservation opportunities and threats; sustainability; and historical and cultural values associated with ecological systems or parts of ecosystems at the watershed or landscape scale. Regions experience the need to communicate the value of ecological protection as they collaborate with other federal agencies and with government partners at the local, state, and regional levels.

EPA's need to communicate the value of its ecological protection programs has two dimensions: 1) a retrospective dimension, because assessments focus on the value of EPA's current and past protection efforts and 2) a prospective dimension, because such assessments are meant to inform decisions about future EPA programs and priorities.

The need to assess the ecological benefits of policy options is woven into most of the Agency's decisions, including the assessment of ecological protection programs . Program assessments are mandated for EPA, as they are for all agencies of the executive branch, by the Government Performance and Results Act of 1993. As part of that assessment, OMB requires EPA to periodically identify its strategic goals and describe both the social costs and budget costs associated with them. EPA's Strategic Plan for 2003-2008 described the current social costs and benefits of EPA's programs and policies under each strategic goal area for the year 2002 (U.S. Environmental Protection Agency 2003). This analysis repeatedly points out that EPA lacks data and methods to quantify the ecological benefits associated with the goals in its strategic plan.

In addition, the Government Performance Results Act of 1993 established requirements for assessing the effectiveness of federal programs. Part of that assessment involves assessing the outcomes of programs intended to protect ecological resources. EPA must report annually on its progress in meeting program objectives linked to strategic plan goals and must engage periodically in an in-depth review [through the Program Assessment Rating Tool (PART)] of selected programs to identify their net benefits and to evaluate their effectiveness in meeting meaningful, ambitious program outcomes. Characterizing ecological benefits associated with EPA programs is a necessary part of the program assessment process.

Institutional and Other Issues Affecting Benefits Assessment at EPA

The committee recognizes that ecological benefits assessment at EPA must be conducted within a set of institutional, legal, organizational, and practical constraints that affect what is and can be done to incorporate ecosystem values into policy evaluations.

In an effort to better understand these issues and their implications for the committee's charge, the committee conducted a series of interviews with Agency staff.³³ The interviews were focused on the process of developing benefit analyses for Regulatory Impact Assessment (RIA) for rulemaking and the relationship between EPA and the Office of Management and Budget. However, many of the questions raised are equally applicable to strategic planning, performance reviews, regional analysis, and other situations in which the agency is called upon to assess the value of ecosystems. Below are some key observations made by the committee based on those interviews.

EPA Program Offices responsible for new rules initiate, finance, and administer the process for developing ecological benefit assessments. The development of a new rule – including definition of the rule itself, options to be weighed, and the assessment of impacts arising from the rule – involves much more than scientific assessment. Political negotiations and legal analysis arguably dominate the process. EPA has a formal rule-development process with several stages, each which impose demands on the Agency and the Agency also develops rules to meet court-imposed deadlines.

Several aspects of these imposed constraints deserve emphasis. First, despite the commonality of the underlying rule-development process, it is clear that there is no single way in which ecological valuation is conducted within the Agency. Practices vary considerably across program offices, reflecting differences in mission, in-house expertise, etc. Program offices have different statutory and strategic missions. The organization, financing, and skills of the program offices differ enormously. The National Center for Environmental Economics (NCEE) is the Agency's centralized reviewer of economic analysis within the agency.³⁴ However, the primary expertise and development of the rules resides within the program offices.

Secondly, the timing of the process largely determines the kinds of analytical techniques that are employed. This is related to court-imposed deadlines on the rule process, as well as intervening requirements related to the collection and analysis of new data. The scientific community is used to much longer time horizons for their analyses. They are also used to the idea that a new rule should call for the collection of new kinds of data. Unfortunately, collecting new data poses a significant bureaucratic problem for the Agency. To collect original data, the Agency must submit an Information Collection Request, which is reviewed within the Agency and by OMB. This hurdle alone can add significant drag to the assessment process. With perhaps a year or two at most to conduct

³³ These interviews were conducted by one Committee member, Dr. James Boyd, in conjunction with the Designated Federal Officer, Dr. Angela Nugent, over the period September 22, 2004 through November 23, 2005. In seven sets of interviews, Dr. Boyd spoke with staff from the Office of Policy, Economics and Innovation, Office of Water, Office of Air and Radiation, Office of Solid Waste and Emergency Response.

³⁴ NCEE is typically brought in by the program offices to both help design and review RIAs. NCEE can be thought to provide a centralized "screening" function for rules and analysis before they go to OMB. NCEE is actively involved in discussions with OMB as rules and supporting analysis are developed and advanced.

a study, this kind of review significantly limits the kind of analysis the Agency can conduct.

A third issue is the role of the Office of Management and Budget (OMB) in defining or directing ecosystem valuation exercises at EPA. It was difficult for the committee to ascertain the EPA-OMB relationship precisely.³⁵ EPA has been given explicit guidance by OMB in the Circular A-4, which the committee views as a reasonable document on its own because of its call for a full characterization of the impacts of different policy options and inclusion of language calling for characterization of benefits that cannot be monetized or cannot be quantified (Office of Management and Budget 2003)³⁶. However, the implications of some sections of the Circular, particularly relating to the treatment of benefits that cannot be readily monetized, remain somewhat ambiguous. For a benefit or cost that cannot be expressed in monetary terms, the Circular instructs Agency staff to “try to measure it in terms of its physical units,” or, if this is not possible either, to “describe the benefit or cost qualitatively.” However, little guidance is provided on how this should be done. Instead, the Circular urges regulators to “exercise professional judgment in identifying the importance of non-quantified factors and assess as best you can how they might change the ranking of alternatives based on estimated net benefits.”

It is clear that the Agency views the OMB as a kind of “court” that reviews its analysis. In front of this “court,” methods that have been accepted in the past create incentive for the use of the same or similar methods in the future. The thinking seems to be “if it made it through OMB once, it will make it through again.” There appears to be a pronounced tendency to use “off-the-shelf” methods to avoid problems with OMB. This creates a bias toward the *status quo* and a reluctance to explore new or innovative approaches. To this end, the committee sees the need to strike an appropriate balance between the use of established methods and the possible need to innovate in an effort to conduct more comprehensive and defensible benefit assessments for use in decision making and evaluation.

A related issue involves RIA review by external parties. The Agency does not take a standardized approach to RIA review.³⁷ EPA staff and managers reported that peer review was focussed only on “novel” elements of an analysis. This raises the question of how the Agency (and perhaps OMB) defines “novel.” Moreover, the novelty standard

³⁵ OMB responded to written questions, but declined to be interviewed by Dr. Boyd. EPA staff were informed that their formal responses to all questions, including the OMB-EPA interview were to be documented as part of the Committee report and this is likely to have had a chilling effect on the discussions.

³⁶ eg., see pp.27 “If monetization is impossible, explain why and present all available quantitative information” and, pp “If you are not able to quantify the effects, you should present any relevant quantitative information along with a description of the unquantified effects, such as ecological gains, improvements in quality of life, and aesthetic beauty.”

³⁷ In some cases, review panels are appointed, in others not. In some cases, contractors are called upon to manage the review. In other cases, Program Offices themselves manage the review process.

actually creates a clear incentive to avoid conducting novel analyses (however defined). It is clearly cheaper and quicker to avoid review altogether. The committee advises the Agency to consider whether there is a role for a standing expert body that can bring consistency to the review of analysis, avoid duplication of review, and be sensitive to timing and resource constraints.

Finally, the committee notes the importance of organization of assessment science within the Agency. Currently, the Agency relies upon a variety of offices to develop assessments, with varying degrees of reliance on other offices (e.g., NCEE) or outside assistance.³⁸ It is not clear which work better than others. In addition, it is not clear how different programs integrate social science and biophysical science.³⁹

Do we want to advocate a “ecosystem services valuation paradigm” and/or development of a set of guidelines for doing ecosystem valuation? Relationship to risk assessment paradigm/guidelines??? See more on this in footnote below.

Comment: Yes, I would say so.

An Illustrative Example of Ecosystem Benefit Assessment at EPA

In an effort to better understand the current state of ecosystem valuation at EPA, the committee examined in detail one specific case where benefit assessment was undertaken, namely, the *Environmental and Economic Benefits Analysis* that EPA prepared in support of new regulations for Concentrated Animal Feeding Operations (CAFOs) (U.S. Environmental Protection Agency 2002).^{40,41} The Agency indicated that

³⁸ Another issue that relates to the organization of science within the Agency is the availability and location of data to support ecosystem valuation. The choice of methods is clearly related to the practical availability of data across the Agency. It is important that data that are housed within individual program offices are made public and readily shared with other offices.

³⁹ One anecdote is that Dr Boyd was able to speak with only one ecologist during the interviews designed (in part) to interview a set of ecologists. Economists in the agency were not able to identify ecologists to interview, for example. It also became clear that simple “counts” of professional background can be deceptive. What the agency terms an “ecologist” is not necessarily what the scientific community would call an ecologist.

⁴⁰ The Committee reviewed and critically evaluated the Environmental and Economic Benefits Analysis at its June 15, 2004 meeting. As stated in the Background Document for SAB Committee on Valuing the Protection of Ecological Systems and Services for its Session on June 15, 2004, the purpose of this exercise was “to provide a vehicle to help the Committee identify approaches, methods, and data for characterizing the full suite of ecological ‘values’ affected by key types of Agency actions and appropriate assumptions regarding those approaches, methods, and data for these types of decisions.” The Committee based its review on EPA’s final benefits report (EPA 2002) and a briefing provided by the EPA Office of Water staff. During the June meeting, members of the Committee divided into two workgroups. The workgroups each worked independently and reported their findings to the combined Committee. The leaders of the two working groups then prepared a consolidated summary of comments from the two workgroups.

⁴¹ In December 2000, EPA proposed a new CAFO rule under the federal Clean Water Act to replace 25-year-old technology requirements and permit regulations (66FR 2959). EPA published its final rule in December 2003 (68 FR 7176). The new CAFO regulations, which cover over 15,000 large CAFO operations, reduce manure and wastewater pollutants from feedlots and land applications of manure and remove exemptions for stormwater-only discharges.

this analysis was typical of other EPA regulatory analyses of ecological benefits in form and general content.

Because the proposed new CAFO rule constituted a “significant regulatory action” under Executive Order 12866, EPA was required to assess the costs and benefits of the rule.⁴² EPA identified a wide variety of potential “use” and “non-use” benefits as part of its analysis.⁴³ Using various economic valuation methods, EPA provided monetary quantifications in its CAFO report for seven environmental benefits.⁴⁴ Approximately eighty-five percent of the monetary benefits quantified by EPA were attributed to recreational use and non-use of affected waterways. According to Agency staff, EPA’s analysis was driven by what it could monetize. EPA focused on those benefits for which data were known as available for quantification of both the baseline condition and the likely changes from the proposed rule, and translation of those changes into monetary equivalents. EPA’s final benefits assessment provides only a brief discussion of the benefits that it could not monetize. The benefits table in the Executive Summary listed a variety of non-monetized benefits⁴⁵ but designated them only as “not monetized.” EPA represented the aggregate effect of these “substantial additional environmental benefits” simply by attaching a “+B” place-holder to the estimated range of total monetized benefits. Although the Executive Summary gave a brief description of these “non-monetized” benefits, the remainder of the report devotes little attention to them.

⁴² Prior to publishing the draft CAFO rule in December 2000, EPA spent two years preparing an initial assessment of the costs and benefits of the major options. After releasing the draft rule, EPA spent another year collecting data, taking public comments, and preparing assessments of new options. EPA published its final assessment in 2003. An intra-agency team at EPA, including economists and environmental scientists in the Office of Water, Office of Air and Radiation, Office of Policy Economics and Innovation, and Office of Research and Development, worked on the benefit assessment. EPA also worked with the U.S. Department of Agriculture in developing the assessment. Dr. Christopher Miller of EPA’s Office of Water estimated that EPA spent approximately \$1 million in overall contract support to develop the benefit assessment. EPA spent approximately \$250,000-\$300,000 on water quality modeling as part of the assessment.

⁴³ The potential “use” benefits included in-stream uses (commercial fisheries, navigation, recreation, subsistence, and human health risk), near-stream uses (non-contact recreation, such as camping, and nonconsumptive, such as wildlife viewing), off-stream consumptive uses (drinking water, agricultural/irrigation uses, and industrial/commercial uses), aesthetic value (for people residing, working, or traveling near water), and the option value of future services. The potential “non-use” values included ecological values (reduced mortality/morbidity of certain species, improved reproductive success, increased diversity, and improved habitat/sustainability), bequest values, and existence values.

⁴⁴ These benefits were recreational use and non-use of affected waterways, protection of drinking water wells, protection of animal water supplies, avoidance of public water treatment, improved shellfish harvest, improved recreational fishing in estuaries, and reduced fish kills.

⁴⁵ These include eutrophication of estuaries; reduced pathogen contamination of drinking water supplies; reduced human and ecological risks from hormones, antibiotics, metals, and salts; improved soil properties from reduced over-application of manure; and “other benefits”.

Although much effort was invested in the CAFO benefits assessment, the assessment illustrates a number of limitations in the current state of ecosystem valuation at EPA.

First, EPA's analysis and report focused nearly exclusively on meeting the requirements as described in Executive Order 12866. This may not be surprising since the Executive Order provided the reason for preparing the analysis and report. However, when EPA prepares a benefit assessment specifically to comply with Executive Order 12866, the Agency need not limit itself to the goals and requirements of the Executive Order. The Executive Order does not preclude EPA from adopting broader goals. The Executive Order provides merely that EPA shall conduct an "analysis" and "assessment" of the "benefits anticipated from the regulatory action" and, "to the extent feasible, a quantification of those benefits." By adopting a narrow focus, the report failed to consider or reflect the broader purposes that a benefit assessment can serve. Environmental benefit assessments, such as the CAFO study, can serve a variety of important purposes, including helping to educate policy-makers and the public more generally about the benefits that stem from EPA regulations.

Second, as noted above, in implementing the Executive Order, the CAFO analysis did not provide the full characterization of ecological benefits using quantitative and qualitative information, as required by the OMB Circular A-4. Instead, the report focused on a limited set of environmental benefits, driven primarily by the ability to monetize these benefits using generally accepted models and existing value measures (benefit transfer).⁴⁶ These benefits did not include all of the major environmental benefits that the new CAFO rule would likely generate, nor all of the benefits that generated public support for the new rule.⁴⁷ The Circular requires that a benefit assessment identify and characterize all the important benefits of the proposed rule, not simply those that can be monetized. By focusing only on a narrow set of benefits, the CAFO analysis and report understates the benefits of the rule change and distorts the rationale supporting the final rule.⁴⁸ An unfortunate effect of this presentation is to

⁴⁶ EPA apparently conducted no new economic valuation studies (although a limited amount of new ecological research was conducted) and did not consider the possible benefits of developing new information where important benefits could not be valued in monetary terms based on existing data. The CAFO report emphasizes EPA's predisposition toward conservative benefits estimates and identifies the lack of adequate data and/or models meeting EPA standards of quality as a basis for truncating the CAFO analysis.

⁴⁷ For example, while the report notes the potential effects of discharging hormones and other pharmaceuticals commonly used in CAFOs into drinking water sources and aquatic ecosystems, the nature and possible ecological significance of these effects is not adequately developed or presented. Similarly, the report does not adequately address the well-known consequences of discharging TMC precursors into drinking-water sources.

⁴⁸ One of the benefits of monetary benefit estimates obviously is the ease of aggregating them by simple arithmetic. However, the Committee does not believe that reporting that a rule produced a total of "218.9 million dollars in annual benefits" is necessarily more useful, meaningful, or defensible for environmental policy than reporting, for example, the achievement of a "10% reduction in the pollution of over 129,000 miles of streams and rivers, 3.2 million acres of lakes and ponds, and 2,800 square miles of estuaries."

suggest to readers that the monetized benefits constitute the principal justification for the CAFO rule.⁴⁹ Although in this case the focus on monetized benefits did not affect the outcome of the regulatory review, it is certainly possible that in a different context, this conservative approach to benefits assessment (based only on easily monetized benefits) could inadvertently undermine support for a rule that would be justified based on a more inclusive characterization of benefits.

Third, the monetary values for many of the emphasized benefits were estimated through highly leveraged benefit transfers that were generally based on dated studies conducted in contexts quite different from the CAFO rule application.⁵⁰ This was undoubtedly driven to a large extent by time, data, and resource constraints, which make it very difficult for the Agency to conduct new surveys or studies and virtually force the Agency to monetize benefits using existing value estimates. However, reliance on dated studies in quite different contexts raises questions about the credibility or validity of the monetary benefit estimates. This is particularly true when values are presented as point estimates, without adequate recognition of the underlying limitations, due to uncertainty and data quality.

Fourth, EPA apparently did not engage in a detailed and systematic effort at the outset to model the rule's ecological impacts. The report presents only a simple conceptual model that traces outputs (a list of pollutants in manure – Exhibit 2-2 in the CAFO report) through pathways (Exhibit 2-1) to environmental and human health effects.⁵¹ This model provided useful guidance, but was not sufficiently detailed to assure an adequately comprehensive and balanced analysis of the rule's ecological impacts. As a consequence the analysis was unduly directed by Agency presumptions (or discoveries) about the availability of relevant data and the likely opportunities to quantify effects precisely and to link and monetize associated benefits. This was undoubtedly driven in part by the time pressures of putting together the regulatory impact analysis. However, without a detailed and comprehensive modeling effort at the outset, EPA had insufficient insight into the potential benefits that needed to be analyzed and valued. Developing integrated models of relevant ecosystems at the outset of a valuation project would also help in identifying

⁴⁹ In the case of this CAFO rule, 97% of the monetized benefits arise from recreation (boating, swimming and fishing) and from private well owners' willingness to pay for water quality, estimated using contingent valuation or travel cost methods.

⁵⁰ EPA used estimates based on a variety of public surveys in its benefit transfer efforts, including: a national survey (1983) that determined individuals' willingness to pay for changes in surface water quality relating to water-based recreational activities (Section 4 of the CAFO Report); a series of surveys (1992, 1995, 1997) of willingness to pay for reduced/avoided nitrate (or unspecified) contamination of drinking water supplies (Section 7); and several studies (1988, 1995) of recreational fishers' values (travel cost, random utility model) for improved/protected fishing success related to nitrate pollution levels in a North Carolina estuary (Section 9).

⁵¹ Although EPA later prepared more detailed conceptual models of the CAFO rule's impact on various ecological systems and services, EPA did not prepare these models until after the Agency finished its analysis.

important secondary effects, which frequently may be of even greater consequence or value than the primary effects.⁵²

Fifth, the CAFO analysis clearly demonstrates the challenges of conducting ecological benefit assessments at the national level.⁵³ National rule-makings inevitably require EPA to generalize away from geographic specifics, both in terms of ecological impacts and associated values. However, it is possible (and desirable) to make use of intensive case studies (e.g., individual watersheds, lakes, streams, estuaries) in support of the national-scale analyses. Existing and ongoing research at local and regional scales offers more detailed data and models that could be better exploited, both to fill in gaps and to systematically validate the national-scale analyses. Systematically performing and documenting comparisons to intensive study sites could indicate the extent to which the national model needs to be adjusted for local/regional conditions and could provide data for estimating the range of error and uncertainty in the projected national-scale effects.

Sixth, although EPA invited public comment on the draft CAFO analysis as required by Executive Order 12866, there is no indication in the draft CAFO report that EPA consulted with the public during its analysis to help it identify, assess, and prioritize the effects and values addressed in its analysis, nor is there discussion in the final CAFO analysis of any comments received on the draft CAFO analysis. Early public involvement could play a valuable role in helping the Agency both a) identify all of the systems and services impacted by the proposed regulations and b) determine the regulatory effects that are likely to be of greatest value. This would ensure that the benefits assessment includes the most important impacts.

Finally, while EPA in its analysis and report appropriately emphasized the importance of using outside peer-reviewed data, methods, and models, EPA did not seek to peer review its application of them or its integration of these components in deriving benefit values for the CAFO rule. Once again, this is undoubtedly due in part to time and resource constraints. However, peer review, especially early in the process, would help EPA staff identify relevant and available data, models, and methods to support its analysis, and provide encouragement, direction, and sanction for more vigorous and effective pursuit of ecological and human wellbeing effects associated with the proposed rule. The general idea is to have individual components of the analysis (e.g., watershed modeling, air dispersal, human health, recreation, aesthetics) each reviewed, as well as a more general review of the overall analytic scheme.

⁵² Contamination of estuaries, for example, might negatively affect fisheries in the estuary (a primary effect) but might have an even greater impact on offshore fisheries that have their nurseries in the estuary (a secondary effect).

⁵³ The goal of EPA's analysis was a national level assessment of the effects of the CAFO rule. This involved the effects of approximately 15,000 individual facilities, each contributing pollutants across local watersheds into local and regional aquatic ecosystems. A few intensive case studies were mentioned in the report and used to calibrate the national scale models (e.g., NWPCAM, GLEAMS), but there was no indication that these more intensive data sets were strategically selected or used systematically for formal sensitivity tests or validations of the national-scale model results.

AN INTEGRATED AND EXPANDED APPROACH TO ECOSYSTEM VALUATION

The CAFO example discussed above highlights a number of limitations to the current state of ecosystem valuation at EPA. The committee’s analysis points to the need for a comprehensive, integrated approach to valuing the ecological impacts of EPA actions, one that focuses on the impacts of most concern to people and integrates ecological analysis with valuation. This section describes a proposed framework, based on the committee’s deliberations to date. A more detailed discussion of the methods that could be used to implement this framework and the issues that arise in doing so will be provided in a subsequent committee report. The goal in this report is simply to provide an organizing framework to guide the more detailed discussion regarding implementation.

Comment: or is it integrating ecological valuation with economic valuation?

A key feature of the framework outlined here is that it integrates ecological analysis with valuation. This integration needs to occur both at an early stage (in the identification of the impacts that matter) and at a later stage (when estimating the value of impacts). Thus, instead of having ecologists work independently initially to estimate ecological impacts and then “pass the baton” on to economists or other social scientists to value those impacts, it envisions collaborative work across disciplines to ensure that the analyses focus on the impacts that are of greatest concern and that the ways in which these impacts are defined and measured are informative during the selection and, if necessary, design of the valuation techniques/methods. Such a framework requires a committed dialog among the relevant bio-physical, ecological, and social/economic scientists and analysts. The various disciplines must reach out to establish useful and credible links to each other. This interaction should commence at the beginning of the process and continue until the completion of the analysis. Ecological models need to be developed, modified, or extended to provide usable inputs for value assessments. Likewise, valuation methods and models need to be developed, modified, or extended to address important ecological/bio-physical effects that are currently underrepresented in value assessments.

Comment: We need to be careful with our terminology. I may be misinterpreting this, but it appears we are using 'valuation' strictly as a shorthand for economic valuation. If so, it is more restrictive than I would suggest, as we have illustrated numerous non-economic ecological methods that are valid valuation approaches.

In addition, the framework envisions the use of a variety of methods to characterize and measure benefits or values, including economic methods, social/psychological assessments, and ecological approaches. The suite of methods to be used will vary with the specific policy or valuation context, due to differences across contexts in: a) information needs, b) the underlying sources of value being captured; c) data availability; and d) methodological strengths and limitations. The framework should serve as a guide to EPA staff as they conduct RIAs and seek to implement the provisions of Circular A-4 (including the provisions relating to benefits that are not readily quantified or monetized), as well as in regional decision-making and program assessment.

Comment: Not sure what an 'underlying source of value' means

The proposed framework has three main components: a) identify the ecosystem context and scope of the benefit assessment, b) identify the ecological systems and services that will be considered in the assessment, and c) characterize, represent or measure those impacts in bio-physical, human, and/or monetary terms. This proposed

Comment: Throughout this document we should determine whether we want to use the work 'impact' or just 'change'. Impact carries a negative connotation of environmental degradation - this may oftentimes be the case but there will be examples where ecological services and benefits may increase due to a 'change'.

framework would parallel the Agency's Framework for Ecological Risk Assessment (U.S. Environmental Protection Agency Risk Assessment Forum 1992) and ultimately be merged with it as part of a broader framework for ecological assessment.
Context and Scope

As noted above, ecological benefit assessment can play a key role in a number of different decision contexts, including national rule-making, local/regional decision-making, and program evaluation. There is a need to formulate the benefit assessment problem within the specific EPA context. These contexts differ not only in the required scale for the analysis (e.g., national vs. local) but possibly also in the type of valuation information that is needed, i.e., whether it requires that benefits be characterized or measured in terms of bio-physical impacts, or the resulting impacts on humans, or both.

The information needed for a given policy decision will in turn depend on the decision approach to be used in evaluating alternatives. The rule to be used could be dictated by statute, regulation, or executive order, or could be determined by the EPA staff. Possible approaches include maximization of (expected) net present value (based on cost-benefit analysis), minimization of the (expected) cost of meeting a given goal (cost-effectiveness), use of a safe minimum standard, use of the precautionary principle, or use of a moral or rights-based rule based on intrinsic value. For example, the Endangered Species Act is based on an underlying presumption that species should be preserved (either because of high existence value or high intrinsic value), and hence the value information necessary to support decisions in this context can be expressed solely in bio-physical terms. In contrast, if a strict cost-benefit rule is to be used in a rule-making context, aggregate dollar values of benefits (and costs) are needed. Under a broader interpretation (e.g., OMB Circular A-4), use of cost-benefit analysis would require that ecological benefits be a) measured in dollar terms when possible, b) measured using other metrics for impacts on humans (e.g., population affected) when monetary valuation is not possible, and c) fully described in qualitative terms, when quantitative information is not available.

Ecological Services to be Included

Decisions about the ecological services to be included in the analysis should be based on an assessment of the impacts that are likely to be most important, depending on both the magnitude and bio-physical importance of the effect and the resulting impact on humans.

3.2.1 Identifying Potentially Important Bio-Physical Impacts. The bio-physical impacts of a given EPA action can be identified at different levels. These include the individual level, the population level, the community level, the ecosystem level (union of biological populations with their surrounding physical environment), the ecoregional level, and the level of the global biosphere. Ecological science is organized according to these scales. For the purposes of ecological benefits assessment, ecological impacts correspond to changes in functions or services provided by the ecosystem, as described above. Living organisms supply goods and services that differ across all levels of organization, from the individual to the ecosystem or global biosphere. For example,

Comment: I don't find alternative d) here - which is the quantitative non-economic determination of ecosystem value. I would put that as c)

Comment:

Comment: Are we just looking at 'impact to humans'? I thought we grew beyond this concept.

the service provided by an individual animal unit is different from the service provided by a given animal population.

Many types of ecological models exist at various levels (e.g., population, community, ecosystem, ecoregion, biosphere) to predict impacts of perturbations on ecosystems. Some have been developed for specific contexts (species, geographic locations) while others are more general. In some cases “off-the-shelf” models may be available, while in others existing models may need to be modified or new models developed. **(what should we say about the current state of ecological modeling?? We need the committee to discuss and come to some agreement about this.)**

In identifying possible impacts, it is important to consider their full range, including both primary and secondary effects, adequately accounting for uncertainty (incomplete information), (in)stability of the system (including the effect of random shocks or management errors and the system’s resilience), heterogeneity within a population or ecosystem, heterogeneity across populations or ecosystems, and dynamic changes in the ecosystem over time. Ecosystems are complex, highly variable systems with many interacting parts. They are subject to both natural and anthropogenic disturbances that can propagate through the system in ways that are difficult to predict. The complexity, variability, and potential instability of the systems need to be considered when identifying impacts with the greatest ecological significance.

3.2.2 Identifying What Matters to People. For benefit assessments based on anthropocentric values, it is important to identify early in the process what people care about, i.e., which ecological services or functions are important to them. For example, are individuals likely to value the re-introduction of native grasses into a marshland, or would they be just as happy with non-native grasses that perform similar ecological functions and aesthetic appeal? Is animal waste disposal a concern to people primarily because of the recreational opportunities lost due to the resulting deterioration in water quality, or are they primarily concerned about other impacts? The range of services that are the focus of the benefits assessment needs to include the services people care most about. Previous benefit assessments have often focused on what can be measured relatively easily rather than what is most important to people. This diminishes the relevance, usefulness and impact of the assessment.

Information about what matters to people can be obtained in a variety of ways. Examples include survey information (from past surveys or surveys conducted specifically for the benefit assessment) or the results of previous valuation studies. In addition, early public involvement⁵⁴ or use of focus groups or workshops comprised of representative individuals from the affected population and relevant scientific experts can

⁵⁴ This could include either a robust public involvement process following Administrative Procedures Act requirements (e.g., FR publication), or some other public involvement process [see EPA’s public involvement policy, (U.S. Environmental Protection Agency Office of Policy 2003) and the SAB report on science and stakeholder involvement (U.S. Environmental Protection Agency Science Advisory Board 2001)].

help to identify relevant or potentially important ecological services for the specific context of interest. (**Add something about group processes here?**)

In eliciting information about what matters to people, it is important to bear in mind that what people say they care about depends on both their preferences and their information, i.e., the extent to which they are informed about an ecological system and the services it provides. Survey respondents or even members of a focus group may have preferences that are representative of the general population but may not be fully informed. Expressions of what is important (e.g., in surveys) can change with the amount of information provided. Collaborative interaction between analysts and public representatives can ensure that respondents have sufficient information when expressing preferences. (**Add something about constructed preferences here?**)

The information about those ecosystem functions and services that are important to people and potentially impacted significantly should then be integrated to select the services to include in the assessment. As noted above, this requires a collaborative effort and dialogue among analysts from a variety of disciplines early on in the valuation process.

Measuring Benefits

Given the services to be included in the assessment, the impact of the EPA action on those services needs to be characterized and, when possible, measured or quantified. To measure impact on humans, the bio-physical measures of ecological impact need to be translated into their effects on the goods and services provided by those ecosystems to humans. These impacts can be measured in non-monetary terms (e.g., population affected, duration of effect, etc.) or, in contexts where benefits are to be compared directly to costs, in monetary terms if possible.

Estimating bio-physical impacts requires information about the ecological production function for the services being considered. This allows an estimation of the *change* in the level of services that could result from a given EPA action or policy. (e.g., percent reductions/avoidances of pollution in streams and lakes, reduced/avoided eutrophication of estuaries, reduced risk from the introduction of hormones and antibiotics into aquatic systems, improved/protected quality of community drinking water sources). As when selecting the services to be considered, in estimating the effect of a given action on those services, it is crucial to account for the complexity of ecosystems. In particular, predicted changes need to account for the interconnectedness of ecosystems, uncertainty about how the systems operate, possible instability of the system (including the effect of random shocks or management errors and the system's resilience), heterogeneity within a population or ecosystem, heterogeneity across populations or ecosystems, and dynamic changes in the ecosystem over time. This complexity and the associated uncertainty underscore the importance of presenting ranges rather than point estimates of values when possible.

In some contexts (e.g., endangered species) where bio-physical impacts are the primary concern, the benefit assessment can end with quantification of the impact of the

EPA action on these bio-physical indicators. However, when EPA policies are to be evaluated in terms of impact on humans, the bio-physical effects must be translated into the corresponding impacts on the flow of goods and services that humans value. First and foremost, this requires that the output from the ecological impact assessment be in a form that can be used as an input in estimating the value of the change in ecosystem services. Again, this requires that ecologists work closely with other disciplines to ensure that the ecological assessment is designed from the start with this requirement in mind.

To translate bio-physical impacts into human benefits, it is necessary to project how ecosystem changes will affect humans through changes in the flow of the goods and services they provide. The extent of the impact on humans can be measured in non-monetary terms using a variety of metrics, such as the number and characteristics of the people/communities affected, the number significantly affected, the likely symptoms avoided or reduced, and the duration of the impact.

Comment: I keep reading this over and over - and continue to feel that we have made this effort and task narrower than the committee was earlier discussing. I think we are missing the intrinsic value component totally, and it is not clear to me why we have taken that jump.

Estimation of impact on humans in terms of the extent of exposure or similar measures is crucial in three possible ways. First, in some contexts, decisions based on moral or religious principles (e.g., protection of children's health) may look directly to these measures as indicators of the appropriate policy choice. Second, even in contexts where monetary measures of value are sought, the human benefits captured by information on exposure or symptoms need to be translated into their monetary equivalents. This requires an understanding of those impacts on humans before this translation can occur. Third, in some cases where monetary values are sought, it may not be possible to monetize all benefits due to data or methodological constraints. In these cases, there may be a tendency simply to "ignore" the benefits that cannot be monetized. Using methods that defensibly report the magnitude and human significance of such effects, rather than ignoring them, would allow the policymakers to draw their own conclusions regarding the associated potential value or benefit. Thus, in all of these cases, estimates of the impact of the ecosystem change on human populations are needed.

In contexts where monetary metrics are sought and the necessary data and methods exist, the impact of the ecosystem change on the provision of services to human populations can be translated into a monetary equivalent of that change using standard economic valuation techniques to determine the tradeoffs that people are willing to make. Economic or monetary methods for valuing changes are relatively well-developed. They are designed to estimate the benefit or cost of a given change in ecological services using a willingness-to-pay or willingness-to-accept measure of the utility equivalent of that change. These methods have been applied to the valuation of ecosystem services in a number of studies that have produced results that are useful for policy evaluation. However, as in the CAFO study, monetary valuation methods have generally been applied to a relatively narrow set of services. In some cases, these might not have been the services that people are most concerned about protecting. There is a need to expand the range of services to which economic valuation is applied.

As with ecological impacts, in estimating the values of impact on humans in either monetary or non-monetary terms, it is necessary to address cross-cutting issues

such as uncertainty (randomness, level of information), dynamics, scale (temporal, geographic), and heterogeneity (spatial variability, heterogeneity across people). In subsequent reports, the committee will assess the challenges of uncertainty arising out of data limitations, theory limitations, and randomness, and will recommend approaches for reducing uncertainty and conveying the magnitude and nature of uncertainty to policymakers.

6. Doug MacLean

Earlier I wrote a draft of a section for our report on the meaning of “values.” (Call this the MacLean Draft.) The September 27 Draft Report incorporates a much truncated version of MacLean Draft in section 1.2.2. I want to raise a question about a few paragraphs of the MacLean Draft that have been excluded from the Draft Report.

The MacLean Draft begins with an introductory paragraph followed by a four paragraph (approx. 400 words) subsection called “Values.” This subsection attempts to characterize value by connecting it to the concept of reasons. The general characterization is this: “To value something is to take oneself to have reasons for holding different positive attitudes toward that thing and for acting in certain ways in regard to it.” It goes on to explain how the connection to reasons is necessary both for distinguishing what we regard as values from what we regard as mere desires (which may include addictions and compulsions). It also explains how the distinction between different *kinds* of values (e.g., moral values, economic values, etc.) “can be understood and explained in terms of the different kinds of reasons one has for adopting positive attitudes and acting in appropriate ways in response to a valued object.”

I think this section is important not only for understanding the nature of values but especially for understanding why many people object to relying too heavily on economic techniques for measuring preferences and favor alternatives to economic approaches to decision making. Among the more popular alternative approaches that have received serious attention on some quarters are deliberative processes that some people see as an alternative to procedures that aim at discovering and measuring preferences. Deliberative processes may be cumbersome and impractical in many situations, but the reason that they are appealing is precisely that they allow people to uncover and assess the reasons for favoring one alternative over another. Since many of our preferences – especially those we tend to care most about – are shaped in response to what we take to be reasons (e.g., facts, beliefs, etc.), it is important to say something about how reasons are connected to values.

My worry is that to leave all reference to reasons entirely out of the opening section of our report is to beg some important questions right at the beginning in favor of economic approaches and to make the alternatives appear even more quirky or odd than they are.

The point I am making here is closely related to the point I was trying to make in the note “Prices and Principles” that I circulated to the Committee several weeks ago.

7. Hal Mooney

pg 5---I wonder if you could just say how we utilize the intrinsic value concept in our study---eg. anthropogenic vs philosophical view. Maybe it is hopeless---but I find that different usages of the same term continuously confusing.

pg. 6, par 3. "negative benefit"---for your amusement, A distinguished Indian scientists contrasts good and services with bads and disservices!!

pgs 12-14. I am a little nervous on how this is constructed. I thought that our CAFO analysis was for our learning about how the agency does these sorts of things. I thought that we were not going to make it sound critical of how they went about it but rather using it to show other possibilities. Angela may have a better memory of exactly what kind of discussions went on to get these people to work with us.

pg. 16, par 2. I thing this may be a little unrealistic---but we should call for a metanalysis of the relevant studies from local areas. Each will have certain idiosyncrasies but certain general info could be gained. Maybe I am reading more into this than you intended.

pg 20, par 2. I think there are a whole set of model types that are standards. Then there are those where we need more progress---eg dealing with surprises and regime shifts, for example, as you state. I am sure the Joan could easily identify a hierarchy. I think models of service delivery are not well developed and models of physical/social interactions in relationship to ecosystem service delivery are also rare.

8. Lou Pitelka

Comments Received as “redline” within document:

1. INTRODUCTION AND BACKGROUND

Scope of this Report and its Intended Audience

The Science Advisory Board (SAB) Committee on Valuing the Protection of Ecological Systems and Services (C-VPESS) began its work in 2003 on a project developed by the SAB to strengthen the Agency's analysis for protecting ecological resources. The SAB saw a need to complement the Agency's ongoing work in ecological science, ecological risk assessment, and ecological benefit assessment by offering advice on how EPA might better value the protection of ecological systems and services and how that information might better support decision making to protect ecological resources. In this project the SAB set the goals of assessing Agency needs and the state of the art and science of valuing protection of ecological systems and services and identifying key areas for improving knowledge, methodologies, practice, and research at EPA. Senior EPA managers supported the concept of this SAB project and participated in the initial background workshop that launched the work of the C-VPESS. The committee is an interdisciplinary group of experts from the following areas: decision science, ecology, economics, engineering, philosophy, psychology, and social sciences with emphasis in ecosystem protection.⁵⁵ The committee sees its work as a three-year initiative.

This report is intended to provide an overview of the committee's conclusions to date.⁵⁶ It is aimed at providing initial advice for strengthening the Agency's approaches for valuing the protection of ecological systems and services, facilitating their use by decision makers, and identifying the key research areas needed to strengthen the science

⁵⁵ The SAB Staff Office published a Federal Register Notice on March 7, 2003 (68 FR 11082-11084) announcing the project and called for the public to nominate experts in the following areas: decision science; ecology; economics; engineering; psychology; and social sciences with emphasis in ecosystem protection. The SAB Staff Office published a memorandum on August 11, 2003 documenting the steps involved in forming the new committee and finalizing its membership.

⁵⁶ The committee developed the conclusions in this report after multiple public meetings and workshops: a) an Initial Background Workshop on October 27, 2003 to learn the range of EPA's needs for science-based information on valuing the protection of ecological systems and services from managers of EPA Headquarters and Regional Offices; b) a Workshop on Different Approaches and Methods for Valuing the Protection of Ecological Systems and Services, held on April 13-14, 2004; c) an advisory meeting focused on support documents for national rulemakings held on June 14-15, 2004; d) an advisory meeting focused on regional science needs, in EPA's Region 9 (San Francisco) Office on Sept. 13, 14, and 15, 2004; and e) advisory meetings held on January 26-26, 2005 and April 12-13, 2005 to review EPA's draft *Ecological Benefits Assessment Strategic Plan* and to discuss economic and other methods for valuing the protection of ecological systems and services. The committee discussed a draft version of this report at a public meeting on (INSERT DATE).

base. The committee will prepare additional reports with more detailed advice at the completion of the project.⁵⁷ However, given the importance of the committee's charge, it felt that it would be useful to the Agency to issue an initial report that would indicate the direction that the committee's work is taking and serve as a prelude to the subsequent committee report(s). These subsequent reports will further develop the concepts in this initial advisory report and provide more detailed discussion of issues, methods, and application. In particular, they will describe in more detail how different methods could be used more effectively to understand the benefits of the protection of ecological systems and services and how results of analyses could be better integrated and communicated to decision-makers.

This initial report focuses on the need for an expanded and integrated approach for valuing EPA's efforts to protect ecological systems and services. It provides advice to the Administrator, EPA managers, EPA scientists and analysts, and EPA staff across the Agency concerned with ecological protection. It adopts a broad view of EPA's work, which it understands to encompass national rulemaking, regional decision making, and programs in general that protect ecological systems and services. It focuses directly on EPA's contributions and impacts, however, and not on the general question of the value of ecosystems or ecological services in themselves. It outlines a call for EPA to expand and integrate its approach in important ways.

This report appears at a time when there is lively interest internationally, nationally, and at EPA itself in the issue of valuing the protection of ecological systems and services. Since the establishment of the SAB C-VPES major reports have been produced developed focusing on how to improve the characterization of ecological resources (Millennium Ecosystem Assessment 2005; Millennium Ecosystem Assessment Board 2003; National Research Council 2004; Pagiola, von Ritter, and Bishop 2004; Silva and Pagiola 2003) The committee's work has benefited from and will build upon those recent efforts. The C-VPES distinguishes its work from those efforts, however, in the following ways. The C-VPES focuses on EPA as an audience. The committee focuses specifically on how EPA can value its own contributions to the protection of ecological systems and services, so that the agency can make better decisions in its eco-protection programs. The C-VPES is inter-disciplinary and does not focus solely on economic methods or values. The committee will offer advice on several benefits assessment approaches and in each case will emphasize issues relevant to EPA policy and decision-making and address how the Agency could better characterize the benefits of ecological protection.

Field Code Changed

The Importance of Valuing Ecosystems and their Services

The Concept of Ecosystem Services

⁵⁷ The Committee has already issued a related advisory report on the Agency's draft *Ecological Benefits Assessment Strategic Plan* (EPA SAB, EPA-SAB-ADV-05-00X). This report complements the *EBASP* Advisory, and provides a discussion of an integrated framework alluded to in that report.

The term “ecosystem” describes the organisms in a given area interacting with their physical environment as a functional unit. Ecosystems can describe organism-physical environment interactions in a woodlot, a watershed, or an extensive landscape. Ecosystems encompass all organisms within the prescribed area, including humans, who are often the dominant element. Processes that link organisms with their physical environment are considered ecosystem processes and include primary productivity and the cycling of nutrients and water. These processes in total describe the functioning of ecosystems. Processes that link organisms with each other, indirectly influencing flows of energy, water and nutrients, can also be considered ecosystem processes, such as pollination, predation and parasitism.

“Ecosystem services” is an anthropocentric concept denoting the benefits that humans derive from the functioning of ecosystems. An operational categorization of ecosystem services has recently been proposed by the Millennium Ecosystem Assessment:

a) **Provisioning services** (products obtained from ecosystems). These include food, fuelwood, fiber, biochemicals, genetic resources and fresh water. Generally these services are traded in the open marketplace.

b) **Regulating services** (benefits received from regulation of ecosystem processes). This category includes a host of benefits that humans derive from the presence and functioning of ecosystems. These include flood protection, human disease regulation, water purification, air quality maintenance, pollination, pest control and climate control. These services are generally not marketed but many have clear value to society and this value will increase for many of these services as the many dimensions of global change proceed.

c) **Cultural services** (the nonmaterial benefits people obtain from ecosystems). Ecosystems provide cultural, spiritual and aesthetic values, and a sense of place.

d) **Supporting services**. These are the processes that maintain ecosystem functioning such as: soil formation, primary productivity, biogeochemistry, and provisioning of habitat. They all affect human well-being, but generally indirectly through their support of the provisioning, regulating and cultural service functions.

Although there are different ways in which ecosystem services can be categorized, the committee feels that the approach adopted in the Millennium Assessment is a useful approach for conveying the concept of ecosystem services and the broad array of functions and processes ecosystem services include. The ecosystem service concept is useful in many ways. First, it is a concept that is readily grasped by society, since it relates directly to human well-being. Secondly, it provides a tool for evaluating the impacts of human actions in terms of the resulting change in the benefits provided by the affected services. “Ecosystem health” can then be defined in terms of the output and sustainability of services. When defined this way, the concept of ecosystem health relates directly to the benefits provided to humans. However, life on earth can be revered

and protected independent of human benefit. As discussed below, the committee recognizes that ecosystems can be valued not only because of the human-based services they provide but also for other non-anthropocentric reasons, including respect for nature based on ethical, religious, or biocentric principles.

1.2.2 The Concept of Value

Because people define and assign values, all values are *anthropogenic*. However, as noted above, not all values are *anthropocentric*. When people talk about environmental values, the values of nature, or the values of ecological systems and services, they may have different things in mind. People have moral, economic, religious, aesthetic, and other values, all of which can affect their thoughts, attitudes, and actions toward nature in general or, more specifically, ecosystems and the services they provide.

The most basic distinction in values is the distinction between means and ends. To value something as a mean is to value it for its usefulness in helping to realize or bring about some thing or state of affairs that is valued in its own right or as an end. Things valued for their usefulness as means in this sense are said to have instrumental value. Of course, it would not make sense to value anything instrumentally or as a means unless there was at least one thing or state that was valued for its own sake or as an end. Things valued as ends are sometimes said to have intrinsic value.⁵⁸ If intrinsic value applies to things other than human beings or human experiences, then this conception of value is non-anthropocentric. Some people defend a non-anthropocentric conception of value or goodness (Goodpaster 1978; Rolston III 1991; Taylor 1986). However, others argue that only human beings or human experiences have intrinsic value, thereby defending an anthropocentric conception of value (Glover 1984; Sidgwick 1901; Williams 1994).

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Ecological systems have instrumental value to the extent that they provide useful services. Some people also claim, however, that an ecological system may have value independently of the services it provides, i.e., its very existence has value. This claim can mean several different things. If it means that the existence of an ecological system is valuable because people derive satisfaction from its existence, then it has what economists call "*existence value*." This concept is anthropocentric. In addition, it is a kind of instrumental value, since it is based on the premise that the existence of the species or ecological system is one of many things that generate human satisfaction, and that the various things that contribute to human satisfaction are potentially substitutable. Some people, however, claim that an ecological system may have intrinsic value of its own, and that we should protect it for its own sake. If the explanation of this claim refers to reasons that are independent of the contribution that the existence of an ecological system can make to human well-being, then this claim of intrinsic value should be understood in a non-anthropocentric sense.

⁵⁸ There is controversy over the meaning of intrinsic value that we will not try to resolve here (Korsgaard 1996). Many people take intrinsic value to mean that the value of something is inherent in that thing. Some philosophers have argued that value or goodness is a simple non-natural property of things (see Moore 1903 for the classical statement of this position), and others have argued that value or goodness is not a simple property of things but one that supervenes on the natural properties to which we appeal to explain a thing's goodness (this view is defended by, among others, contemporary moral realists; see (Brink 1989; McDowell 1985; Sayre-McCord 1988; Sturgeon 1985).

This committee recognizes that there are many possible sources of value derived from ecosystems and the services they provide. Thus, throughout this report, the term "value" is used broadly to include values predicated on their contributions to human society (broadly defined), as well as those based on an ethical, religious, or biocentric notion of intrinsic value.

Related to the concept of value are the concepts of "benefits" and "valuation." Both of these terms are relative to a specific change. In this report, the change of interest is the change in the state of an ecosystem or the flow of services it provides stemming from an actual or proposed action by EPA. Thus, the term "ecosystem benefits" refers to the increase in the value of the ecological system and/or its services. This assumes a positive change in value. Analogously, a reduction in value, for example from damages to an ecosystem, can be viewed as a "negative benefit" or cost.

Similarly, the term "valuation" will refer to the process of characterizing or measuring benefits or changes in value using various methods and techniques. For example, economic valuation measures benefits in terms of the amount people are willing to pay (WTP) to ensure an ecological improvement or the amount people are willing to accept (WTA) to forego the improvement.⁵⁹ A social/psychological assessment method might present the same ecological change and ask people to rate the importance of achieving (or preventing) that change relative to a selection of changes in a number of other (potentially competing) social goals. An ecological approach might assess the value of the targeted change in terms of the magnitude of its effect on biodiversity or some other indicator of ecological health based on the consensus that ecological health is important to human/social well-being. All of these assessments are based on an anthropocentric view of values, where ecological values are assessed in terms of their contribution to human well-being. However, they differ in terms of the means by which values are expressed, and by the extent to which the value of the targeted ecological change can then be explicitly compared (traded off) against other social values. Economic assessments claim the broadest range and most explicit method for assessing tradeoffs between, for example, ecological improvements and changes in other goods or services that also contribute to human well-being. The social/psychological methods generally settle for a relative measure of the value of the targeted ecological change and largely constrain tradeoff implications to options and circumstances that are closely related to the set of alternatives explicitly presented in the assessment. Ecological assessments might restrict tradeoff implications to ecosystem properties, the biosphere. In all cases, the ultimate purpose of the valuation process is to characterize or measure the benefits (or costs) associated with an ecological change in a way that provides useful information about these benefits to policymakers and the public at large. The committee plans to discuss these methods, what they may offer analysts and decision makers at EPA in capturing different kinds of benefits, and their limitations and related issues in a future report.

Comment: I think "biosphere" is wrong here because it includes humans and human social systems (such as monetization). Thus, a preferable term would be one that more clearly limits the assessment to ecological attributes.

1.2.3 The Importance of Assessing Ecosystem Benefits

⁵⁹ A large literature exists on the use of economic valuation methods to estimate the value of changes in environmental quality. For a comprehensive description of these methods, see Freeman (1993).

Given the important role that ecosystems play in supporting life on earth and providing goods and services that people value, changes in the state of these systems or the flow of services they provide can have important implications. This importance has been increasingly recognized by many, both within the U.S. and internationally. The recent study by the National Research Council and the Millennium Ecosystem Assessment are indicative of this growing recognition.

Many EPA actions (e.g., regulations, rules, programs, policy decisions) affect the state of ecosystems and the flow of services derived from them. EPA actions can either lead to changes in the conditions of ecosystems (improvement or deterioration) or prevent changes that would otherwise have occurred. These impacts can occur both at a relatively small, local scale as well as more broadly at a national scale. Yet, to date, ecosystem impacts have received relatively limited consideration in EPA policy analyses. Failure to consider these impacts as fully as possible can lead to distorted policy decisions, particularly in regulatory contexts where benefits are being compared to costs. In many cases, the result will be an under-valuation of (or failure to fully recognize) the benefits of EPA actions aimed at protecting the environment. This can occur, for example, when actions are evaluated based primarily on their impacts on human health, without a recognition of potentially important ecosystem impacts.

Valuing the changes in ecological systems and services and assessing the ecosystem benefits that result from EPA policies or programs is challenging for a number of reasons. Major challenges include: a) understanding the many sources of value that ecosystems generate, b) predicting the ecological impacts of alternative EPA actions, and expressing those predictions in the temporal and spatial scale most appropriate for decision-making, c) linking those impacts to changes in the dimensions of ecosystems or the service flows that people value, d) developing methods and techniques that can be used to characterize and/or measure the value of protecting ecological systems and services so that they may be incorporated or properly reflected in environmental decisions and policies, e) aggregating to a national level using local or regional studies from regions with different ecological and/or economic characteristics, and f) finding measures or means of representing ecological values or benefits that are commensurable with values of non-ecological changes caused by EPA actions, such as human health. Despite these challenges, it is imperative that EPA improve its ability to assess ecosystem benefits to ensure that ecological impacts are adequately considered in the evaluation of EPA actions.

ECOSYSTEM VALUATION AT EPA

There are several different contexts in which EPA policy decisions have ecological impacts and hence in which the need for ecosystem benefits assessment will arise. In addition, when assessing benefits, EPA must operate within a set of institutional, legal, organizational and practical constraints that affect this process at the Agency. Thus, EPA has specific needs in this regard that must be recognized and addressed. These needs arise in different parts of the Agency for different purposes and for different audiences. Some of the needs present structured requirements for valuing protection of ecological systems and services, while needs in other contexts are less prescriptive.

Policy Contexts at EPA Where Ecosystem Valuation Can be Important

The most prescriptive requirements are for national rule making. Benefit assessments are required for national rulemaking by two of EPA's governing statutes (the Toxic Substances Control Act and the Federal Insecticide, Fungicide and Rodenticide Act) and by Executive Order 12866 for "significant regulatory actions". The circular on "Regulatory Analysis" issued by the Office of Management and Budget (OMB) in September 2003, *OMB Circular A-4*, identified key elements of a regulatory analysis for such "economically significant rules." One of these elements is an evaluation of the benefits and costs of a proposed regulatory action and identification of the main alternatives identified. The circular provided general guidance on how to provide monetized, quantitative, and qualitative information to fully characterize benefits, and EPA itself has developed initial guidance for ecological benefit assessment (U.S. Environmental Protection Agency 2000). In developing its draft *Ecological Benefits Assessment Strategic Plan* and in discussions with the committee (U.S. Environmental Protection Agency Science Advisory Board 2003), EPA identified the need for improved models and methods to help implement the requirements of the circular. The Agency identified needs both to expand methods and data for economic valuation through benefit-cost or cost-effectiveness analysis and to explore other assessment methods to provide information on ecological effects that are currently un-monetized and assigned an implicit value of \$0. Managers seek approaches that are "sound, credible, and scientifically supportable" as well as flexible, affordable, and able to be implemented within the time constraints required by rulemaking (U.S. Environmental Protection Agency Science Advisory Board 2004).

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EPA's regional offices, although generally not responsible for national rule-making, are responsible for several kinds of decisions and activities where the benefits of ecological protection come into question:

- Priority setting for regional action, such as targeting projects for wetland restoration and enhancement or identifying critical ecosystems or ecological resources for regional attention
- Setting Supplemental Environmental Protection (SEPs) penalties for enforcement cases where those penalties involve protection of ecological systems and services

- Choice of options for Superfund and Resource Conservation and Recovery Act (RCRA) cleanups that could take ecological benefits into account
- Review of Environmental Impact Statements prepared by other federal agencies to comply with the National Environmental Protection Act
- Assisting state and local governments and other federal Agencies with protecting lands and land uses, where assessment of the value of protection options could help decision-makers make better-informed decisions.

Regions seek low-cost methods that can be implemented quickly to inform "place-based" decisions. They seek methods that provide information on the value of ecological services; ecological diversity; conservation opportunities and threats; sustainability; and historical and cultural values associated with ecological systems or parts of ecosystems at the watershed or landscape scale. Regions experience the need to communicate the value of ecological protection as they collaborate with other federal agencies and with government partners at the local, state, and regional levels.

EPA's need to communicate the value of its ecological protection programs has two dimensions: 1) a retrospective dimension, because assessments focus on the value of EPA's current and past protection efforts and 2) a prospective dimension, because such assessments are meant to inform decisions about future EPA programs and priorities.

The need to assess the ecological benefits of policy options is woven into most of the Agency's decisions, including the assessment of ecological protection programs . Program assessments are mandated for EPA, as they are for all agencies of the executive branch, by the Government Performance and Results Act of 1993. As part of that assessment, OMB requires EPA to periodically identify its strategic goals and describe both the social costs and budget costs associated with them. EPA's Strategic Plan for 2003-2008 described the current social costs and benefits of EPA's programs and policies under each strategic goal area for the year 2002 (U.S. Environmental Protection Agency 2003). This analysis repeatedly points out that EPA lacks data and methods to quantify the ecological benefits associated with the goals in its strategic plan.

In addition, the Government Performance Results Act of 1993 established requirements for assessing the effectiveness of federal programs. Part of that assessment involves assessing the outcomes of programs intended to protect ecological resources. EPA must report annually on its progress in meeting program objectives linked to strategic plan goals and must engage periodically in an in-depth review [through the Program Assessment Rating Tool (PART)] of selected programs to identify their net benefits and to evaluate their effectiveness in meeting meaningful, ambitious program outcomes. Characterizing ecological benefits associated with EPA programs is a necessary part of the program assessment process.

Institutional and Other Issues Affecting Benefits Assessment at EPA

The committee recognizes that ecological benefits assessment at EPA must be conducted within a set of institutional, legal, organizational, and practical constraints that affect what is and can be done to incorporate ecosystem values into policy evaluations.

In an effort to better understand these issues and their implications for the committee's charge, the committee conducted a series of interviews with Agency staff.⁶⁰ The interviews were focused on the process of developing benefit analyses for Regulatory Impact Assessment (RIA) for rulemaking and the relationship between EPA and the Office of Management and Budget. However, many of the questions raised are equally applicable to strategic planning, performance reviews, regional analysis, and other situations in which the agency is called upon to assess the value of ecosystems. Below are some key observations made by the committee based on those interviews.

EPA Program Offices responsible for new rules initiate, finance, and administer the process for developing ecological benefit assessments. The development of a new rule – including definition of the rule itself, options to be weighed, and the assessment of impacts arising from the rule – involves much more than scientific assessment. Political negotiations and legal analysis arguably dominate the process. EPA has a formal rule-development process with several stages, each which impose demands on the Agency and the Agency also develops rules to meet court-imposed deadlines.

Several aspects of these imposed constraints deserve emphasis. First, despite the commonality of the underlying rule-development process, it is clear that there is no single way in which ecological valuation is conducted within the Agency. Practices vary considerably across program offices, reflecting differences in mission, in-house expertise, etc. Program offices have different statutory and strategic missions. The organization, financing, and skills of the program offices differ enormously. The National Center for Environmental Economics (NCEE) is the Agency's centralized reviewer of economic analysis within the agency.⁶¹ However, the primary expertise and development of the rules resides within the program offices.

Secondly, the timing of the process largely determines the kinds of analytical techniques that are employed. This is related to court-imposed deadlines on the rule process, as well as intervening requirements related to the collection and analysis of new data. The scientific community is used to much longer time horizons for their analyses. They are also used to the idea that a new rule should call for the collection of new kinds of data. Unfortunately, collecting new data poses a significant bureaucratic problem for the Agency. To collect original data, the Agency must submit an Information Collection Request, which is reviewed within the Agency and by OMB. This hurdle alone can add significant drag to the assessment process. With perhaps a year or two at most to conduct

⁶⁰ These interviews were conducted by one Committee member, Dr. James Boyd, in conjunction with the Designated Federal Officer, Dr. Angela Nugent, over the period September 22, 2004 through November 23, 2005. In seven sets of interviews, Dr. Boyd spoke with staff from the Office of Policy, Economics and Innovation, Office of Water, Office of Air and Radiation, Office of Solid Waste and Emergency Response.

⁶¹ NCEE is typically brought in by the program offices to both help design and review RIAs. NCEE can be thought to provide a centralized "screening" function for rules and analysis before they go to OMB. NCEE is actively involved in discussions with OMB as rules and supporting analysis are developed and advanced.

a study, this kind of review significantly limits the kind of analysis the Agency can conduct.

A third issue is the role of the Office of Management and Budget (OMB) in defining or directing ecosystem valuation exercises at EPA. It was difficult for the committee to ascertain the EPA-OMB relationship precisely.⁶² EPA has been given explicit guidance by OMB in the Circular A-4, which the committee views as a reasonable document on its own because of its call for a full characterization of the impacts of different policy options and inclusion of language calling for characterization of benefits that cannot be monetized or cannot be quantified (Office of Management and Budget 2003)⁶³. However, the implications of some sections of the Circular, particularly relating to the treatment of benefits that cannot be readily monetized, remain somewhat ambiguous. For a benefit or cost that cannot be expressed in monetary terms, the Circular instructs Agency staff to “try to measure it in terms of its physical units,” or, if this is not possible either, to “describe the benefit or cost qualitatively.” However, little guidance is provided on how this should be done. Instead, the Circular urges regulators to “exercise professional judgment in identifying the importance of non-quantified factors and assess as best you can how they might change the ranking of alternatives based on estimated net benefits.”

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It is clear that the Agency views the OMB as a kind of “court” that reviews its analysis. In front of this “court,” methods that have been accepted in the past create incentive for the use of the same or similar methods in the future. The thinking seems to be “if it made it through OMB once, it will make it through again.” There appears to be a pronounced tendency to use “off-the-shelf” methods to avoid problems with OMB. This creates a bias toward the *status quo* and a reluctance to explore new or innovative approaches. To this end, the committee sees the need to strike an appropriate balance between the use of established methods and the possible need to innovate in an effort to conduct more comprehensive and defensible benefit assessments for use in decision making and evaluation.

A related issue involves RIA review by external parties. The Agency does not take a standardized approach to RIA review.⁶⁴ EPA staff and managers reported that peer review was focussed only on “novel” elements of an analysis. This raises the question of how the Agency (and perhaps OMB) defines “novel.” Moreover, the novelty standard

⁶² OMB responded to written questions, but declined to be interviewed by Dr. Boyd. EPA staff were informed that their formal responses to all questions, including the OMB-EPA interview were to be documented as part of the Committee report and this is likely to have had a chilling effect on the discussions.

⁶³ eg., see pp.27 “If monetization is impossible, explain why and present all available quantitative information” and, pp “If you are not able to quantify the effects, you should present any relevant quantitative information along with a description of the unquantified effects, such as ecological gains, improvements in quality of life, and aesthetic beauty.”

⁶⁴ In some cases, review panels are appointed, in others not. In some cases, contractors are called upon to manage the review. In other cases, Program Offices themselves manage the review process.

actually creates a clear incentive to avoid conducting novel analyses (however defined). It is clearly cheaper and quicker to avoid review altogether. The committee advises the Agency to consider whether there is a role for a standing expert body that can bring consistency to the review of analysis, avoid duplication of review, and be sensitive to timing and resource constraints.

Finally, the committee notes the importance of organization of assessment science within the Agency. Currently, the Agency relies upon a variety of offices to develop assessments, with varying degrees of reliance on other offices (e.g., NCEE) or outside assistance.⁶⁵ It is not clear which work better than others. In addition, it is not clear how different programs integrate social science and biophysical science.⁶⁶

Do we want to advocate a “ecosystem services valuation paradigm” and/or development of a set of guidelines for doing ecosystem valuation? Relationship to risk assessment paradigm/guidelines??? See more on this in footnote below.

An Illustrative Example of Ecosystem Benefit Assessment at EPA

In an effort to better understand the current state of ecosystem valuation at EPA, the committee examined in detail one specific case where benefit assessment was undertaken, namely, the *Environmental and Economic Benefits Analysis* that EPA prepared in support of new regulations for Concentrated Animal Feeding Operations (CAFOs) (U.S. Environmental Protection Agency 2002).^{67,68} The Agency indicated that

⁶⁵ Another issue that relates to the organization of science within the Agency is the availability and location of data to support ecosystem valuation. The choice of methods is clearly related to the practical availability of data across the Agency. It is important that data that are housed within individual program offices are made public and readily shared with other offices.

⁶⁶ One anecdote is that Dr Boyd was able to speak with only one ecologist during the interviews designed (in part) to interview a set of ecologists. Economists in the agency were not able to identify ecologists to interview, for example. It also became clear that simple “counts” of professional background can be deceptive. What the agency terms an “ecologist” is not necessarily what the scientific community would call an ecologist.

⁶⁷ The Committee reviewed and critically evaluated the Environmental and Economic Benefits Analysis at its June 15, 2004 meeting. As stated in the Background Document for SAB Committee on Valuing the Protection of Ecological Systems and Services for its Session on June 15, 2004, the purpose of this exercise was “to provide a vehicle to help the Committee identify approaches, methods, and data for characterizing the full suite of ecological ‘values’ affected by key types of Agency actions and appropriate assumptions regarding those approaches, methods, and data for these types of decisions.” The Committee based its review on EPA’s final benefits report (EPA 2002) and a briefing provided by the EPA Office of Water staff. During the June meeting, members of the Committee divided into two workgroups. The workgroups each worked independently and reported their findings to the combined Committee. The leaders of the two working groups then prepared a consolidated summary of comments from the two workgroups.

⁶⁸ In December 2000, EPA proposed a new CAFO rule under the federal Clean Water Act to replace 25-year-old technology requirements and permit regulations (66FR 2959). EPA published its final rule in December 2003 (68 FR 7176). The new CAFO regulations, which cover over 15,000 large CAFO operations, reduce manure and wastewater pollutants from feedlots and land applications of manure and remove exemptions for stormwater-only discharges.

this analysis was typical of other EPA regulatory analyses of ecological benefits in form and general content.

Because the proposed new CAFO rule constituted a “significant regulatory action” under Executive Order 12866, EPA was required to assess the costs and benefits of the rule.⁶⁹ EPA identified a wide variety of potential “use” and “non-use” benefits as part of its analysis.⁷⁰ Using various economic valuation methods, EPA provided monetary quantifications in its CAFO report for seven environmental benefits.⁷¹ Approximately eighty-five percent of the monetary benefits quantified by EPA were attributed to recreational use and non-use of affected waterways. According to Agency staff, EPA’s analysis was driven by what it could monetize. EPA focused on those benefits for which data were known as available for quantification of both the baseline condition and the likely changes from the proposed rule, and translation of those changes into monetary equivalents. EPA’s final benefits assessment provides only a brief discussion of the benefits that it could not monetize. The benefits table in the Executive Summary listed a variety of non-monetized benefits⁷² but designated them only as “not monetized.” EPA represented the aggregate effect of these “substantial additional environmental benefits” simply by attaching a “+B” place-holder to the estimated range of total monetized benefits. Although the Executive Summary gave a brief description of these “non-monetized” benefits, the remainder of the report devotes little attention to them.

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Comment: See my suggested change in the footnote. I suggested this change earlier, and it was not accepted, but I don't understand why. Eutrophication is “bad”, so a benefit is “reduced eutrophication”, not “eutrophication”. Several of the other benefits involved reduction of something, so to be consistent in describing benefits, it should be “reduced eutrophication of estuaries”.

⁶⁹ Prior to publishing the draft CAFO rule in December 2000, EPA spent two years preparing an initial assessment of the costs and benefits of the major options. After releasing the draft rule, EPA spent another year collecting data, taking public comments, and preparing assessments of new options. EPA published its final assessment in 2003. An intra-agency team at EPA, including economists and environmental scientists in the Office of Water, Office of Air and Radiation, Office of Policy Economics and Innovation, and Office of Research and Development, worked on the benefit assessment. EPA also worked with the U.S. Department of Agriculture in developing the assessment. Dr. Christopher Miller of EPA’s Office of Water estimated that EPA spent approximately \$1 million in overall contract support to develop the benefit assessment. EPA spent approximately \$250,000-\$300,000 on water quality modeling as part of the assessment.

⁷⁰ The potential “use” benefits included in-stream uses (commercial fisheries, navigation, recreation, subsistence, and human health risk), near-stream uses (non-contact recreation, such as camping, and nonconsumptive, such as wildlife viewing), off-stream consumptive uses (drinking water, agricultural/irrigation uses, and industrial/commercial uses), aesthetic value (for people residing, working, or traveling near water), and the option value of future services. The potential “non-use” values included ecological values (reduced mortality/morbidity of certain species, improved reproductive success, increased diversity, and improved habitat/sustainability), bequest values, and existence values.

⁷¹ These benefits were recreational use and non-use of affected waterways, protection of drinking water wells, protection of animal water supplies, avoidance of public water treatment, improved shellfish harvest, improved recreational fishing in estuaries, and reduced fish kills.

⁷² These include [reduced](#) eutrophication of estuaries; reduced pathogen contamination of drinking water supplies; reduced human and ecological risks from hormones, antibiotics, metals, and salts; improved soil properties from reduced over-application of manure; and “other benefits”.

Although much effort was invested in the CAFO benefits assessment, the assessment illustrates a number of limitations in the current state of ecosystem valuation at EPA.

First, EPA's analysis and report focused nearly exclusively on meeting the requirements as described in Executive Order 12866. This may not be surprising since the Executive Order provided the reason for preparing the analysis and report. However, when EPA prepares a benefit assessment specifically to comply with Executive Order 12866, the Agency need not limit itself to the goals and requirements of the Executive Order. The Executive Order does not preclude EPA from adopting broader goals. The Executive Order provides merely that EPA shall conduct an "analysis" and "assessment" of the "benefits anticipated from the regulatory action" and, "to the extent feasible, a quantification of those benefits." By adopting a narrow focus, the report failed to consider or reflect the broader purposes that a benefit assessment can serve. Environmental benefit assessments, such as the CAFO study, can serve a variety of important purposes, including helping to educate policy-makers and the public more generally about the benefits that stem from EPA regulations.

Second, as noted above, in implementing the Executive Order, the CAFO analysis did not provide the full characterization of ecological benefits using quantitative and qualitative information, as required by the OMB Circular A-4. Instead, the report focused on a limited set of environmental benefits, driven primarily by the ability to monetize these benefits using generally accepted models and existing value measures (benefit transfer).⁷³ These benefits did not include all of the major environmental benefits that the new CAFO rule would likely generate, nor all of the benefits that generated public support for the new rule.⁷⁴ The Circular requires that a benefit assessment identify and characterize all the important benefits of the proposed rule, not simply those that can be monetized. By focusing only on a narrow set of benefits, the CAFO analysis and report understates the benefits of the rule change and distorts the rationale supporting the final rule.⁷⁵ An unfortunate effect of this presentation is to

⁷³ EPA apparently conducted no new economic valuation studies (although a limited amount of new ecological research was conducted) and did not consider the possible benefits of developing new information where important benefits could not be valued in monetary terms based on existing data. The CAFO report emphasizes EPA's predisposition toward conservative benefits estimates and identifies the lack of adequate data and/or models meeting EPA standards of quality as a basis for truncating the CAFO analysis.

⁷⁴ For example, while the report notes the potential effects of discharging hormones and other pharmaceuticals commonly used in CAFOs into drinking water sources and aquatic ecosystems, the nature and possible ecological significance of these effects is not adequately developed or presented. Similarly, the report does not adequately address the well-known consequences of discharging TMC precursors into drinking-water sources.

⁷⁵ One of the benefits of monetary benefit estimates obviously is the ease of aggregating them by simple arithmetic. However, the Committee does not believe that reporting that a rule produced a total of "218.9 million dollars in annual benefits" is necessarily more useful, meaningful, or defensible for environmental policy than reporting, for example, the achievement of a "10% reduction in the pollution of over 129,000 miles of streams and rivers, 3.2 million acres of lakes and ponds, and 2,800 square miles of estuaries."

suggest to readers that the monetized benefits constitute the principal justification for the CAFO rule.⁷⁶ Although in this case the focus on monetized benefits did not affect the outcome of the regulatory review, it is certainly possible that in a different context, this conservative approach to benefits assessment (based only on easily monetized benefits) could inadvertently undermine support for a rule that would be justified based on a more inclusive characterization of benefits.

Third, the monetary values for many of the emphasized benefits were estimated through highly leveraged benefit transfers that were generally based on dated studies conducted in contexts quite different from the CAFO rule application.⁷⁷ This was undoubtedly driven to a large extent by time, data, and resource constraints, which make it very difficult for the Agency to conduct new surveys or studies and virtually force the Agency to monetize benefits using existing value estimates. However, reliance on dated studies in quite different contexts raises questions about the credibility or validity of the monetary benefit estimates. This is particularly true when values are presented as point estimates, without adequate recognition of the underlying limitations, due to uncertainty and data quality.

Fourth, EPA apparently did not engage in a detailed and systematic effort at the outset to model the rule's ecological impacts. The report presents only a simple conceptual model that traces outputs (a list of pollutants in manure – Exhibit 2-2 in the CAFO report) through pathways (Exhibit 2-1) to environmental and human health effects.⁷⁸ This model provided useful guidance, but was not sufficiently detailed to assure an adequately comprehensive and balanced analysis of the rule's ecological impacts. As a consequence the analysis was unduly directed by Agency presumptions (or discoveries) about the availability of relevant data and the likely opportunities to quantify effects precisely and to link and monetize associated benefits. This was undoubtedly driven in part by the time pressures of putting together the regulatory impact analysis. However, without a detailed and comprehensive modeling effort at the outset, EPA had insufficient insight into the potential benefits that needed to be analyzed and valued. Developing integrated models of relevant ecosystems at the outset of a valuation project would also help in identifying

⁷⁶ In the case of this CAFO rule, 97% of the monetized benefits arise from recreation (boating, swimming and fishing) and from private well owners' willingness to pay for water quality, estimated using contingent valuation or travel cost methods.

⁷⁷ EPA used estimates based on a variety of public surveys in its benefit transfer efforts, including: a national survey (1983) that determined individuals' willingness to pay for changes in surface water quality relating to water-based recreational activities (Section 4 of the CAFO Report); a series of surveys (1992, 1995, 1997) of willingness to pay for reduced/avoided nitrate (or unspecified) contamination of drinking water supplies (Section 7); and several studies (1988, 1995) of recreational fishers' values (travel cost, random utility model) for improved/protected fishing success related to nitrate pollution levels in a North Carolina estuary (Section 9).

⁷⁸ Although EPA later prepared more detailed conceptual models of the CAFO rule's impact on various ecological systems and services, EPA did not prepare these models until after the Agency finished its analysis.

important secondary effects, which frequently may be of even greater consequence or value than the primary effects.⁷⁹

Fifth, the CAFO analysis clearly demonstrates the challenges of conducting ecological benefit assessments at the national level.⁸⁰ National rule-makings inevitably require EPA to generalize away from geographic specifics, both in terms of ecological impacts and associated values. However, it is possible (and desirable) to make use of intensive case studies (e.g., individual watersheds, lakes, streams, estuaries) in support of the national-scale analyses. Existing and ongoing research at local and regional scales offers more detailed data and models that could be better exploited, both to fill in gaps and to systematically validate the national-scale analyses. Systematically performing and documenting comparisons to intensive study sites could indicate the extent to which the national model needs to be adjusted for local/regional conditions and could provide data for estimating the range of error and uncertainty in the projected national-scale effects.

Sixth, although EPA invited public comment on the draft CAFO analysis as required by Executive Order 12866, there is no indication in the draft CAFO report that EPA consulted with the public during its analysis to help it identify, assess, and prioritize the effects and values addressed in its analysis, nor is there discussion in the final CAFO analysis of any comments received on the draft CAFO analysis. Early public involvement could play a valuable role in helping the Agency both a) identify all of the systems and services impacted by the proposed regulations and b) determine the regulatory effects that are likely to be of greatest value. This would ensure that the benefits assessment includes the most important impacts.

Finally, while EPA in its analysis and report appropriately emphasized the importance of using outside peer-reviewed data, methods, and models, EPA did not seek to peer review its application of them or its integration of these components in deriving benefit values for the CAFO rule. Once again, this is undoubtedly due in part to time and resource constraints. However, peer review, especially early in the process, would help EPA staff identify relevant and available data, models, and methods to support its analysis, and provide encouragement, direction, and sanction for more vigorous and effective pursuit of ecological and human wellbeing effects associated with the proposed rule. The general idea is to have individual components of the analysis (e.g., watershed modeling, air dispersal, human health, recreation, aesthetics) each reviewed, as well as a more general review of the overall analytic scheme.

⁷⁹ Contamination of estuaries, for example, might negatively affect fisheries in the estuary (a primary effect) but might have an even greater impact on offshore fisheries that have their nurseries in the estuary (a secondary effect).

⁸⁰ The goal of EPA's analysis was a national level assessment of the effects of the CAFO rule. This involved the effects of approximately 15,000 individual facilities, each contributing pollutants across local watersheds into local and regional aquatic ecosystems. A few intensive case studies were mentioned in the report and used to calibrate the national scale models (e.g., NWPCAM, GLEAMS), but there was no indication that these more intensive data sets were strategically selected or used systematically for formal sensitivity tests or validations of the national-scale model results.

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AN INTEGRATED AND EXPANDED APPROACH TO ECOSYSTEM VALUATION

The CAFO example discussed above highlights a number of limitations to the current state of ecosystem valuation at EPA. The committee's analysis points to the need for a comprehensive, integrated approach to valuing the ecological impacts of EPA actions, one that focuses on the impacts of most concern to people and integrates ecological analysis with valuation. This section describes a proposed framework, based on the committee's deliberations to date. A more detailed discussion of the methods that could be used to implement this framework and the issues that arise in doing so will be provided in a subsequent committee report. The goal in this report is simply to provide an organizing framework to guide the more detailed discussion regarding implementation.

A key feature of the framework outlined here is that it integrates ecological analysis with valuation. This integration needs to occur both at an early stage (in the identification of the impacts that matter) and at a later stage (when estimating the value of impacts). Thus, instead of having ecologists work independently initially to estimate ecological impacts and then "pass the baton" on to economists or other social scientists to value those impacts, it envisions collaborative work across disciplines to ensure that the analysis focuses on the impacts that are of greatest concern and that the ways in which these impacts are defined and measured are informative during the selection and, if necessary, design of the valuation techniques/methods. Such a framework requires a committed dialog among the relevant bio-physical, ecological, and social/economic scientists and analysts. The various disciplines must reach out to establish useful and credible links to each other. This interaction should commence at the beginning of the process and continue until the completion of the analysis. Ecological models need to be developed, modified, or extended to provide usable inputs for value assessments. Likewise, valuation methods and models need to be developed, modified, or extended to address important ecological/bio-physical effects that are currently underrepresented in value assessments.

In addition, the framework envisions the use of a variety of methods to characterize and measure benefits or values, including economic methods, social/psychological assessments, and ecological approaches. The suite of methods to be used will vary with the specific policy or valuation context, due to differences across contexts in: a) information needs, b) the underlying sources of value being captured; c) data availability; and d) methodological limitations. The framework should serve as a guide to EPA staff as they conduct RIAs and seek to implement the provisions of Circular A-4 (including the provisions relating to benefits that are not readily quantified or monetized), as well as in regional decision-making and program assessment.

The proposed framework has three main components: a) identify the context and scope of the benefit assessment, b) identify the ecological services that will be considered in the assessment, and c) characterize, represent or measure those impacts in bio-physical, human, and/or monetary terms. This proposed framework would parallel the Agency's Framework for Ecological Risk Assessment (U.S. Environmental Protection

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Agency Risk Assessment Forum 1992) and ultimately be merged with it as part of a broader framework for ecological assessment.

Context and Scope

As noted above, ecological benefit assessment can play a key role in a number of different decision contexts, including national rule-making, local/regional decision-making, and program evaluation. There is a need to formulate the benefit assessment problem within the specific EPA context. These contexts differ not only in the required scale for the analysis (e.g., national vs. local) but possibly also in the type of valuation information that is needed, i.e., whether it requires that benefits be characterized or measured in terms of bio-physical impacts, or the resulting impacts on humans, or both.

The information needed for a given policy decision will in turn depend on the decision approach to be used in evaluating alternatives. The rule to be used could be dictated by statute, regulation, or executive order, or could be determined by the EPA staff. Possible approaches include maximization of (expected) net present value (based on cost-benefit analysis), minimization of the (expected) cost of meeting a given goal (cost-effectiveness), use of a safe minimum standard, use of the precautionary principle, or use of a moral or rights-based rule based on intrinsic value. For example, the Endangered Species Act is based on an underlying presumption that species should be preserved (either because of high existence value or high intrinsic value), and hence the value information necessary to support decisions in this context can be expressed solely in bio-physical terms. In contrast, if a strict cost-benefit rule is to be used in a rule-making context, aggregate dollar values of benefits (and costs) are needed. Under a broader interpretation (e.g., OMB Circular A-4), use of cost-benefit analysis would require that ecological benefits be a) measured in dollar terms when possible, b) measured using other metrics for impacts on humans (e.g., population affected) when monetary valuation is not possible, and c) fully described in qualitative terms, when quantitative information is not available.

Ecological Services to be Included

Decisions about the ecological services to be included in the analysis should be based on an assessment of the impacts that are likely to be most important, depending on both the magnitude and bio-physical importance of the effect and the resulting impact on humans.

3.2.1 Identifying Potentially Important Bio-Physical Impacts. The bio-physical impacts of a given EPA action can be identified at different levels. These include the individual level, the population level, the community level, the ecosystem level (union of biological populations with their surrounding physical environment), and the level of the global biosphere. Ecological science is organized according to these scales. For the purposes of ecological benefits assessment, ecological impacts correspond to changes in functions or services provided by the ecosystem, as described above. Living organisms supply goods and services that differ across all levels of organization, from the individual to the ecosystem or global biosphere. For example, the

service provided by an individual animal unit is different from the service provided by a given animal population.

Many types of ecological models exist at various levels (e.g., population, community, ecosystem, biosphere) to predict impacts of perturbations on ecosystems. Some have been developed for specific contexts (species, geographic locations) while others are more general. In some cases “off-the-shelf” models may be available, while in others existing models may need to be modified or new models developed. **(what should we say about the current state of ecological modeling???) We need the committee to discuss and come to some agreement about this.)**

In identifying possible impacts, it is important to consider their full range, including both primary and secondary effects, adequately accounting for uncertainty (incomplete information), (in)stability of the system (including the effect of random shocks or management errors and the system’s resilience), heterogeneity within a population or ecosystem, heterogeneity across populations or ecosystems, and dynamic changes in the ecosystem over time. Ecosystems are complex, highly variable systems with many interacting parts. They are subject to both natural and anthropogenic disturbances that can propagate through the system in ways that are difficult to predict. The complexity, variability, and potential instability of the systems need to be considered when identifying impacts with the greatest ecological significance.

3.2.2 Identifying What Matters to People. For benefit assessments based on anthropocentric values, it is important to identify early in the process what people care about, i.e., which ecological services or functions are important to them. For example, are individuals likely to value the re-introduction of native grasses into a marshland, or would they be just as happy with non-native grasses that perform similar ecological functions and aesthetic appeal? Is animal waste disposal a concern to people primarily because of the recreational opportunities lost due to the resulting deterioration in water quality, or are they primarily concerned about other impacts? The range of services that are the focus of the benefits assessment needs to include the services people care most about. Previous benefit assessments have often focused on what can be measured relatively easily rather than what is most important to people. This diminishes the relevance, usefulness and impact of the assessment.

Information about what matters to people can be obtained in a variety of ways. Examples include survey information (from past surveys or surveys conducted specifically for the benefit assessment) or the results of previous valuation studies. In addition, early public involvement⁸¹ or use of focus groups or workshops comprised of representative individuals from the affected population and relevant scientific experts can

⁸¹ This could include either a robust public involvement process following Administrative Procedures Act requirements (e.g., FR publication), or some other public involvement process [see EPA's public involvement policy, (U.S. Environmental Protection Agency Office of Policy 2003) and the SAB report on science and stakeholder involvement (U.S. Environmental Protection Agency Science Advisory Board 2001)].

help to identify relevant or potentially important ecological services for the specific context of interest. (Add something about group processes here?)

In eliciting information about what matters to people, it is important to bear in mind that what people say they care about depends on both their preferences and their information, i.e., the extent to which they are informed about an ecological system and the services it provides. Survey respondents or even members of a focus group may have preferences that are representative of the general population but may not be fully informed. Expressions of what is important (e.g., in surveys) can change with the amount of information provided. Collaborative interaction between analysts and public representatives can ensure that respondents have sufficient information when expressing preferences. (Add something about constructed preferences here?)

The information about those ecosystem functions and services that are important to people and potentially impacted significantly should then be integrated to select the services to include in the assessment. As noted above, this requires a collaborative effort and dialogue among analysts from a variety of disciplines early on in the valuation process.

Measuring Benefits

Given the services to be included in the assessment, the impact of the EPA action on those services needs to be characterized and, when possible, measured or quantified. To measure impact on humans, the bio-physical measures of ecological impact need to be translated into their effects on the goods and services provided by those ecosystems to humans. These impacts can be measured in non-monetary terms (e.g., population affected, duration of effect, etc.) or, in contexts where benefits are to be compared directly to costs, in monetary terms if possible.

Estimating bio-physical impacts requires information about the ecological production function for the services being considered. This allows an estimation of the change in the level of services that could result from a given EPA action or policy. (e.g., percent reductions/avoidances of pollution in streams and lakes, reduced/avoided eutrophication of estuaries, reduced risk from the introduction of hormones and antibiotics into aquatic systems, improved/protected quality of community drinking water sources). As when selecting the services to be considered, in estimating the effect of a given action on those services, it is crucial to account for the complexity of ecosystems. In particular, predicted changes need to account for the interconnectedness of ecosystems, uncertainty about how the systems operate, possible instability of the system (including the effect of random shocks or management errors and the system's resilience), heterogeneity within a population or ecosystem, heterogeneity across populations or ecosystems, and dynamic changes in the ecosystem over time. This complexity and the associated uncertainty underscore the importance of presenting ranges rather than point estimates of values when possible.

In some contexts (e.g., endangered species) where bio-physical impacts are the primary concern, the benefit assessment can end with quantification of the impact of the

EPA action on these bio-physical indicators. However, when EPA policies are to be evaluated in terms of impact on humans, the bio-physical effects must be translated into the corresponding impacts on the flow of goods and services that humans value. First and foremost, this requires that the output from the ecological impact assessment be in a form that can be used as an input in estimating the value of the change in ecosystem services. Again, this requires that ecologists work closely with other disciplines to ensure that the ecological assessment is designed from the start with this requirement in mind.

To translate bio-physical impacts into human benefits, it is necessary to project how ecosystem changes will affect humans through changes in the flow of the goods and services they provide. The extent of the impact on humans can be measured in non-monetary terms using a variety of metrics, such as the number and characteristics of the people/communities affected, the number significantly affected, the likely symptoms avoided or reduced, and the duration of the impact.

Estimation of impact on humans in terms of the extent of exposure or similar measures is crucial in three possible ways. First, in some contexts, decisions based on moral or religious principles (e.g., protection of children's health) may look directly to these measures as indicators of the appropriate policy choice. Second, even in contexts where monetary measures of value are sought, the human benefits captured by information on exposure or symptoms need to be translated into their monetary equivalents. This requires an understanding of those impacts on humans before this translation can occur. Third, in some cases where monetary values are sought, it may not be possible to monetize all benefits due to data or methodological constraints. In these cases, there may be a tendency simply to "ignore" the benefits that cannot be monetized. Using methods that defensibly report the magnitude and human significance of such effects, rather than ignoring them, would allow the policymakers to draw their own conclusions regarding the associated potential value or benefit. Thus, in all of these cases, estimates of the impact of the ecosystem change on human populations are needed.

In contexts where monetary metrics are sought and the necessary data and methods exist, the impact of the ecosystem change on the provision of services to human populations can be translated into a monetary equivalent of that change using standard economic valuation techniques to determine the tradeoffs that people are willing to make. Economic or monetary methods for valuing changes are relatively well-developed. They are designed to estimate the benefit or cost of a given change in ecological services using a willingness-to-pay or willingness-to-accept measure of the utility equivalent of that change. These methods have been applied to the valuation of ecosystem services in a number of studies that have produced results that are useful for policy evaluation. However, as in the CAFO study, monetary valuation methods have generally been applied to a relatively narrow set of services. In some cases, these might not have been the services that people are most concerned about protecting. There is a need to expand the range of services to which economic valuation is applied.

As with ecological impacts, in estimating the values of impact on humans in either monetary or non-monetary terms, it is necessary to address cross-cutting issues

such as uncertainty (randomness, level of information), dynamics, scale (temporal, geographic), and heterogeneity (spatial variability, heterogeneity across people). In subsequent reports, the committee will assess the challenges of uncertainty arising out of data limitations, theory limitations, and randomness, and will recommend approaches for reducing uncertainty and conveying the magnitude and nature of uncertainty to policymakers.

CONCLUSIONS AND RECOMMENDATIONS

[to be added]

9. Paul Rissers

Comments highlighted in yellow:

1. INTRODUCTION AND BACKGROUND

Scope of this Report and its Intended Audience

The Science Advisory Board (SAB) Committee on Valuing the Protection of Ecological Systems and Services (C-VPESS) began its work in 2003 on a project developed by the SAB to strengthen the Agency's analysis for protecting ecological resources. The SAB saw a need to complement the Agency's ongoing work in ecological science, ecological risk assessment, and ecological benefit assessment by offering advice on how EPA might better value the protection of ecological systems and services and how that information might better support decision making to protect ecological resources. In this project the SAB set the goals of (a) assessing Agency needs and the state of the art and science of valuing protection of ecological systems and services and (b) identifying key areas for improving knowledge, methodologies, practice, and research at EPA. Senior EPA managers supported the concept of this SAB project and participated in the initial background workshop that launched the work of the C-VPESS. The committee, which sees its work as a three-year initiative, is an interdisciplinary group of experts from the following areas: decision science, ecology, economics, engineering, philosophy, psychology, and social sciences with emphasis in ecosystem protection.⁸² \

This report provides an overview of the committee's conclusions to date.⁸³ It is aimed at providing initial advice for strengthening the Agency's approaches for valuing the protection of ecological systems and services, facilitating their use by decision

⁸² The SAB Staff Office published a Federal Register Notice on March 7, 2003 (68 FR 11082-11084) announcing the project and called for the public to nominate experts in the following areas: decision science; ecology; economics; engineering; psychology; and social sciences with emphasis in ecosystem protection. The SAB Staff Office published a memorandum on August 11, 2003 documenting the steps involved in forming the new committee and finalizing its membership.

⁸³ The committee developed the conclusions in this report after multiple public meetings and workshops: a) an Initial Background Workshop on October 27, 2003 to learn the range of EPA's needs for science-based information on valuing the protection of ecological systems and services from managers of EPA Headquarters and Regional Offices; b) a Workshop on Different Approaches and Methods for Valuing the Protection of Ecological Systems and Services, held on April 13-14, 2004; c) an advisory meeting focused on support documents for national rulemakings held on June 14-15, 2004; d) an advisory meeting focused on regional science needs, in EPA's Region 9 (San Francisco) Office on Sept. 13, 14, and 15, 2004; and e) advisory meetings held on January 26-26, 2005 and April 12-13, 2005 to review EPA's draft *Ecological Benefits Assessment Strategic Plan* and to discuss economic and other methods for valuing the protection of ecological systems and services. The committee discussed a draft version of this report at a public meeting on (INSERT DATE).

makers, and identifying the key research areas needed to strengthen the science base. The committee will prepare additional reports with more detailed advice at the completion of the project.⁸⁴ However, given the importance of the committee's charge, it felt that it would be useful to the Agency to issue an initial report that would indicate the direction that the committee's work is taking and serve as a prelude to the subsequent committee report(s). These subsequent reports will further develop the concepts in this initial advisory report and provide more detailed discussion of issues, methods, and application. In particular, they will describe in more detail how different methods could be used more effectively to understand the benefits of the protection of ecological systems and services and how results of analyses could be better integrated and communicated to decision-makers.

This initial report focuses on the need for an expanded and integrated approach for valuing EPA's efforts to protect ecological systems and services. It provides advice to the Administrator, EPA managers, EPA scientists and analysts, and EPA staff across the Agency concerned with ecological protection. It adopts a broad view of EPA's work, which it understands to encompass national rulemaking, regional decision making, and programs in general that protect ecological systems and services. It focuses directly on EPA's contributions and impacts, however, and not on the general question of the value of ecosystems or ecological services in themselves. It outlines a call for EPA to expand and integrate its approach in important ways.

This report appears at a time when there is lively interest internationally, nationally, and at EPA itself in the issue of valuing the protection of ecological systems and services. Since the establishment of the SAB C-VPES, major reports have been developed focusing on how to improve the characterization of ecological resources (Millennium Ecosystem Assessment 2005; Millennium Ecosystem Assessment Board 2003; National Research Council 2004; Pagiola, von Ritter, and Bishop 2004; Silva and Pagiola 2003) The committee's work has benefited from and will build upon those recent efforts. The C-VPES distinguishes its work from those efforts, however, in the following ways. The C-VPES focuses on EPA as an audience. The committee focuses specifically on how EPA can value its own contributions to the protection of ecological systems and services, so that the agency can make better decisions in its eco-protection programs. The C-VPES is inter-disciplinary and does not focus solely on economic methods or values (but, neither do other reports such as the NRC report). The committee will offer advice on several benefits assessment approaches and in each case will emphasize issues relevant to EPA policy and decision-making and address how the Agency could better characterize the (negative or positive) benefits of ecological protection (this terminology of "characterizing the benefits" implies only a positive benefits unless the qualifiers are included.)

The Importance of Valuing Ecosystems and their Services

⁸⁴ The Committee has already issued a related advisory report on the Agency's draft *Ecological Benefits Assessment Strategic Plan* (EPA SAB, EPA-SAB-ADV-05-00X). This report complements the *EBASP* Advisory, and provides a discussion of an integrated framework alluded to in that report.

The Concept of Ecosystem Services

The term “ecosystem” describes the organisms in a given area interacting with their physical environment as a functional unit. Ecosystems can describe organism-physical environment interactions in a woodlot, a watershed, or an extensive landscape. Ecosystems encompass all organisms within the prescribed area, including humans, who are often the dominant element. Processes that link organisms with their physical environment are considered ecosystem processes and include primary productivity and the cycling of nutrients and water. These processes in total describe the functioning of ecosystems. Processes that link organisms with each other, indirectly influencing flows of energy, water and nutrients, can also be considered ecosystem processes, such as pollination, predation and parasitism. (it might be useful to also note that the term “ecosystem” also denotes the concept of these interacting components as well as the description of a physical entity.)

“Ecosystem services” is an anthropocentric concept denoting the benefits that humans derive from the functioning of ecosystems. An operational categorization of ecosystem services has recently been proposed by the Millennium Ecosystem Assessment:

a) **Provisioning services** (products obtained from ecosystems). These include food, fuelwood, fiber, biochemicals, genetic resources and fresh water. Generally these services are traded in the open marketplace.

b) **Regulating services** (benefits received from regulation of ecosystem processes). This category includes a host of benefits that humans derive from the presence and functioning of ecosystems. These include flood protection, human disease regulation, water purification, air quality maintenance, pollination, pest control and climate control. These services are generally not marketed but many have clear value to society and this value will increase for many of these services as the many dimensions of global change proceed.

c) **Cultural services** (the nonmaterial benefits people obtain from ecosystems). Ecosystems provide cultural, spiritual and aesthetic values, and a sense of place.

d) **Supporting services**. These are the processes that maintain ecosystem functioning such as: soil formation, primary productivity, biogeochemistry, and provisioning of habitat. They all affect human well-being, but generally indirectly through their support of the provisioning, regulating and cultural service functions.

Although there are different ways in which ecosystem services can be categorized, the committee feels that the approach adopted in the Millennium Assessment is a useful approach for conveying the concept of ecosystem services and the broad array of functions and processes ecosystem services include. The ecosystem service concept is useful in many ways. First, it is a concept that is readily grasped by society, since it relates directly to human well-being. Secondly, it provides a tool for evaluating the

impacts of human actions in terms of the resulting change in the benefits provided by the affected services. “Ecosystem health” can then be defined in terms of the output and sustainability of services. When defined this way, the concept of ecosystem health relates directly to the benefits provided to humans. However, life on earth can be revered and protected independent of human benefit. As discussed below, the committee recognizes that ecosystems can be valued not only because of the human-based services they provide but also for other non-anthropocentric reasons, including respect for nature based on ethical, religious, or biocentric principles.

Yes, by definition, “ecological services” is an anthropocentric concept. But it misses the value of ecological services to non-human components in the ecosystem. For example, in the Supporting Services component of the Millennium report, primary productivity is a service to primary consumers in the system. So, although the human-oriented definition of ecological services is useful as describe here, we should also acknowledge that ecological services, as described in human terms, are also conferred on non-human components of an ecosystem. This is different from the intrinsic values noted below.

1.2.2 The Concept of Value

Because people define and assign values, all values are *anthropogenic*. However, as noted above, not all values are *anthropocentric*. When people talk about environmental values, the values of nature, or the values of ecological systems and services, they may have different things in mind. People have moral, economic, religious, aesthetic, and other values, all of which can affect their thoughts, attitudes, and actions toward nature in general or, more specifically, ecosystems and the services they provide.

The most basic distinction in values is the distinction between means and ends. To value something as a mean is to value it for its usefulness in helping to realize or bring about some thing or state of affairs that is valued in its own right or as an end. Things valued for their usefulness as means in this sense are said to have instrumental value. Of course, it would not make sense to value anything instrumentally or as a means unless there was at least one thing or state that was valued for its own sake or as an end. Things valued as ends are sometimes said to have intrinsic value.⁸⁵ If intrinsic value applies to things other than human beings or human experiences, then this conception of value is non-anthropocentric. Some people defend a non-anthropocentric conception of value or goodness (Goodpaster 1978; Rolston III 1991; Taylor 1986). However, others argue that only human beings or human experiences have intrinsic value, thereby defending an anthropocentric conception of value (Glover 1984; Sidgwick 1901; Williams 1994).

Ecological systems have instrumental value to the extent that they provide useful services. Some people also claim, however, that an ecological system may have value independently of the services it provides, i.e., its very existence has value. This claim can

⁸⁵ There is controversy over the meaning of intrinsic value that we will not try to resolve here (Korsgaard 1996). Many people take intrinsic value to mean that the value of something is inherent in that thing. Some philosophers have argued that value or goodness is a simple non-natural property of things (see Moore 1903 for the classical statement of this position), and others have argued that value or goodness is not a simple property of things but one that supervenes on the natural properties to which we appeal to explain a thing’s goodness (this view is defended by, among others, contemporary moral realists; see (Brink 1989; McDowell 1985; Sayre-McCord 1988; Sturgeon 1985).

mean several different things. If it means that the existence of an ecological system is valuable because people derive satisfaction from its existence, then it has what economists call “*existence value*.” This concept is anthropocentric. In addition, it is a kind of instrumental value, since it is based on the premise that the existence of the species or ecological system is one of many things that generate human satisfaction, and that the various things that contribute to human satisfaction are potentially substitutable. Some people, however, claim that an ecological system may have intrinsic value of its own, and that we should protect it for its own sake. If the explanation of this claim refers to reasons that are independent of the contribution that the existence of an ecological system can make to human well-being, then this claim of intrinsic value should be understood in a non-anthropocentric sense.

This committee recognizes that there are many possible sources of value derived from ecosystems and the services they provide. Thus, throughout this report, the term “value” is used broadly to include values predicated on their contributions to human society (broadly defined), as well as those based on an ethical, religious, or biocentric notion of intrinsic value.

Related to the concept of value are the concepts of “benefits” and “valuation.” Both of these terms are relative to a specific change. In this report, the change of interest is the change in the state of an ecosystem or the flow of services it provides stemming from an actual or proposed action by EPA. Thus, the term “ecosystem benefits” refers to the increase in the value of the ecological system and/or its services. This assumes a positive change in value. Analogously, a reduction in value, for example from damages to an ecosystem, can be viewed as a “negative benefit” or cost.

Similarly, the term “valuation” will refer to the process of characterizing or measuring benefits or changes in value using various methods and techniques. For example, economic valuation measures benefits in terms of the amount people are willing to pay (WTP) to ensure an ecological improvement or the amount people are willing to accept (WTA) to forego the improvement.⁸⁶ A social/psychological assessment method might present the same ecological change and ask people to rate the importance of achieving (or preventing) that change relative to a selection of changes in a number of other (potentially competing) social goals. An ecological approach might assess the value of the targeted change in terms of the magnitude of its effect on biodiversity or some other indicator of ecological health based on the consensus that ecological health is important to human/social well-being. All of these assessments are based on an anthropocentric view of values, where ecological values are assessed in terms of their contribution to human well-being. However, they differ in terms of the means by which values are expressed, and by the extent to which the value of the targeted ecological change can then be explicitly compared (traded off) against other social values.

Economic assessments claim the broadest range and most explicit method for assessing tradeoffs between, for example, ecological improvements and changes in other goods or

⁸⁶ A large literature exists on the use of economic valuation methods to estimate the value of changes in environmental quality. For a comprehensive description of these methods, see Freeman (1993).

services that also contribute to human well-being. The social/psychological methods generally settle for a relative measure of the value of the targeted ecological change and largely constrain tradeoff implications to options and circumstances that are closely related to the set of alternatives explicitly presented in the assessment. Ecological assessments might restrict tradeoff implications to the biosphere (Not sure what this sentence says?). In all cases, the ultimate purpose of the valuation process is to characterize or measure the benefits (or costs) associated with an ecological change in a way that provides useful information about these benefits to policymakers and the public at large. The committee plans to discuss these methods, what they may offer analysts and decision makers at EPA in capturing different kinds of benefits, and their limitations and related issues in a future report.

1.2.3 The Importance of Assessing Ecosystem Benefits

Given the important role that ecosystems play in supporting life on earth and providing goods and services that people value, changes in the state of these systems or the flow of services they provide can have important implications. This importance has been increasingly recognized by many, both within the U.S. and internationally. The recent study by the National Research Council and the Millennium Ecosystem Assessment are indicative of this growing recognition.

Many EPA actions (e.g., regulations, rules, programs, policy decisions) affect the state of ecosystems and the flow of services derived from them. EPA actions can either lead to changes in the conditions (and services provided by) of ecosystems (improvement or deterioration) or prevent changes that would otherwise have occurred. These impacts can occur both at a relatively small, local scale as well as more broadly at a national scale. Yet, to date, ecosystem impacts have received relatively limited consideration in EPA policy analyses. Failure to consider these impacts as fully as possible can lead to distorted policy decisions, particularly in regulatory contexts where benefits are being compared to costs. In many cases, the result will be an under-valuation of (or failure to fully recognize) the benefits of EPA actions aimed at protecting the environment. This can occur, for example, when actions are evaluated based primarily on their impacts on human health, without a recognition of potentially important ecosystem impacts.

Valuing the changes in ecological systems and services and assessing the ecosystem benefits that result from EPA policies or programs is challenging for a number of reasons. Major challenges include: a) understanding the many sources of value that ecosystems generate, b) predicting the ecological impacts of alternative EPA actions, and expressing those predictions in the temporal and spatial scale most appropriate for decision-making, c) linking those impacts to changes in the dimensions of ecosystems or the service flows that people value, d) developing methods and techniques that can be used to characterize and/or measure the value of protecting ecological systems and services so that they may be incorporated or properly reflected in environmental decisions and policies, e) aggregating to a national level using local or regional studies from regions with different ecological and/or economic characteristics, and f) finding measures or means of representing ecological values or benefits that are commensurable

with values of non-ecological changes caused by EPA actions, such as human health. Despite these challenges, it is imperative that EPA improve its ability to assess ecosystem benefits to ensure that ecological impacts are adequately considered in the evaluation of EPA actions.

ECOSYSTEM VALUATION AT EPA

There are several contexts in which EPA policy decisions **result in** ecological impacts and hence in which the need for ecosystem benefits assessment will arise. In addition, when assessing benefits, EPA must operate within a set of institutional, legal, organizational and practical constraints that affect this process at the Agency. Thus, EPA has specific needs in this regard that must be recognized and addressed. These needs arise in different parts of the Agency for different purposes and for different audiences. Some of the needs present structured requirements for valuing protection of ecological systems and services, while needs in other contexts are less prescriptive.

Policy Contexts at EPA Where Ecosystem Valuation Can be Important

The most prescriptive requirements are for national rule making. Benefit assessments are required for national rulemaking by two of EPA's governing statutes (the Toxic Substances Control Act and the Federal Insecticide, Fungicide and Rodenticide Act) and by Executive Order 12866 for "significant regulatory actions". The circular on "Regulatory Analysis" issued by the Office of Management and Budget (OMB) in September 2003, *OMB Circular A-4*, identified key elements of a regulatory analysis for such "economically significant rules." One of these elements is an evaluation of the benefits and costs of a proposed regulatory action and the main alternatives identified. The circular provided general guidance on how to provide monetized, quantitative, and qualitative information to fully characterize benefits and EPA itself has developed initial guidance for ecological benefit assessment (U.S. Environmental Protection Agency 2000). In developing its draft *Ecological Benefits Assessment Strategic Plan* and in discussions with the committee (U.S. Environmental Protection Agency Science Advisory Board 2003), EPA identified the need for improved models and methods to help implement the requirements of the circular. The Agency identified needs both to expand methods and data for economic valuation through benefit-cost or cost-effectiveness analysis and to explore other assessment methods to provide information on ecological effects that are currently un-monetized and assigned an implicit value of \$0. Managers seek approaches that are "sound, credible, and scientifically supportable" as well as flexible, affordable, and able to be implemented within the time constraints required by rulemaking (U.S. Environmental Protection Agency Science Advisory Board 2004).

EPA's regional offices, although generally not responsible for national rule-making, are responsible for several kinds of decisions and activities where the benefits of ecological protection come into question:

- Priority setting for regional action, such as targeting projects for wetland restoration and enhancement or identifying critical ecosystems or ecological resources for regional attention
- Setting Supplemental Environmental Protection (SEPs) penalties for enforcement cases where those penalties involve protection of ecological systems and services
- Choice of options for Superfund and Resource Conservation and Recovery Act (RCRA) cleanups that could take ecological benefits into account

- Review of Environmental Impact Statements prepared by other federal agencies to comply with the National Environmental Protection Act
- Assisting state and local governments and other federal Agencies with protecting lands and land uses, where assessment of the value of protection options could help decision-makers make better-informed decisions.

Regions seek low-cost methods that can be implemented quickly to inform "place-based" decisions. They seek methods that provide information on the value of ecological services; ecological diversity; conservation opportunities and threats; sustainability; and historical and cultural values associated with ecological systems or parts of ecosystems at the watershed or landscape scale. Regions experience the need to communicate the value of ecological protection as they collaborate with other federal agencies and with government partners at the local, state, and regional levels.

EPA's need to communicate the value of its ecological protection programs has two dimensions: 1) a retrospective dimension, because assessments focus on the value of EPA's current and past protection efforts and 2) a prospective dimension, because such assessments are meant to inform decisions about future EPA programs and priorities.

The need to assess the ecological benefits of policy options is woven into most of the Agency's decisions, including the assessment of ecological protection programs. Program assessments are mandated for EPA, as they are for all agencies of the executive branch, by the Government Performance and Results Act of 1993. As part of that assessment, OMB requires EPA to periodically identify its strategic goals and describe both the social costs and budget costs associated with them. EPA's Strategic Plan for 2003-2008 described the current social costs and benefits of EPA's programs and policies under each strategic goal area for the year 2002 (U.S. Environmental Protection Agency 2003). This analysis repeatedly points out that EPA lacks data and methods to quantify the ecological benefits associated with the goals in its strategic plan.

In addition, the Government Performance Results Act of 1993 established requirements for assessing the effectiveness of federal programs. Part of that assessment involves assessing the outcomes of programs intended to protect ecological resources. EPA must report annually on its progress in meeting program objectives linked to strategic plan goals and must engage periodically in an in-depth review [through the Program Assessment Rating Tool (PART)] of selected programs to identify their net benefits and to evaluate their effectiveness in meeting meaningful, program outcomes. Characterizing ecological benefits associated with EPA programs is a necessary part of the program assessment process.

Institutional and Other Issues Affecting Benefits Assessment at EPA

The committee recognizes that ecological benefits assessment at EPA must be conducted within a set of institutional, legal, organizational, and practical constraints that affect what is and can be done to incorporate ecosystem values into policy evaluations. In an effort to better understand these issues and their implications for the committee's

charge, the committee conducted a series of interviews with Agency staff.⁸⁷ The interviews focused on the process of developing benefit analyses for Regulatory Impact Assessment (RIA) for rulemaking and the relationship between EPA and the Office of Management and Budget. However, many of the questions raised are equally applicable to strategic planning, performance reviews, regional analysis, and other situations in which the agency is called upon to assess the value of ecosystems. Below are some key observations made by the committee based on those interviews.

EPA Program Offices responsible for new rules initiate, finance, and administer the process for developing ecological benefit assessments. The development of a new rule – including definition of the rule itself, options to be weighed, and the assessment of impacts arising from the rule – involves much more than scientific assessment. Political negotiations and legal analysis arguably (should? currently?) dominate the process. EPA has a formal rule-development process with several stages, each of which imposes demands on the Agency and the Agency also develops rules to meet court-imposed deadlines.

Several aspects of these imposed constraints deserve emphasis. First, despite the commonality of the underlying rule-development process, it is clear that there is no single way in which ecological valuation is conducted within the Agency. Practices vary considerably across program offices, reflecting differences in mission, in-house expertise, etc. Program offices have different statutory and strategic missions. The organization, financing, and skills of the program offices differ enormously. The National Center for Environmental Economics (NCEE) is the Agency's centralized reviewer of economic analysis within the agency.⁸⁸ However, the primary expertise and development of the rules resides within the program offices.

Secondly, the timing of the process largely determines the kinds of analytical techniques that are employed. This is related to court-imposed deadlines on the rule process, as well as intervening requirements related to the collection and analysis of new data. The scientific community is accustomed to much longer time horizons for their analyses. They are also used to the idea that a new rule should call for the collection of new kinds of data (I am not sure this is a correct interpretation. That is, scientists call for data when the current data is insufficient for a judgment or interpretation within a certain level of confidence. As written, the sentence implies that scientist call for more data regardless of the sufficiency of current information.). Unfortunately, collecting new data poses a significant bureaucratic problem for the Agency. To collect original data, the

⁸⁷ These interviews were conducted by one Committee member, Dr. James Boyd, in conjunction with the Designated Federal Officer, Dr. Angela Nugent, over the period September 22, 2004 through November 23, 2005. In seven sets of interviews, Dr. Boyd spoke with staff from the Office of Policy, Economics and Innovation, Office of Water, Office of Air and Radiation, Office of Solid Waste and Emergency Response.

⁸⁸ NCEE is typically brought in by the program offices to both help design and review RIAs. NCEE can be thought to provide a centralized “screening” function for rules and analysis before they go to OMB. NCEE is actively involved in discussions with OMB as rules and supporting analysis are developed and advanced.

Agency must submit an Information Collection Request, which is reviewed within the Agency and by OMB. This hurdle alone can add significant drag to the assessment process. With perhaps a year or two at most to conduct a study, this kind of review significantly limits the kind of analysis the Agency can conduct.

A third issue is the role of the Office of Management and Budget (OMB) in defining or directing ecosystem valuation exercises at EPA. It was difficult for the committee to ascertain the EPA-OMB relationship precisely.⁸⁹ EPA has been given explicit guidance by OMB in the Circular A-4, which the committee views as a reasonable document on its own because of its call for a full characterization of the impacts of different policy options and inclusion of language calling for characterization of benefits that cannot be monetized or cannot be quantified (Office of Management and Budget 2003)⁹⁰. However, the implications of some sections of the Circular, particularly relating to the treatment of benefits that cannot be readily monetized, remain somewhat ambiguous. For a benefit or cost that cannot be expressed in monetary terms, the Circular instructs Agency staff to “try to measure it in terms of its physical units,” or, if this is not possible either, to “describe the benefit or cost qualitatively.” However, little guidance is provided on how this should be done. Instead, the Circular urges regulators to “exercise professional judgment in identifying the importance of non-quantified factors and assess as best you can how they might change the ranking of alternatives based on estimated net benefits.”

It is clear that the Agency views the OMB as a kind of “court” that reviews its analysis. In front of this “court,” methods that have been accepted in the past create incentive for the use of the same or similar methods in the future. The thinking seems to be “if it made it through OMB once, it will make it through again.” There appears to be a pronounced tendency to use “off-the-shelf” methods to avoid problems with OMB. This creates a bias toward the *status quo* and a **disincentive** to explore new or innovative approaches. To this end, the committee sees the need to strike an appropriate balance between the use of established methods and the possible need to innovate in an effort to conduct more comprehensive and defensible benefit assessments for use in decision making and evaluation.

A related issue involves RIA review by external parties. The Agency does not take a standardized approach to RIA review.⁹¹ EPA staff and managers reported that peer

⁸⁹ OMB responded to written questions, but declined to be interviewed by Dr. Boyd. EPA staff were informed that their formal responses to all questions, including the OMB-EPA interview were to be documented as part of the Committee report and this is likely to have had a chilling effect on the discussions.

⁹⁰ eg., see pp.27 “If monetization is impossible, explain why and present all available quantitative information” and, pp “If you are not able to quantify the effects, you should present any relevant quantitative information along with a description of the unquantified effects, such as ecological gains, improvements in quality of life, and aesthetic beauty.”

⁹¹ In some cases, review panels are appointed, in others not. In some cases, contractors are called upon to manage the review. In other cases, Program Offices themselves manage the review process.

review was focused only on “novel” elements of an analysis. This raises the question of how the Agency (and perhaps OMB) defines “novel.” Moreover, the novelty standard actually creates a clear incentive to avoid conducting novel analyses (however defined). It is clearly cheaper and quicker to avoid review altogether. The committee advises the Agency to consider whether there is a role for a standing expert body that can bring consistency to the review of analysis, avoid duplication of review, and be sensitive to timing and resource constraints. (I agree with the recommendation, but this is the first time in the text, which has otherwise been explanatory, inserts a recommendation.)

Finally, the committee notes the importance of organization of assessment science within the Agency. Currently, the Agency relies upon a variety of offices to develop assessments, with varying degrees of reliance on other offices (e.g., NCEE) or outside assistance.⁹² It is not clear which work better than others. In addition, it is not clear how different programs integrate social science and biophysical science.⁹³

Do we want to advocate a “ecosystem services valuation paradigm” and/or development of a set of guidelines for doing ecosystem valuation? Relationship to risk assessment paradigm/guidelines??? See more on this in footnote below.

An Illustrative Example of Ecosystem Benefit Assessment at EPA

In an effort to better understand the current state of ecosystem valuation at EPA, the committee examined in detail one specific case where benefit assessment was undertaken, namely, the *Environmental and Economic Benefits Analysis* that EPA prepared in support of new regulations for Concentrated Animal Feeding Operations (CAFOs) (U.S. Environmental Protection Agency 2002).^{94,95} The Agency indicated that

⁹² Another issue that relates to the organization of science within the Agency is the availability and location of data to support ecosystem valuation. The choice of methods is clearly related to the practical availability of data across the Agency. It is important that data that are housed within individual program offices are made public and readily shared with other offices.

⁹³ One anecdote is that Dr Boyd was able to speak with only one ecologist during the interviews designed (in part) to interview a set of ecologists. Economists in the agency were not able to identify ecologists to interview, for example. It also became clear that simple “counts” of professional background can be deceptive. What the agency terms an “ecologist” is not necessarily what the scientific community would call an ecologist.

⁹⁴ The Committee reviewed and critically evaluated the Environmental and Economic Benefits Analysis at its June 15, 2004 meeting. As stated in the Background Document for SAB Committee on Valuing the Protection of Ecological Systems and Services for its Session on June 15, 2004, the purpose of this exercise was “to provide a vehicle to help the Committee identify approaches, methods, and data for characterizing the full suite of ecological ‘values’ affected by key types of Agency actions and appropriate assumptions regarding those approaches, methods, and data for these types of decisions.” The Committee based its review on EPA’s final benefits report (EPA 2002) and a briefing provided by the EPA Office of Water staff. During the June meeting, members of the Committee divided into two workgroups. The workgroups each worked independently and reported their findings to the combined Committee. The leaders of the two working groups then prepared a consolidated summary of comments from the two workgroups.

this analysis was typical of other EPA regulatory analyses of ecological benefits in form and general content.

Because the proposed new CAFO rule constituted a “significant regulatory action” under Executive Order 12866, EPA was required to assess the costs and benefits of the rule.⁹⁶ EPA identified a wide variety of potential “use” and “non-use” benefits as part of its analysis.⁹⁷ Using various economic valuation methods, EPA provided monetary quantifications in its CAFO report for seven environmental benefits.⁹⁸ Approximately eighty-five percent of the monetary benefits quantified by EPA were attributed to recreational use and non-use of affected waterways. According to Agency staff, EPA’s analysis was driven by what it could monetize. EPA focused on those benefits for which data were known as available for quantification of both the baseline condition and the likely changes from the proposed rule, and translation of those changes into monetary equivalents. EPA’s final benefits assessment provides only a brief discussion of the benefits that it could not monetize. The benefits table in the Executive Summary listed a variety of non-monetized benefits⁹⁹ but designated them only as “not monetized.” EPA represented the aggregate effect of these “substantial additional environmental benefits” simply by attaching a “+B” place-holder to the estimated range

⁹⁵ In December 2000, EPA proposed a new CAFO rule under the federal Clean Water Act to replace 25-year-old technology requirements and permit regulations (66FR 2959). EPA published its final rule in December 2003 (68 FR 7176). The new CAFO regulations, which cover over 15,000 large CAFO operations, reduce manure and wastewater pollutants from feedlots and land applications of manure and remove exemptions for stormwater-only discharges.

⁹⁶ Prior to publishing the draft CAFO rule in December 2000, EPA spent two years preparing an initial assessment of the costs and benefits of the major options. After releasing the draft rule, EPA spent another year collecting data, taking public comments, and preparing assessments of new options. EPA published its final assessment in 2003. An intra-agency team at EPA, including economists and environmental scientists in the Office of Water, Office of Air and Radiation, Office of Policy Economics and Innovation, and Office of Research and Development, worked on the benefit assessment. EPA also worked with the U.S. Department of Agriculture in developing the assessment. Dr. Christopher Miller of EPA’s Office of Water estimated that EPA spent approximately \$1 million in overall contract support to develop the benefit assessment. EPA spent approximately \$250,000-\$300,000 on water quality modeling as part of the assessment.

⁹⁷ The potential “use” benefits included in-stream uses (commercial fisheries, navigation, recreation, subsistence, and human health risk), near-stream uses (non-contact recreation, such as camping, and nonconsumptive, such as wildlife viewing), off-stream consumptive uses (drinking water, agricultural/irrigation uses, and industrial/commercial uses), aesthetic value (for people residing, working, or traveling near water), and the option value of future services. The potential “non-use” values included ecological values (reduced mortality/morbidity of certain species, improved reproductive success, increased diversity, and improved habitat/sustainability), bequest values, and existence values.

⁹⁸ These benefits were recreational use and non-use of affected waterways, protection of drinking water wells, protection of animal water supplies, avoidance of public water treatment, improved shellfish harvest, improved recreational fishing in estuaries, and reduced fish kills.

⁹⁹ These include eutrophication of estuaries; reduced pathogen contamination of drinking water supplies; reduced human and ecological risks from hormones, antibiotics, metals, and salts; improved soil properties from reduced over-application of manure; and “other benefits”.

of total monetized benefits. Although the Executive Summary gave a brief description of these “non-monetized” benefits, the remainder of the report devotes little attention to them.

Although much effort was invested in the CAFO benefits assessment, the assessment illustrates a number of limitations in the current state of ecosystem valuation at EPA.

First, EPA’s analysis and report focused nearly exclusively on meeting the requirements as described in Executive Order 12866. This may not be surprising since the Executive Order provided the reason for preparing the analysis and report. However, when EPA prepares a benefit assessment specifically to comply with Executive Order 12866, the Agency need not limit itself to the goals and requirements of the Executive Order. The Executive Order does not preclude EPA from adopting broader goals. The Executive Order provides merely that EPA shall conduct an “analysis” and “assessment” of the “benefits anticipated from the regulatory action” and, “to the extent feasible, a quantification of those benefits.” By adopting a narrow focus, the report failed to consider or reflect the broader purposes that a benefit assessment can serve. Environmental benefit assessments, such as the CAFO study, can serve a variety of important purposes, including helping to educate policy-makers and the public more generally about the benefits that stem from EPA regulations. (But, we should recognize that the process does not “reward” EPA in any way for expanding its scope of study.)

Second, as noted above, in implementing the Executive Order, the CAFO analysis did not provide the full characterization of ecological benefits using quantitative and qualitative information, as required by the OMB Circular A-4. Instead, the report focused on a limited set of environmental benefits, driven primarily by the ability to monetize these benefits using generally accepted models and existing value measures (benefit transfer).¹⁰⁰ These benefits did not include all of the major environmental benefits that the new CAFO rule would likely generate, nor all of the benefits that generated public support for the new rule.¹⁰¹ The Circular requires that a benefit assessment identify and characterize all the important benefits of the proposed rule, not simply those that can be monetized. By focusing only on a narrow set of benefits, the CAFO analysis and report understates the benefits of the rule change and distorts the

¹⁰⁰ EPA apparently conducted no new economic valuation studies (although a limited amount of new ecological research was conducted) and did not consider the possible benefits of developing new information where important benefits could not be valued in monetary terms based on existing data. The CAFO report emphasizes EPA’s predisposition toward conservative benefits estimates and identifies the lack of adequate data and/or models meeting EPA standards of quality as a basis for truncating the CAFO analysis.

¹⁰¹ For example, while the report notes the potential effects of discharging hormones and other pharmaceuticals commonly used in CAFOs into drinking water sources and aquatic ecosystems, the nature and possible ecological significance of these effects is not adequately developed or presented. Similarly, the report does not adequately address the well-known consequences of discharging TMC precursors into drinking-water sources.

rationale supporting the final rule.¹⁰² An unfortunate effect of this presentation is to suggest to readers that the monetized benefits constitute the principal justification for the CAFO rule.¹⁰³ Although in this case the focus on monetized benefits did not affect the outcome of the regulatory review, it is certainly possible that in a different context, this conservative approach to benefits assessment (based only on easily monetized benefits) could inadvertently undermine support for a rule that would be justified based on a more inclusive characterization of benefits. (I don't think this is a full characterization of the issue. The text seems to imply that the limited number of considerations was based on only those that could be monetized. It is just as plausible that some of the important considerations were omitted because the agency did not comprehensively model the system before selecting high impact/magnitude considerations.)

Third, the monetary values for many of the emphasized benefits were estimated through highly leveraged benefit transfers that were generally based on dated studies conducted in contexts quite different from the CAFO rule application.¹⁰⁴ This was undoubtedly driven to a large extent by time, data, and resource constraints, which make it very difficult for the Agency to conduct new surveys or studies and virtually force the Agency to monetize benefits using existing value estimates. However, reliance on dated studies in quite different contexts raises questions about the credibility or validity of the monetary benefit estimates. This is particularly true when values are presented as point estimates, without adequate recognition of the underlying limitations, due to uncertainty and data quality.

Fourth, EPA apparently did not engage in a detailed and systematic effort at the outset to model the rule's ecological impacts (ok, see above). The report presents only a simple conceptual model that traces outputs (a list of pollutants in manure – Exhibit 2-2 in the CAFO report) through pathways (Exhibit 2-1) to environmental and human health effects.¹⁰⁵ This model provided useful guidance, but was not sufficiently detailed to

¹⁰² One of the benefits of monetary benefit estimates obviously is the ease of aggregating them by simple arithmetic. However, the Committee does not believe that reporting that a rule produced a total of “218.9 million dollars in annual benefits” is necessarily more useful, meaningful, or defensible for environmental policy than reporting, for example, the achievement of a “10% reduction in the pollution of over 129,000 miles of streams and rivers, 3.2 million acres of lakes and ponds, and 2,800 square miles of estuaries.”

¹⁰³ In the case of this CAFO rule, 97% of the monetized benefits arise from recreation (boating, swimming and fishing) and from private well owners' willingness to pay for water quality, estimated using contingent valuation or travel cost methods.

¹⁰⁴ EPA used estimates based on a variety of public surveys in its benefit transfer efforts, including: a national survey (1983) that determined individuals' willingness to pay for changes in surface water quality relating to water-based recreational activities (Section 4 of the CAFO Report); a series of surveys (1992, 1995, 1997) of willingness to pay for reduced/avoided nitrate (or unspecified) contamination of drinking water supplies (Section 7); and several studies (1988, 1995) of recreational fishers' values (travel cost, random utility model) for improved/protected fishing success related to nitrate pollution levels in a North Carolina estuary (Section 9).

¹⁰⁵ Although EPA later prepared more detailed conceptual models of the CAFO rule's impact on various ecological systems and services, EPA did not prepare these models until after the Agency finished its analysis.

assure an adequately comprehensive and balanced analysis of the rule's ecological impacts. As a consequence the analysis was unduly directed by Agency presumptions (or discoveries) about the availability of relevant data and the likely opportunities to quantify effects precisely and to link and monetize associated benefits. This was undoubtedly driven in part by the time pressures of putting together the regulatory impact analysis. However, without a detailed and comprehensive modeling effort at the outset, EPA had insufficient insight into the potential benefits that needed to be analyzed and valued. Developing integrated models of relevant ecosystems at the outset of a valuation project would also help in identifying important secondary effects, which frequently may be of even greater consequence or value than the primary effects.¹⁰⁶

Fifth, the CAFO analysis clearly demonstrates the challenges of conducting ecological benefit assessments at the national level.¹⁰⁷ National rule-makings inevitably require EPA to generalize away from geographic specifics, both in terms of ecological impacts and associated values. However, it is possible (and desirable) to make use of intensive case studies (e.g., individual watersheds, lakes, streams, estuaries) in support of the national-scale analyses. Existing and ongoing research at local and regional scales offers more detailed data and models that could be better exploited, both to fill in gaps and to systematically validate the national-scale analyses. Systematically performing and documenting comparisons to intensive study sites could indicate the extent to which the national model needs to be adjusted for local/regional conditions and could provide data for estimating the range of error and uncertainty in the projected national-scale effects.

Sixth, although EPA invited public comment on the draft CAFO analysis as required by Executive Order 12866, there is no indication in the draft CAFO report that EPA consulted with the public during its analysis to help it identify, assess, and prioritize the effects and values addressed in its analysis, nor is there discussion in the final CAFO analysis of any comments received on the draft CAFO analysis. Early public involvement could play a valuable role in helping the Agency both a) identify all of the systems and services impacted by the proposed regulations and b) determine the regulatory effects that are likely to be of greatest value. This would ensure that the benefits assessment includes the most important impacts.

Finally, while EPA in its analysis and report appropriately emphasized the importance of using outside peer-reviewed data, methods, and models, EPA did not seek

¹⁰⁶ Contamination of estuaries, for example, might negatively affect fisheries in the estuary (a primary effect) but might have an even greater impact on offshore fisheries that have their nurseries in the estuary (a secondary effect).

¹⁰⁷ The goal of EPA's analysis was a national level assessment of the effects of the CAFO rule. This involved the effects of approximately 15,000 individual facilities, each contributing pollutants across local watersheds into local and regional aquatic ecosystems. A few intensive case studies were mentioned in the report and used to calibrate the national scale models (e.g., NWPCAM, GLEAMS), but there was no indication that these more intensive data sets were strategically selected or used systematically for formal sensitivity tests or validations of the national-scale model results.

to peer review its application of them or its integration of these components in deriving benefit values for the CAFO rule. Once again, this is undoubtedly due in part to time and resource constraints. However, peer review, especially early in the process, would help EPA staff identify relevant and available data, models, and methods to support its analysis, and provide encouragement, direction, and sanction for more vigorous and effective pursuit of ecological and human wellbeing effects associated with the proposed rule. The general idea is to have individual components of the analysis (e.g., watershed modeling, air dispersal, human health, recreation, aesthetics) each reviewed, as well as a more general review of the overall analytic scheme.

AN INTEGRATED AND EXPANDED APPROACH TO ECOSYSTEM VALUATION

The CAFO example discussed above highlights a number of limitations to the current state of ecosystem valuation at EPA. The committee's analysis points to the need for a comprehensive, integrated approach to valuing the ecological impacts of EPA actions, one that focuses on the impacts of most concern to people and integrates ecological analysis with valuation. This section describes a proposed framework, based on the committee's deliberations to date. A more detailed discussion of the methods that could be used to implement this framework and the issues that arise in doing so will be provided in a subsequent committee report. The goal in this report is simply to provide an organizing framework to guide the more detailed discussion regarding implementation.

A key feature of the framework outlined here is that it integrates ecological analysis with valuation. This integration needs to occur both at an early stage (in the identification of the impacts that matter) and at a later stage (when estimating the value of impacts). Thus, instead of having ecologists work independently initially to estimate ecological impacts and then "pass the baton" on to economists or other social scientists to value those impacts, it envisions collaborative work across disciplines to ensure that the analysis focuses on the impacts that are of greatest concern and that the ways in which these impacts are defined and measured are informative during the selection and, if necessary, design of the valuation techniques/methods. Such a framework requires a committed dialog (I have always objected to the casual implication of "dialog" and hope that we can infer something more intense, such as "intensive, interactive analysis" or something similar.) among the relevant bio-physical, ecological, and social/economic scientists and analysts. The various disciplines must reach out to establish useful and credible links to each other. This interaction should commence at the beginning of the process and continue until the completion of the analysis. Ecological models need to be developed, modified, or extended to provide usable inputs for value assessments. Likewise, valuation methods and models need to be developed, modified, or extended to address important ecological/bio-physical effects that are currently underrepresented in value assessments.

In addition, the framework envisions the use of a variety of methods to characterize and measure benefits or values, including economic methods, social/psychological assessments, and ecological approaches. The suite of methods to be used will vary with the specific policy or valuation context, due to differences across contexts in: a) information needs, b) the underlying sources of value being captured; c) data availability; and d) methodological limitations. (And, we need to address how we will reconcile or state priorities among the tools in our arsenal.) The framework should serve as a guide to EPA staff as they conduct RIAs and seek to implement the provisions of Circular A-4 (including the provisions relating to benefits that are not readily quantified or monetized), as well as in regional decision-making and program assessment.

The proposed framework has three main components: a) identify the context and scope of the benefit assessment, b) identify the ecological services that will be considered in the assessment, and c) characterize, represent or measure those impacts in bio-physical, human, and/or monetary terms. This proposed framework would parallel the Agency's Framework for Ecological Risk Assessment (U.S. Environmental Protection Agency Risk Assessment Forum 1992) and ultimately be merged with it as part of a broader framework for ecological assessment.

Context and Scope

As noted above, ecological benefit assessment can play a key role in a number of different decision contexts, including national rule-making, local/regional decision-making, and program evaluation. There is a need to formulate the benefit assessment problem within the specific EPA context. These contexts differ not only in the required scale for the analysis (e.g., national vs. local) but possibly also in the type of valuation information that is needed, i.e., whether it requires that benefits be characterized or measured in terms of bio-physical impacts, or the resulting impacts on humans, or both.

The information needed for a given policy decision will in turn depend on the decision approach to be used in evaluating alternatives. The rule to be used could be dictated by statute, regulation, or executive order, or could be determined by the EPA staff. Possible approaches include maximization of (expected) net present value (based on cost-benefit analysis), minimization of the (expected) cost of meeting a given goal (cost-effectiveness), use of a safe minimum standard, use of the precautionary principle, or use of a moral or rights-based rule based on intrinsic value. For example, the Endangered Species Act is based on an underlying presumption that species should be preserved (either because of high existence value or high intrinsic value), and hence the value information necessary to support decisions in this context can be expressed solely in bio-physical terms. In contrast, if a strict cost-benefit rule is to be used in a rule-making context, aggregate dollar values of benefits (and costs) are needed. Under a broader interpretation (e.g., OMB Circular A-4), use of cost-benefit analysis would require that ecological benefits be a) measured in dollar terms when possible, b) measured using other metrics for impacts on humans (e.g., population affected) when monetary valuation is not possible, and c) fully described in qualitative terms, when quantitative information is not available.

Ecological Services to be Included

Decisions about the ecological services to be included in the analysis should be based on an assessment of the impacts that are likely to be most important, depending on both the magnitude and bio-physical importance of the effect and the resulting impact on humans.

3.2.1 Identifying Potentially Important Bio-Physical Impacts. The bio-physical impacts of a given EPA action can be identified at different levels (**temporal, spatial and ecosystem organizational levels**). These include the individual level, the population level, the community level, the ecosystem level (union of biological populations with their surrounding physical environment), and the level of the global

biosphere. Ecological science is organized according to these scales. For the purposes of ecological benefits assessment, ecological impacts correspond to changes in functions or services provided by the ecosystem, as described above. Living organisms supply goods and services that differ across all levels of organization, from the individual to the ecosystem or global biosphere. For example, the service provided by an individual animal unit is different from the service provided by a given animal population.

Many types of ecological models exist at various levels (e.g., population, community, ecosystem, biosphere) to predict impacts of perturbations on ecosystems. Some have been developed for specific contexts (species, geographic locations) while others are more general. In some cases “off-the-shelf” models may be available, while in others existing models may need to be modified or new models developed. **(what should we say about the current state of ecological modeling??? We need the committee to discuss and come to some agreement about this.) The discussion needs to include distinctions among different types of models, e.g., population and biogeochemical models, spatially explicit models, predictive and optimization, and those that include economic and social valuations. My suggestion is to use the CAFO example, and describe the models that were or could have been used in this evaluation—this example would serve as the framework for discussing ecological models. This exercise would provide an organized and circumscribed way of presenting ecological models and discussing the tests for applicability, confidence levels and the methods and challenges of linking models from different spatial and temporal scales as noted in the following paragraph.**

In identifying possible impacts, it is important to consider their full range, including both primary and secondary effects, adequately accounting for uncertainty (incomplete information), (in)stability of the system (including the effect of random shocks or management errors and the system’s resilience), heterogeneity within a population or ecosystem, heterogeneity across populations or ecosystems, and dynamic changes in the ecosystem over time. Ecosystems are complex, highly variable systems with many interacting parts. They are subject to both natural and anthropogenic disturbances that can propagate through the system in ways that are difficult to predict. The complexity, variability, and potential instability of the systems need to be considered when identifying impacts with the greatest ecological significance.

3.2.2 Identifying What Matters to People. For benefit assessments based on anthropocentric values, it is important to identify early in the process what people care about, i.e., which ecological services or functions are important to them. For example, are individuals likely to value the re-introduction of native grasses into a marshland, or would they be just as happy with non-native grasses that perform similar ecological functions and aesthetic appeal? Is animal waste disposal a concern to people primarily because of the recreational opportunities lost due to the resulting deterioration in water quality, or are they primarily concerned about other impacts? The range of services that are the focus of the benefits assessment needs to include the services people care most about. Previous benefit assessments have often focused on what can be measured relatively easily rather than what is most important to people. This diminishes the

relevance, usefulness and impact of the assessment. Yes, but we should not leave the impression that we choose to analyze only what is important to people. That is, the slow contamination of a groundwater source may not be on the top of people's list of concerns, but over long time periods could have a significant effect. Also, there is the danger of a thousand cuts and the danger of the commons. So, we should consider the implications of NINBY, temporal, cumulative and tragedy of the commons reasons for selecting what matters to people.

Information about what matters to people can be obtained in a variety of ways. Examples include survey information (from past surveys or surveys conducted specifically for the benefit assessment) or the results of previous valuation studies. In addition, early public involvement¹⁰⁸ or use of focus groups or workshops comprised of representative individuals from the affected population and relevant scientific experts can help to identify relevant or potentially important ecological services for the specific context of interest. **(Add something about group processes here?)** Yes, there are good examples of group involvement and the value they add to the process, for example, watersheds in the Willamette Valley—Steve knows about this.

In eliciting information about what matters to people, it is important to bear in mind that what people say they care about depends on both their preferences and their information, i.e., the extent to which they are informed about an ecological system and the services it provides. Survey respondents or even members of a focus group may have preferences that are representative of the general population but may not be fully informed. Expressions of what is important (e.g., in surveys) can change with the amount of information provided. Collaborative interaction between analysts and public representatives can ensure that respondents have sufficient information when expressing preferences. **(Add something about constructed preferences here?)**

The information about those ecosystem functions and services that are important to people and potentially impacted significantly should then be integrated to select the services to include in the assessment. As noted above, this requires a collaborative effort and dialogue among analysts from a variety of disciplines early on in the valuation process.

Measuring Benefits

Given the services to be included in the assessment, the impact of the EPA action on those services needs to be characterized and, when possible, measured or quantified. To measure impact on humans, the bio-physical measures of ecological impact need to be translated into their effects on the goods and services provided by those ecosystems to humans. These impacts can be measured in non-monetary terms (e.g., population

¹⁰⁸ This could include either a robust public involvement process following Administrative Procedures Act requirements (e.g., FR publication), or some other public involvement process [see EPA's public involvement policy, (U.S. Environmental Protection Agency Office of Policy 2003) and the SAB report on science and stakeholder involvement (U.S. Environmental Protection Agency Science Advisory Board 2001)].

affected, duration of effect, etc.) or, in contexts where benefits are to be compared directly to costs, in monetary terms if possible.

Estimating bio-physical impacts requires information about the ecological production function for the services being considered. This allows an estimation of the *change* in the level of services that could result from a given EPA action or policy. (e.g., percent reductions/avoidances of pollution in streams and lakes, reduced/avoided eutrophication of estuaries, reduced risk from the introduction of hormones and antibiotics into aquatic systems, improved/protected quality of community drinking water sources). As when selecting the services to be considered, in estimating the effect of a given action on those services, it is crucial to account for the complexity of ecosystems. In particular, predicted changes need to account for the interconnectedness of ecosystems, uncertainty about how the systems operate, possible instability of the system (including the effect of random shocks or management errors and the system's resilience), heterogeneity within a population or ecosystem, heterogeneity across populations or ecosystems, and dynamic changes in the ecosystem over time. This complexity and the associated uncertainty underscore the importance of presenting ranges rather than point estimates of values when possible.

In some contexts (e.g., endangered species) where bio-physical impacts are the primary concern, the benefit assessment can end with quantification of the impact of the EPA action on these bio-physical indicators. However, when EPA policies are to be evaluated in terms of impact on humans, the bio-physical effects must be translated into the corresponding impacts on the flow of goods and services that humans value. First and foremost, this requires that the output from the ecological impact assessment be in a form that can be used as an input in estimating the value of the change in ecosystem services. Again, this requires that ecologists work closely with other disciplines to ensure that the ecological assessment is designed from the start with this requirement in mind.

To translate bio-physical impacts into human benefits, it is necessary to project how ecosystem changes will affect humans through changes in the flow of the goods and services they provide. The extent of the impact on humans can be measured in non-monetary terms using a variety of metrics, such as the number and characteristics of the people/communities affected, the number significantly affected, the likely symptoms avoided or reduced, and the duration of the impact.

Estimation of impact on humans in terms of the extent of exposure or similar measures is crucial in three possible ways. First, in some contexts, decisions based on moral or religious principles (e.g., protection of children's health) may look directly to these measures as indicators of the appropriate policy choice. Second, even in contexts where monetary measures of value are sought, the human benefits captured by information on exposure or symptoms need to be translated into their monetary equivalents. This requires an understanding of those impacts on humans before this translation can occur. Third, in some cases where monetary values are sought, it may not be possible to monetize all benefits due to data or methodological constraints. In these cases, there may be a tendency simply to "ignore" the benefits that cannot be monetized.

Using methods that defensibly report the magnitude and human significance of such effects, rather than ignoring them, would allow the policymakers to draw their own conclusions regarding the associated potential value or benefit. Thus, in all of these cases, estimates of the impact of the ecosystem change on human populations are needed.

In contexts where monetary metrics are sought and the necessary data and methods exist, the impact of the ecosystem change on the provision of services to human populations can be translated into a monetary equivalent of that change using standard economic valuation techniques to determine the tradeoffs that people are willing to make. Economic or monetary methods for valuing changes are relatively well-developed. They are designed to estimate the benefit or cost of a given change in ecological services using a willingness-to-pay or willingness-to-accept measure of the utility equivalent of that change. These methods have been applied to the valuation of ecosystem services in a number of studies that have produced results that are useful for policy evaluation. However, as in the CAFO study, monetary valuation methods have generally been applied to a relatively narrow set of services. In some cases, these might not have been the services that people are most concerned about protecting. There is a need to expand the range of services to which economic valuation is applied.

As with ecological impacts, in estimating the values of impact on humans in either monetary or non-monetary terms, it is necessary to address cross-cutting issues such as uncertainty (randomness, level of information), dynamics, scale (temporal, geographic), and heterogeneity (spatial variability, heterogeneity across people). In subsequent reports, the committee will assess the challenges of uncertainty arising out of data limitations, theory limitations, and randomness, and will recommend approaches for reducing uncertainty and conveying the magnitude and nature of uncertainty to policymakers.

10. Joan Roughgarden

Comments received as “redline” within document:

1. INTRODUCTION AND BACKGROUND

Scope of this Report and its Intended Audience

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The Science Advisory Board (SAB) Committee on Valuing the Protection of Ecological Systems and Services (C-VPES) began its work in 2003 on a project developed by the SAB to strengthen the Agency's analysis for protecting ecological resources. The SAB saw a need to complement the Agency's ongoing work in ecological science, ecological risk assessment, and ecological benefit assessment by offering advice on how EPA might better value the protection of ecological systems and services and how that information might better support decision making to protect ecological resources. In this project the SAB set the goals of assessing Agency needs and the state of the art and science of valuing protection of ecological systems and services and identifying key areas for improving knowledge, methodologies, practice, and research at EPA. Senior EPA managers supported the concept of this SAB project and participated in the initial background workshop that launched the work of the C-VPES. The committee is an interdisciplinary group of experts from the following areas: decision science, ecology, economics, engineering, philosophy, psychology, and social sciences with emphasis in ecosystem protection.¹⁰⁹ The committee sees its work as a three-year initiative.

This report is intended to provide an overview of the committee's conclusions to date.¹¹⁰ It is aimed at providing initial advice for strengthening the Agency's approaches for valuing the protection of ecological systems and services, facilitating their use by decision makers, and identifying the key research areas needed to strengthen the science base. The committee will prepare additional reports with more detailed advice at the

¹⁰⁹ The SAB Staff Office published a Federal Register Notice on March 7, 2003 (68 FR 11082-11084) announcing the project and called for the public to nominate experts in the following areas: decision science; ecology; economics; engineering; psychology; and social sciences with emphasis in ecosystem protection. The SAB Staff Office published a memorandum on August 11, 2003 documenting the steps involved in forming the new committee and finalizing its membership.

¹¹⁰ The committee developed the conclusions in this report after multiple public meetings and workshops: a) an Initial Background Workshop on October 27, 2003 to learn the range of EPA's needs for science-based information on valuing the protection of ecological systems and services from managers of EPA Headquarters and Regional Offices; b) a Workshop on Different Approaches and Methods for Valuing the Protection of Ecological Systems and Services, held on April 13-14, 2004; c) an advisory meeting focused on support documents for national rulemakings held on June 14-15, 2004; d) an advisory meeting focused on regional science needs, in EPA's Region 9 (San Francisco) Office on Sept. 13, 14, and 15, 2004; and e) advisory meetings held on January 26-26, 2005 and April 12-13, 2005 to review EPA's draft *Ecological Benefits Assessment Strategic Plan* and to discuss economic and other methods for valuing the protection of ecological systems and services. The committee discussed a draft version of this report at a public meeting on (INSERT DATE).

completion of the project.¹¹¹ However, given the importance of the committee's charge, it felt that it would be useful to the Agency to issue an initial report that would indicate the direction that the committee's work is taking and serve as a prelude to the subsequent committee report(s). These subsequent reports will further develop the concepts in this initial advisory report and provide more detailed discussion of issues, methods, and application. In particular, they will describe in more detail how different methods could be used more effectively to understand the benefits of the protection of ecological systems and services and how results of analyses could be better integrated and communicated to decision-makers.

This initial report focuses on the need for an expanded and integrated approach for valuing EPA's efforts to protect ecological systems and services. It provides advice to the Administrator, EPA managers, EPA scientists and analysts, and EPA staff across the Agency concerned with ecological protection. It adopts a broad view of EPA's work, which it understands to encompass national rulemaking, regional decision making, and programs in general that protect ecological systems and services. It focuses directly on EPA's contributions and impacts, however, and not on the general question of the value of ecosystems or ecological services in themselves. [why not?](#) It outlines a call for EPA to expand and integrate its approach in important ways.

This report appears at a time when there is lively interest internationally, nationally, and at EPA itself in the issue of valuing the protection of ecological systems and services. Since the establishment of the SAB C-VPASS major reports have been developed focusing on how to improve the characterization of ecological resources (Millennium Ecosystem Assessment 2005; Millennium Ecosystem Assessment Board 2003; National Research Council 2004; Pagiola, von Ritter, and Bishop 2004; Silva and Pagiola 2003) The committee's work has benefited from and will build upon those recent efforts. The C-VPASS distinguishes its work from those efforts, however, in the following ways. The C-VPASS focuses on EPA as an audience. The committee focuses specifically on how EPA can value its own contributions to the protection of ecological systems and services, so that the agency can make better decisions in its eco-protection programs. The C-VPASS is inter-disciplinary and does not focus solely on economic methods or values. The committee will offer advice on several benefits assessment approaches and in each case will emphasize issues relevant to EPA policy and decision-making and address how the Agency could better characterize the benefits of ecological protection.

The Importance of Valuing Ecosystems and their Services

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The Concept of Ecosystem Services

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The term "ecosystem" describes the organisms in a given area interacting with their physical environment as a functional unit. Ecosystems can describe organism-

¹¹¹ The Committee has already issued a related advisory report on the Agency's draft *Ecological Benefits Assessment Strategic Plan* (EPA SAB, EPA-SAB-ADV-05-00X). This report complements the *EBASP* Advisory, and provides a discussion of an integrated framework alluded to in that report.

physical environment interactions in a woodlot, a watershed, or an extensive landscape. Ecosystems encompass all organisms within the prescribed area, including humans, who are often the dominant element. Processes that link organisms with their physical environment are considered ecosystem processes and include primary productivity and the cycling of nutrients and water. These processes in total describe the functioning of ecosystems. Processes that link organisms with each other, indirectly influencing flows of energy, water and nutrients, can also be considered ecosystem processes, such as pollination, predation and parasitism.

“Ecosystem services” is an anthropocentric concept denoting the benefits that humans derive from the functioning of ecosystems. An operational categorization of ecosystem services has recently been proposed by the Millennium Ecosystem Assessment:

a) **Provisioning services** (products obtained from ecosystems). These include food, fuelwood, fiber, biochemicals, genetic resources and fresh water. Generally these services are traded in the open marketplace.

b) **Regulating services** (benefits received from regulation of ecosystem processes). This category includes a host of benefits that humans derive from the presence and functioning of ecosystems. These include flood protection, human disease regulation, water purification, air quality maintenance, pollination, pest control and climate control. These services are generally not marketed but many have clear value to society and this value will increase for many of these services as the many dimensions of global change proceed.

c) **Cultural services** (the nonmaterial benefits people obtain from ecosystems). Ecosystems provide cultural, spiritual and aesthetic values, and a sense of place.

d) **Supporting services**. These are the processes that maintain ecosystem functioning such as: soil formation, primary productivity, biogeochemistry, and provisioning of habitat. They all affect human well-being, but generally indirectly through their support of the provisioning, regulating and cultural service functions.

Although there are different ways in which ecosystem services can be categorized, the committee feels that the approach adopted in the Millennium Assessment is a useful approach for conveying the concept of ecosystem services and the broad array of functions and processes ecosystem services include. The ecosystem service concept is useful in many ways. First, it is a concept that is readily grasped by society, since it relates directly to human well-being. Secondly, it provides a tool for evaluating the impacts of human actions in terms of the resulting change in the benefits provided by the affected services. “Ecosystem health” can then be defined in terms of the output and sustainability of services. When defined this way, the concept of ecosystem health relates directly to the benefits provided to humans. However, life on earth can be revered and protected independent of human benefit. As discussed below, the committee recognizes that ecosystems can be valued not only because of the human-based services

they provide but also for other non-anthropocentric reasons, including respect for nature based on ethical, religious, or biocentric principles.

1.2.2 The Concept of Value

Because people define and assign values, all values are *anthropogenic*. However, as noted above, not all values are *anthropocentric*. When people talk about environmental values, the values of nature, or the values of ecological systems and services, they may have different things in mind. People have moral, economic, religious, aesthetic, and other values, all of which can affect their thoughts, attitudes, and actions toward nature in general or, more specifically, ecosystems and the services they provide.

The most basic distinction in values is the distinction between means and ends. To value something as a means is to value it for its usefulness in helping to realize or bring about some thing or state of affairs that is valued in its own right or as an end. Things valued for their usefulness as means in this sense are said to have instrumental value. Of course, it would not make sense to value anything instrumentally or as a means unless there was at least one thing or state that was valued for its own sake or as an end. Things valued as ends are sometimes said to have intrinsic value.¹¹² If intrinsic value applies to things other than human beings or human experiences, then this conception of value is non-anthropocentric. Some people defend a non-anthropocentric conception of value or goodness (Goodpaster 1978; Rolston III 1991; Taylor 1986). However, others argue that only human beings or human experiences have intrinsic value, thereby defending an anthropocentric conception of value (Glover 1984; Sidgwick 1901; Williams 1994).

Ecological systems have instrumental value to the extent that they provide useful services. Some people also claim, however, that an ecological system may have value independently of the services it provides, i.e., its very existence has value. This claim can mean several different things. If it means that the existence of an ecological system is valuable because people derive satisfaction from its existence, then it has what economists call “*existence value*.” This concept is anthropocentric. In addition, it is a kind of instrumental value, since it is based on the premise that the existence of the species or ecological system is one of many things that generate human satisfaction, and that the various things that contribute to human satisfaction are potentially substitutable. Some people, however, claim that an ecological system may have intrinsic value of its own, and that we should protect it for its own sake. If the explanation of this claim refers to reasons that are independent of the contribution that the existence of an ecological system can make to human well-being, then this claim of intrinsic value should be understood in a non-anthropocentric sense.

¹¹² There is controversy over the meaning of intrinsic value that we will not try to resolve here (Korsgaard 1996). Many people take intrinsic value to mean that the value of something is inherent in that thing. Some philosophers have argued that value or goodness is a simple non-natural property of things (see Moore 1903 for the classical statement of this position), and others have argued that value or goodness is not a simple property of things but one that supervenes on the natural properties to which we appeal to explain a thing’s goodness (this view is defended by, among others, contemporary moral realists; see (Brink 1989; McDowell 1985; Sayre-McCord 1988; Sturgeon 1985).

This committee recognizes that there are many possible sources of value derived from ecosystems and the services they provide. Thus, throughout this report, the term "value" is used broadly to include values predicated on their contributions to human society (broadly defined), as well as those based on an ethical, religious, or biocentric notion of intrinsic value.

Related to the concept of value are the concepts of "benefits" and "valuation." Both of these terms are relative to a specific change. ?? In this report, the change of interest is the change in the state of an ecosystem or the flow of services it provides stemming from an actual or proposed action by EPA. Thus, the term "ecosystem benefits" refers to the increase in the value of the ecological system and/or its services. This assumes a positive change in value. Analogously, a reduction in value, for example from damages to an ecosystem, can be viewed as a "negative benefit" or cost.

Similarly, the term "valuation" will refer to the process of characterizing or measuring benefits or changes in value using various methods and techniques. For example, economic valuation measures benefits in terms of the amount people are willing to pay (WTP) to ensure an ecological improvement or the amount people are willing to accept (WTA) to forego the improvement.¹¹³ A social/psychological assessment method might present the same ecological change and ask people to rate the importance of achieving (or preventing) that change relative to a selection of changes in a number of other (potentially competing) social goals. An ecological approach might assess the value of the targeted change in terms of the magnitude of its effect on biodiversity or some other indicator of ecological health based on the consensus that ecological health is important to human/social well-being. [I don't see ecological science as supplying a valuation](#) All of these assessments are based on an anthropocentric view of values, where ecological values are assessed in terms of their contribution to human well-being. However, they differ in terms of the means by which values are expressed, and by the extent to which the value of the targeted ecological change can then be explicitly compared (traded off) against other social values. Economic assessments claim the broadest range and most explicit method for assessing tradeoffs between, for example, ecological improvements and changes in other goods or services that also contribute to human well-being. The social/psychological methods generally settle for a relative measure of the value of the targeted ecological change and largely constrain tradeoff implications to options and circumstances that are closely related to the set of alternatives explicitly presented in the assessment. Ecological assessments might restrict tradeoff implications to the biosphere. [These are not then valuations, but a description of linkages and interconnection.](#) In all cases, the ultimate purpose of the valuation process is to characterize or measure the benefits (or costs) associated with an ecological change in a way that provides useful information about these benefits to policymakers and the public at large. The committee plans to discuss these methods, what they may offer analysts and decision makers at EPA in capturing different kinds of benefits, and their limitations and related issues in a future report.

¹¹³ A large literature exists on the use of economic valuation methods to estimate the value of changes in environmental quality. For a comprehensive description of these methods, see Freeman (1993).

1.2.3 The Importance of Assessing Ecosystem Benefits

Given the important role that ecosystems play in supporting life on earth and providing goods and services that people value, changes in the state of these systems or the flow of services they provide can have important implications. This importance has been increasingly recognized by many, both within the U.S. and internationally. The recent study by the National Research Council and the Millennium Ecosystem Assessment are indicative of this growing recognition.

Many EPA actions (e.g., regulations, rules, programs, policy decisions) affect the state of ecosystems and the flow of services derived from them. EPA actions can either lead to changes in the conditions of ecosystems (improvement or deterioration) or prevent changes that would otherwise have occurred. These impacts can occur both at a relatively small, local scale as well as more broadly at a national scale. Yet, to date, ecosystem impacts have received relatively limited consideration in EPA policy analyses. Failure to consider these impacts as fully as possible can lead to distorted policy decisions, particularly in regulatory contexts where benefits are being compared to costs. In many cases, the result will be an under-valuation of (or failure to fully recognize) the benefits of EPA actions aimed at protecting the environment. This can occur, for example, when actions are evaluated based primarily on their impacts on human health, without a recognition of potentially important ecosystem impacts.

Valuing the changes in ecological systems and services and assessing the ecosystem benefits that result from EPA policies or programs is challenging for a number of reasons. Major challenges include: a) understanding the many sources of value that ecosystems generate, b) predicting the ecological impacts of alternative EPA actions, and expressing those predictions in the temporal and spatial scale most appropriate for decision-making, c) linking those impacts to changes in the dimensions of ecosystems or the service flows that people value, d) developing methods and techniques that can be used to characterize and/or measure the value of protecting ecological systems and services so that they may be incorporated or properly reflected in environmental decisions and policies, e) aggregating to a national level using local or regional studies from regions with different ecological and/or economic characteristics, and f) finding measures or means of representing ecological values or benefits that are commensurable with values of non-ecological changes caused by EPA actions, such as human health. Despite these challenges, it is imperative that EPA improve its ability to assess ecosystem benefits to ensure that ecological impacts are adequately considered in the evaluation of EPA actions.

ECOSYSTEM VALUATION AT EPA

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There are several different contexts in which EPA policy decisions have ecological impacts and hence in which the need for ecosystem benefits assessment will arise. In addition, when assessing benefits, EPA must operate within a set of institutional, legal, organizational and practical constraints that affect this process at the Agency. Thus, EPA has specific needs in this regard that must be recognized and addressed. These needs arise in different parts of the Agency for different purposes and for different audiences. Some of the needs present structured requirements for valuing protection of ecological systems and services, while needs in other contexts are less prescriptive.

Policy Contexts at EPA Where Ecosystem Valuation Can be Important

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The most prescriptive requirements are for national rule making. Benefit assessments are required for national rulemaking by two of EPA's governing statutes (the Toxic Substances Control Act and the Federal Insecticide, Fungicide and Rodenticide Act) and by Executive Order 12866 for "significant regulatory actions". The circular on "Regulatory Analysis" issued by the Office of Management and Budget (OMB) in September 2003, *OMB Circular A-4*, identified key elements of a regulatory analysis for such "economically significant rules." One of these elements is an evaluation of the benefits and costs of a proposed regulatory action and the main alternatives identified. The circular provided general guidance on how to provide monetized, quantitative, and qualitative information to fully characterize benefits and EPA itself has developed initial guidance for ecological benefit assessment (U.S. Environmental Protection Agency 2000). In developing its draft *Ecological Benefits Assessment Strategic Plan* and in discussions with the committee (U.S. Environmental Protection Agency Science Advisory Board 2003), EPA identified the need for improved models and methods to help implement the requirements of the circular. The Agency identified needs both to expand methods and data for economic valuation through benefit-cost or cost-effectiveness analysis and to explore other assessment methods to provide information on ecological effects that are currently un-monetized and assigned an implicit value of \$0. Managers seek approaches that are "sound, credible, and scientifically supportable" as well as flexible, affordable, and able to be implemented within the time constraints required by rulemaking (U.S. Environmental Protection Agency Science Advisory Board 2004).

EPA's regional offices, although generally not responsible for national rule-making, are responsible for several kinds of decisions and activities where the benefits of ecological protection come into question:

- Priority setting for regional action, such as targeting projects for wetland restoration and enhancement or identifying critical ecosystems or ecological resources for regional attention
- Setting Supplemental Environmental Protection (SEPs) penalties for enforcement cases where those penalties involve protection of ecological systems and services

- Choice of options for Superfund and Resource Conservation and Recovery Act (RCRA) cleanups that could take ecological benefits into account
- Review of Environmental Impact Statements prepared by other federal agencies to comply with the National Environmental Protection Act
- Assisting state and local governments and other federal Agencies with protecting lands and land uses, where assessment of the value of protection options could help decision-makers make better-informed decisions.

Regions seek low-cost methods that can be implemented quickly to inform "place-based" decisions. They seek methods that provide information on the value of ecological services; ecological diversity; conservation opportunities and threats; sustainability; and historical and cultural values associated with ecological systems or parts of ecosystems at the watershed or landscape scale. Regions experience the need to communicate the value of ecological protection as they collaborate with other federal agencies and with government partners at the local, state, and regional levels.

EPA's need to communicate the value of its ecological protection programs has two dimensions: 1) a retrospective dimension, because assessments focus on the value of EPA's current and past protection efforts and 2) a prospective dimension, because such assessments are meant to inform decisions about future EPA programs and priorities.

The need to assess the ecological benefits of policy options is woven into most of the Agency's decisions, including the assessment of ecological protection programs. Program assessments are mandated for EPA, as they are for all agencies of the executive branch, by the Government Performance and Results Act of 1993. As part of that assessment, OMB requires EPA to periodically identify its strategic goals and describe both the social costs and budget costs associated with them. EPA's Strategic Plan for 2003-2008 described the current social costs and benefits of EPA's programs and policies under each strategic goal area for the year 2002 (U.S. Environmental Protection Agency 2003). This analysis repeatedly points out that EPA lacks data and methods to quantify the ecological benefits associated with the goals in its strategic plan.

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In addition, the Government Performance Results Act of 1993 established requirements for assessing the effectiveness of federal programs. Part of that assessment involves assessing the outcomes of programs intended to protect ecological resources. EPA must report annually on its progress in meeting program objectives linked to strategic plan goals and must engage periodically in an in-depth review [through the Program Assessment Rating Tool (PART)] of selected programs to identify their net benefits and to evaluate their effectiveness in meeting meaningful, ambitious program outcomes. Characterizing ecological benefits associated with EPA programs is a necessary part of the program assessment process.

Institutional and Other Issues Affecting Benefits Assessment at EPA

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The committee recognizes that ecological benefits assessment at EPA must be conducted within a set of institutional, legal, organizational, and practical constraints that affect what is and can be done to incorporate ecosystem values into policy evaluations.

In an effort to better understand these issues and their implications for the committee's charge, the committee conducted a series of interviews with Agency staff.¹¹⁴ The interviews were focused on the process of developing benefit analyses for Regulatory Impact Assessment (RIA) for rulemaking and the relationship between EPA and the Office of Management and Budget. However, many of the questions raised are equally applicable to strategic planning, performance reviews, regional analysis, and other situations in which the agency is called upon to assess the value of ecosystems. Below are some key observations made by the committee based on those interviews.

EPA Program Offices responsible for new rules initiate, finance, and administer the process for developing ecological benefit assessments. The development of a new rule – including definition of the rule itself, options to be weighed, and the assessment of impacts arising from the rule – involves much more than scientific assessment. Political negotiations and legal analysis arguably dominate the process. EPA has a formal rule-development process with several stages, each which impose demands on the Agency and the Agency also develops rules to meet court-imposed deadlines.

Several aspects of these imposed constraints deserve emphasis. First, despite the commonality of the underlying rule-development process, it is clear that there is no single way in which ecological valuation is conducted within the Agency. Practices vary considerably across program offices, reflecting differences in mission, in-house expertise, etc. Program offices have different statutory and strategic missions. The organization, financing, and skills of the program offices differ enormously. The National Center for Environmental Economics (NCEE) is the Agency's centralized reviewer of economic analysis within the agency.¹¹⁵ However, the primary expertise and development of the rules resides within the program offices.

Secondly, the timing of the process largely determines the kinds of analytical techniques that are employed. This is related to court-imposed deadlines on the rule process, as well as intervening requirements related to the collection and analysis of new data. The scientific community is used to much longer time horizons for their analyses. They are also used to the idea that a new rule should call for the collection of new kinds of data. Unfortunately, collecting new data poses a significant bureaucratic problem for the Agency. To collect original data, the Agency must submit an Information Collection Request, which is reviewed within the Agency and by OMB. This hurdle alone can add significant drag to the assessment process. With perhaps a year or two at most to conduct

¹¹⁴ These interviews were conducted by one Committee member, Dr. James Boyd, in conjunction with the Designated Federal Officer, Dr. Angela Nugent, over the period September 22, 2004 through November 23, 2005. In seven sets of interviews, Dr. Boyd spoke with staff from the Office of Policy, Economics and Innovation, Office of Water, Office of Air and Radiation, Office of Solid Waste and Emergency Response.

¹¹⁵ NCEE is typically brought in by the program offices to both help design and review RIAs. NCEE can be thought to provide a centralized "screening" function for rules and analysis before they go to OMB. NCEE is actively involved in discussions with OMB as rules and supporting analysis are developed and advanced.

a study, this kind of review significantly limits the kind of analysis the Agency can conduct.

A third issue is the role of the Office of Management and Budget (OMB) in defining or directing ecosystem valuation exercises at EPA. It was difficult for the committee to ascertain the EPA-OMB relationship precisely.¹¹⁶ EPA has been given explicit guidance by OMB in the Circular A-4, which the committee views as a reasonable document on its own because of its call for a full characterization of the impacts of different policy options and inclusion of language calling for characterization of benefits that cannot be monetized or cannot be quantified (Office of Management and Budget 2003)¹¹⁷. However, the implications of some sections of the Circular, particularly relating to the treatment of benefits that cannot be readily monetized, remain somewhat ambiguous. For a benefit or cost that cannot be expressed in monetary terms, the Circular instructs Agency staff to “try to measure it in terms of its physical units,” or, if this is not possible either, to “describe the benefit or cost qualitatively.” However, little guidance is provided on how this should be done. Instead, the Circular urges regulators to “exercise professional judgment in identifying the importance of non-quantified factors and assess as best you can how they might change the ranking of alternatives based on estimated net benefits.”

It is clear that the Agency views the OMB as a kind of “court” that reviews its analysis. In front of this “court,” methods that have been accepted in the past create incentive for the use of the same or similar methods in the future. The thinking seems to be “if it made it through OMB once, it will make it through again.” There appears to be a pronounced tendency to use “off-the-shelf” methods to avoid problems with OMB. This creates a bias toward the *status quo* and a reluctance to explore new or innovative approaches. To this end, the committee sees the need to strike an appropriate balance between the use of established methods and the possible need to innovate in an effort to conduct more comprehensive and defensible benefit assessments for use in decision making and evaluation.

A related issue involves RIA review by external parties. The Agency does not take a standardized approach to RIA review.¹¹⁸ EPA staff and managers reported that peer review was focused only on “novel” elements of an analysis. This raises the question of how the Agency (and perhaps OMB) defines “novel.” Moreover, the novelty

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¹¹⁶ OMB responded to written questions, but declined to be interviewed by Dr. Boyd. EPA staff were informed that their formal responses to all questions, including the OMB-EPA interview were to be documented as part of the Committee report and this is likely to have had a chilling effect on the discussions.

¹¹⁷ eg., see pp.27 “If monetization is impossible, explain why and present all available quantitative information” and, pp “If you are not able to quantify the effects, you should present any relevant quantitative information along with a description of the unquantified effects, such as ecological gains, improvements in quality of life, and aesthetic beauty.”

¹¹⁸ In some cases, review panels are appointed, in others not. In some cases, contractors are called upon to manage the review. In other cases, Program Offices themselves manage the review process.

standard actually creates a clear incentive to avoid conducting novel analyses (however defined). It is clearly cheaper and quicker to avoid review altogether. The committee advises the Agency to consider whether there is a role for a standing expert body that can bring consistency to the review of analysis, avoid duplication of review, and be sensitive to timing and resource constraints.

Finally, the committee notes the importance of organization of assessment science within the Agency. Currently, the Agency relies upon a variety of offices to develop assessments, with varying degrees of reliance on other offices (e.g., NCEE) or outside assistance.¹¹⁹ It is not clear which work better than others. In addition, it is not clear how different programs integrate social science and biophysical science.¹²⁰

Do we want to advocate a “ecosystem services valuation paradigm” and/or development of a set of guidelines for doing ecosystem valuation? Relationship to risk assessment paradigm/guidelines??? See more on this in footnote below.

An Illustrative Example of Ecosystem Benefit Assessment at EPA

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In an effort to better understand the current state of ecosystem valuation at EPA, the committee examined in detail one specific case where benefit assessment was undertaken, namely, the *Environmental and Economic Benefits Analysis* that EPA prepared in support of new regulations for Concentrated Animal Feeding Operations (CAFOs) (U.S. Environmental Protection Agency 2002).^{121,122} The Agency indicated

¹¹⁹ Another issue that relates to the organization of science within the Agency is the availability and location of data to support ecosystem valuation. The choice of methods is clearly related to the practical availability of data across the Agency. It is important that data that are housed within individual program offices are made public and readily shared with other offices.

¹²⁰ One anecdote is that Dr Boyd was able to speak with only one ecologist during the interviews designed (in part) to interview a set of ecologists. Economists in the agency were not able to identify ecologists to interview, for example. It also became clear that simple “counts” of professional background can be deceptive. What the agency terms an “ecologist” is not necessarily what the scientific community would call an ecologist.

¹²¹ The Committee reviewed and critically evaluated the Environmental and Economic Benefits Analysis at its June 15, 2004 meeting. As stated in the Background Document for SAB Committee on Valuing the Protection of Ecological Systems and Services for its Session on June 15, 2004, the purpose of this exercise was “to provide a vehicle to help the Committee identify approaches, methods, and data for characterizing the full suite of ecological ‘values’ affected by key types of Agency actions and appropriate assumptions regarding those approaches, methods, and data for these types of decisions.” The Committee based its review on EPA’s final benefits report (EPA 2002) and a briefing provided by the EPA Office of Water staff. During the June meeting, members of the Committee divided into two workgroups. The workgroups each worked independently and reported their findings to the combined Committee. The leaders of the two working groups then prepared a consolidated summary of comments from the two workgroups.

¹²² In December 2000, EPA proposed a new CAFO rule under the federal Clean Water Act to replace 25-year-old technology requirements and permit regulations (66FR 2959). EPA published its final rule in December 2003 (68 FR 7176). The new CAFO regulations, which cover over 15,000 large CAFO operations, reduce manure and wastewater pollutants from feedlots and land applications of manure and remove exemptions for stormwater-only discharges.

that this analysis was typical of other EPA regulatory analyses of ecological benefits in form and general content.

Because the proposed new CAFO rule constituted a “significant regulatory action” under Executive Order 12866, EPA was required to assess the costs and benefits of the rule.¹²³ EPA identified a wide variety of potential “use” and “non-use” benefits as part of its analysis.¹²⁴ Using various economic valuation methods, EPA provided monetary quantifications in its CAFO report for seven environmental benefits.¹²⁵

Approximately eighty-five percent of the monetary benefits quantified by EPA were attributed to recreational use and non-use of affected waterways. According to Agency staff, EPA’s analysis was driven by what it could monetize. EPA focused on those benefits for which data were known as available for quantification of both the baseline condition and the likely changes from the proposed rule, and translation of those changes into monetary equivalents. EPA’s final benefits assessment provides only a brief discussion of the benefits that it could not monetize. The benefits table in the Executive Summary listed a variety of non-monetized benefits¹²⁶ but designated them only as “not monetized.” EPA represented the aggregate effect of these “substantial additional environmental benefits” simply by attaching a “+B” place-holder to the estimated range of total monetized benefits. Although the Executive Summary gave a brief description of these “non-monetized” benefits, the remainder of the report devotes little attention to them.

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¹²³ Prior to publishing the draft CAFO rule in December 2000, EPA spent two years preparing an initial assessment of the costs and benefits of the major options. After releasing the draft rule, EPA spent another year collecting data, taking public comments, and preparing assessments of new options. EPA published its final assessment in 2003. An intra-agency team at EPA, including economists and environmental scientists in the Office of Water, Office of Air and Radiation, Office of Policy Economics and Innovation, and Office of Research and Development, worked on the benefit assessment. EPA also worked with the U.S. Department of Agriculture in developing the assessment. Dr. Christopher Miller of EPA’s Office of Water estimated that EPA spent approximately \$1 million in overall contract support to develop the benefit assessment. EPA spent approximately \$250,000-\$300,000 on water quality modeling as part of the assessment.

¹²⁴ The potential “use” benefits included in-stream uses (commercial fisheries, navigation, recreation, subsistence, and human health risk), near-stream uses (non-contact recreation, such as camping, and nonconsumptive, such as wildlife viewing), off-stream consumptive uses (drinking water, agricultural/irrigation uses, and industrial/commercial uses), aesthetic value (for people residing, working, or traveling near water), and the option value of future services. The potential “non-use” values included ecological values (reduced mortality/morbidity of certain species, improved reproductive success, increased diversity, and improved habitat/sustainability), bequest values, and existence values.

¹²⁵ These benefits were recreational use and non-use of affected waterways, protection of drinking water wells, protection of animal water supplies, avoidance of public water treatment, improved shellfish harvest, improved recreational fishing in estuaries, and reduced fish kills.

¹²⁶ These include eutrophication of estuaries; reduced pathogen contamination of drinking water supplies; reduced human and ecological risks from hormones, antibiotics, metals, and salts; improved soil properties from reduced over-application of manure; and “other benefits”.

Although much effort was invested in the CAFO benefits assessment, the assessment illustrates a number of limitations in the current state of ecosystem valuation at EPA.

First, EPA's analysis and report focused nearly exclusively on meeting the requirements as described in Executive Order 12866. This may not be surprising since the Executive Order provided the reason for preparing the analysis and report. However, when EPA prepares a benefit assessment specifically to comply with Executive Order 12866, the Agency need not limit itself to the goals and requirements of the Executive Order. The Executive Order does not preclude EPA from adopting broader goals. The Executive Order provides merely that EPA shall conduct an "analysis" and "assessment" of the "benefits anticipated from the regulatory action" and, "to the extent feasible, a quantification of those benefits." By adopting a narrow focus, the report failed to consider or reflect the broader purposes that a benefit assessment can serve. Environmental benefit assessments, such as the CAFO study, can serve a variety of important purposes, including helping to educate policy-makers and the public more generally about the benefits that stem from EPA regulations.

Second, as noted above, in implementing the Executive Order, the CAFO analysis did not provide the full characterization of ecological benefits using quantitative and qualitative information, as required by the OMB Circular A-4. Instead, the report focused on a limited set of environmental benefits, driven primarily by the ability to monetize these benefits using generally accepted models and existing value measures (benefit transfer).¹²⁷ These benefits did not include all of the major environmental benefits that the new CAFO rule would likely generate, nor all of the benefits that generated public support for the new rule.¹²⁸ The Circular requires that a benefit assessment identify and characterize all the important benefits of the proposed rule, not simply those that can be monetized. By focusing only on a narrow set of benefits, the CAFO analysis and report understates the benefits of the rule change and distorts the rationale supporting the final rule.¹²⁹ An unfortunate effect of this presentation is to

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¹²⁷ EPA apparently conducted no new economic valuation studies (although a limited amount of new ecological research was conducted) and did not consider the possible benefits of developing new information where important benefits could not be valued in monetary terms based on existing data. The CAFO report emphasizes EPA's predisposition toward conservative benefits estimates and identifies the lack of adequate data and/or models meeting EPA standards of quality as a basis for truncating the CAFO analysis.

¹²⁸ For example, while the report notes the potential effects of discharging hormones and other pharmaceuticals commonly used in CAFOs into drinking water sources and aquatic ecosystems, the nature and possible ecological significance of these effects is not adequately developed or presented. Similarly, the report does not adequately address the well-known consequences of discharging TMC precursors into drinking-water sources.

¹²⁹ One of the benefits of monetary benefit estimates obviously is the ease of aggregating them by simple arithmetic. However, the Committee does not believe that reporting that a rule produced a total of "218.9 million dollars in annual benefits" is necessarily more useful, meaningful, or defensible for environmental policy than reporting, for example, the achievement of a "10% reduction in the pollution of over 129,000 miles of streams and rivers, 3.2 million acres of lakes and ponds, and 2,800 square miles of estuaries."

suggest to readers that the monetized benefits constitute the principal justification for the CAFO rule.¹³⁰ Although in this case the focus on monetized benefits did not affect the outcome of the regulatory review, it is certainly possible that in a different context, this conservative approach to benefits assessment (based only on easily monetized benefits) could inadvertently undermine support for a rule that would be justified based on a more inclusive characterization of benefits.

Third, the monetary values for many of the emphasized benefits were estimated through highly leveraged benefit transfers that were generally based on dated studies conducted in contexts quite different from the CAFO rule application.¹³¹ This was undoubtedly driven to a large extent by time, data, and resource constraints, which make it very difficult for the Agency to conduct new surveys or studies and virtually force the Agency to monetize benefits using existing value estimates. However, reliance on dated studies in quite different contexts raises questions about the credibility or validity of the monetary benefit estimates. This is particularly true when values are presented as point estimates, without adequate recognition of the underlying limitations, due to uncertainty and data quality.

Fourth, EPA apparently did not engage in a detailed and systematic effort at the outset to model the rule's ecological impacts. The report presents only a simple conceptual model that traces outputs (a list of pollutants in manure – Exhibit 2-2 in the CAFO report) through pathways (Exhibit 2-1) to environmental and human health effects.¹³² This model provided useful guidance, but was not sufficiently detailed to assure an adequately comprehensive and balanced analysis of the rule's ecological impacts. As a consequence the analysis was unduly directed by Agency presumptions (or discoveries) about the availability of relevant data and the likely opportunities to quantify effects precisely and to link and monetize associated benefits. This was undoubtedly driven in part by the time pressures of putting together the regulatory impact analysis. However, without a detailed and comprehensive modeling effort at the outset, EPA had insufficient insight into the potential benefits that needed to be analyzed and valued. Developing integrated models of relevant ecosystems at the outset of a valuation project would also help in identifying

¹³⁰ In the case of this CAFO rule, 97% of the monetized benefits arise from recreation (boating, swimming and fishing) and from private well owners' willingness to pay for water quality, estimated using contingent valuation or travel cost methods.

¹³¹ EPA used estimates based on a variety of public surveys in its benefit transfer efforts, including: a national survey (1983) that determined individuals' willingness to pay for changes in surface water quality relating to water-based recreational activities (Section 4 of the CAFO Report); a series of surveys (1992, 1995, 1997) of willingness to pay for reduced/avoided nitrate (or unspecified) contamination of drinking water supplies (Section 7); and several studies (1988, 1995) of recreational fishers' values (travel cost, random utility model) for improved/protected fishing success related to nitrate pollution levels in a North Carolina estuary (Section 9).

¹³² Although EPA later prepared more detailed conceptual models of the CAFO rule's impact on various ecological systems and services, EPA did not prepare these models until after the Agency finished its analysis.

important secondary effects, which frequently may be of even greater consequence or value than the primary effects.¹³³

Fifth, the CAFO analysis clearly demonstrates the challenges of conducting ecological benefit assessments at the national level.¹³⁴ National rule-makings inevitably require EPA to generalize away from geographic specifics, both in terms of ecological impacts and associated values. However, it is possible (and desirable) to make use of intensive case studies (e.g., individual watersheds, lakes, streams, estuaries) in support of the national-scale analyses. Existing and ongoing research at local and regional scales offers more detailed data and models that could be better exploited, both to fill in gaps and to systematically validate the national-scale analyses. Systematically performing and documenting comparisons to intensive study sites could indicate the extent to which the national model needs to be adjusted for local/regional conditions and could provide data for estimating the range of error and uncertainty in the projected national-scale effects.

Sixth, although EPA invited public comment on the draft CAFO analysis as required by Executive Order 12866, there is no indication in the draft CAFO report that EPA consulted with the public during its analysis to help it identify, assess, and prioritize the effects and values addressed in its analysis, nor is there discussion in the final CAFO analysis of any comments received on the draft CAFO analysis. Early public involvement could play a valuable role in helping the Agency both a) identify all of the systems and services impacted by the proposed regulations and b) determine the regulatory effects that are likely to be of greatest value. This would ensure that the benefits assessment includes the most important impacts.

Finally, while EPA in its analysis and report appropriately emphasized the importance of using outside peer-reviewed data, methods, and models, EPA did not seek to peer review its application of them or its integration of these components in deriving benefit values for the CAFO rule. Once again, this is undoubtedly due in part to time and resource constraints. However, peer review, especially early in the process, would help EPA staff identify relevant and available data, models, and methods to support its analysis, and provide encouragement, direction, and sanction for more vigorous and effective pursuit of ecological and human wellbeing effects associated with the proposed rule. The general idea is to have individual components of the analysis (e.g., watershed modeling, air dispersal, human health, recreation, aesthetics) each reviewed, as well as a more general review of the overall analytic scheme.

¹³³ Contamination of estuaries, for example, might negatively affect fisheries in the estuary (a primary effect) but might have an even greater impact on offshore fisheries that have their nurseries in the estuary (a secondary effect).

¹³⁴ The goal of EPA's analysis was a national level assessment of the effects of the CAFO rule. This involved the effects of approximately 15,000 individual facilities, each contributing pollutants across local watersheds into local and regional aquatic ecosystems. A few intensive case studies were mentioned in the report and used to calibrate the national scale models (e.g., NWPCAM, GLEAMS), but there was no indication that these more intensive data sets were strategically selected or used systematically for formal sensitivity tests or validations of the national-scale model results.

AN INTEGRATED AND EXPANDED APPROACH TO ECOSYSTEM VALUATION

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The CAFO example discussed above highlights a number of limitations to the current state of ecosystem valuation at EPA. The committee's analysis points to the need for a comprehensive, integrated approach to valuing the ecological impacts of EPA actions, one that focuses on the impacts of most concern to people and integrates ecological analysis with valuation. This section describes a proposed framework, based on the committee's deliberations to date. A more detailed discussion of the methods that could be used to implement this framework and the issues that arise in doing so will be provided in a subsequent committee report. The goal in this report is simply to provide an organizing framework to guide the more detailed discussion regarding implementation.

A key feature of the framework outlined here is that it integrates ecological analysis with valuation. This integration needs to occur both at an early stage (in the identification of the impacts that matter) and at a later stage (when estimating the value of impacts). Thus, instead of having ecologists work independently initially to estimate ecological impacts and then "pass the baton" on to economists or other social scientists to value those impacts, it envisions collaborative work across disciplines to ensure that the analysis focuses on the impacts that are of greatest concern and that the ways in which these impacts are defined and measured are informative during the selection and, if necessary, design of the valuation techniques/methods. Such a framework requires a committed dialog among the relevant bio-physical, ecological, and social/economic scientists and analysts. The various disciplines must reach out to establish useful and credible links to each other. This interaction should commence at the beginning of the process and continue until the completion of the analysis. Ecological models need to be developed, modified, or extended to provide usable inputs for value assessments. Likewise, valuation methods and models need to be developed, modified, or extended to address important ecological/bio-physical effects that are currently underrepresented in value assessments.

In addition, the framework envisions the use of a variety of methods to characterize and measure benefits or values, including economic methods, social/psychological assessments, and ecological approaches. ?? The suite of methods to be used will vary with the specific policy or valuation context, due to differences across contexts in: a) information needs, b) the underlying sources of value being captured; c) data availability; and d) methodological limitations. The framework should serve as a guide to EPA staff as they conduct RIAs and seek to implement the provisions of Circular A-4 (including the provisions relating to benefits that are not readily quantified or monetized), as well as in regional decision-making and program assessment.

The proposed framework has three main components: a) identify the context and scope of the benefit assessment, b) identify the ecological services that will be considered in the assessment, and c) characterize, represent or measure those impacts in bio-physical, human, and/or monetary terms. This proposed framework would parallel the Agency's Framework for Ecological Risk Assessment (U.S. Environmental Protection

Agency Risk Assessment Forum 1992) and ultimately be merged with it as part of a broader framework for ecological assessment.

Context and Scope

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As noted above, ecological benefit assessment can play a key role in a number of different decision contexts, including national rule-making, local/regional decision-making, and program evaluation. There is a need to formulate the benefit assessment problem within the specific EPA context. These contexts differ not only in the required scale for the analysis (e.g., national vs. local) but possibly also in the type of valuation information that is needed, i.e., whether it requires that benefits be characterized or measured in terms of bio-physical impacts, or the resulting impacts on humans, or both.

The information needed for a given policy decision will in turn depend on the decision approach to be used in evaluating alternatives. The rule to be used could be dictated by statute, regulation, or executive order, or could be determined by the EPA staff. Possible approaches include maximization of (expected) net present value (based on cost-benefit analysis), minimization of the (expected) cost of meeting a given goal (cost-effectiveness), use of a safe minimum standard, use of the precautionary principle, or use of a moral or rights-based rule based on intrinsic value. For example, the Endangered Species Act is based on an underlying presumption that species should be preserved (either because of high existence value or high intrinsic value), and hence the value information necessary to support decisions in this context can be expressed solely in bio-physical terms. ?? In contrast, if a strict cost-benefit rule is to be used in a rule-making context, aggregate dollar values of benefits (and costs) are needed. Under a broader interpretation (e.g., OMB Circular A-4), use of cost-benefit analysis would require that ecological benefits be a) measured in dollar terms when possible, b) measured using other metrics for impacts on humans (e.g., population affected) when monetary valuation is not possible, and c) fully described in qualitative terms, when quantitative information is not available.

Ecological Services to be Included

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Decisions about the ecological services to be included in the analysis should be based on an assessment of the impacts that are likely to be most important, depending on both the magnitude and bio-physical importance of the effect and the resulting impact on humans.

3.2.1 Identifying Potentially Important Bio-Physical Impacts. The bio-physical impacts of a given EPA action can be identified at different levels. These include the individual level, the population level, the community level, the ecosystem level (union of biological populations with their surrounding physical environment), and the level of the global biosphere. Ecological science is organized according to these scales. For the purposes of ecological benefits assessment, ecological impacts correspond to changes in functions or services provided by the ecosystem, as described above. Living organisms supply goods and services that differ across all levels of organization, from the individual to the ecosystem or global biosphere. For example, the

service provided by an individual animal unit is different from the service provided by a given animal population.

Many types of ecological models exist at various levels (e.g., population, community, ecosystem, biosphere) to predict impacts of perturbations on ecosystems. Some have been developed for specific contexts (species, geographic locations) while others are more general. In some cases “off-the-shelf” models may be available, while in others existing models may need to be modified or new models developed. **(what should we say about the current state of ecological modeling??? We need the committee to discuss and come to some agreement about this.)**

do we then also wish to say something about the current state of economic modeling we should say simply that:

The many ecological models that now exist provide a rich basis for developing particular models specialized for the various rule-making and other administrative actions EPA must consider. The EPA should, as a matter of ordinary practice, plan to formulate mathematical models of the systems to which its actions pertain. It needs to acquire the expertise, both in house and through use of consultants, to carry out this part of its mission.

In identifying possible impacts, it is important to consider their full range, including both primary and secondary effects, adequately accounting for uncertainty, stability of the system (including the effect of random shocks and management errors), heterogeneity within a population or ecosystem, heterogeneity across populations or ecosystems, and dynamic changes in the ecosystem over time.

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3.2.2 Identifying What Matters to People. For benefit assessments based on anthropocentric values, it is important to identify early in the process what people care about, i.e., which ecological services or functions are important to them. For example, are individuals likely to value the re-introduction of native grasses into a marshland, or would they be just as happy with non-native grasses that perform similar ecological functions and aesthetic appeal? Is animal waste disposal a concern to people primarily because of the recreational opportunities lost due to the resulting deterioration in water quality, or are they primarily concerned about other impacts? The range of services that are the focus of the benefits assessment needs to include the services people care most about. Previous benefit assessments have often focused on what can be measured relatively easily rather than what is most important to people. This diminishes the relevance, usefulness and impact of the assessment.

Information about what matters to people can be obtained in a variety of ways. Examples include survey information (from past surveys or surveys conducted specifically for the benefit assessment) or the results of previous valuation studies. In addition, early public involvement¹³⁵ or use of focus groups or workshops comprised of

¹³⁵ This could include either a robust public involvement process following Administrative Procedures Act requirements (e.g., FR publication), or some other public involvement process [see EPA's public

representative individuals from the affected population and relevant scientific experts can help to identify relevant or potentially important ecological services for the specific context of interest. **(Add something about group processes here?)**

In eliciting information about what matters to people, it is important to bear in mind that what people say they care about depends on both their preferences and their information, i.e., the extent to which they are informed about an ecological system and the services it provides. Survey respondents or even members of a focus group may have preferences that are representative of the general population but may not be fully informed. Expressions of what is important (e.g., in surveys) can change with the amount of information provided. Collaborative interaction between analysts and public representatives can ensure that respondents have sufficient information when expressing preferences. **(Add something about constructed preferences here?)**

The information about those ecosystem functions and services that are important to people and potentially impacted significantly should then be integrated to select the services to include in the assessment. As noted above, this requires a collaborative effort and dialogue among analysts from a variety of disciplines early on in the valuation process.

Measuring Benefits

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Given the services to be included in the assessment, the impact of the EPA action on those services needs to be characterized and, when possible, measured or quantified. To measure impact on humans, the bio-physical measures of ecological impact need to be translated into their effects on the goods and services provided by those ecosystems to humans. These impacts can be measured in non-monetary terms (e.g., population affected, duration of effect, etc.) or, in contexts where benefits are to be compared directly to costs, in monetary terms if possible.

Estimating bio-physical impacts requires information about the ecological production function for the services being considered. This allows an estimation of the *change* in the level of services that could result from a given EPA action or policy. (e.g., percent reductions/avoidances of pollution in streams and lakes, reduced/avoided eutrophication of estuaries, reduced risk from the introduction of hormones and antibiotics into aquatic systems, improved/protected quality of community drinking water sources). As when selecting the services to be considered, in estimating the effect of a given action on those services, it is crucial to account for stability of the system (ability to recover from random shocks and management errors), heterogeneity within a population or ecosystem, heterogeneity across populations or ecosystems, and dynamic changes in the ecosystem over time.

In some contexts (e.g., endangered species) where bio-physical impacts are the primary concern, ?? huh the benefit assessment can end with quantification of the impact

involvement policy. (U.S. Environmental Protection Agency Office of Policy 2003) and the SAB report on science and stakeholder involvement (U.S. Environmental Protection Agency Science Advisory Board 2001)].

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of the EPA action on these bio-physical indicators. I doubt this very much. However, when EPA policies are to be evaluated in terms of impact on humans, the bio-physical effects must be translated into the corresponding impacts on the flow of goods and services that humans value. First and foremost, this requires that the output from the ecological impact assessment be in a form that can be used as an input in estimating the value of the change in ecosystem services.

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To translate bio-physical impacts into human benefits, it is necessary to project how ecosystem changes will affect humans through changes in the flow of the goods and services they provide. The extent of the impact on humans can be measured in non-monetary terms using a variety of metrics, such as the number and characteristics of the people/communities affected, the number significantly affected, the likely symptoms avoided or reduced, and the duration of the impact.

Estimation of impact on humans in terms of the extent of exposure or similar measures is crucial in three possible ways. First, in some contexts, decisions based on moral or religious principles may look directly to these measures as indicators of the appropriate policy choice. Second, even in contexts where monetary measures of value are sought, the human benefits captured by information on exposure or symptoms need to be translated into their monetary equivalents. This requires an understanding of those impacts on humans before this translation can occur. Third, in some cases where monetary values are sought, it may not be possible to monetize all benefits due to data or methodological constraints. In these cases, there may be a tendency simply to “ignore” the benefits that cannot be monetized. Using methods that defensibly report the magnitude and human significance of such effects, rather than ignoring them, would allow the policymakers to draw their own conclusions regarding the associated potential value or benefit. Thus, in all of these cases, estimates of the impact of the ecosystem change on human populations are needed.

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In contexts where monetary metrics are sought and the necessary data and methods exist, the impact of the ecosystem change on the provision of services to human populations can be translated into a monetary equivalent of that change using standard economic valuation techniques to determine the tradeoffs that people are willing to make. Economic or monetary methods for valuing changes are relatively well-developed. They are designed to estimate the benefit or cost of a given change in ecological services using a willingness-to-pay or willingness-to-accept measure of the utility equivalent of that change. These methods have been applied to the valuation of ecosystem services in a number of studies that have produced results that are useful for policy evaluation. However, as in the CAFO study, monetary valuation methods have generally been applied to a relatively narrow set of services. In some cases, these might not have been the services that people are most concerned about protecting. There is a need to expand the range of services to which economic valuation is applied.

As with ecological impacts, in estimating the values of impact on humans in either monetary or non-monetary terms, it is necessary to address cross-cutting issues such as uncertainty (randomness, level of information), dynamics, scale (temporal, geographic), and heterogeneity (spatial variability, heterogeneity across people). In

subsequent reports, the committee will assess the challenges of uncertainty arising out of data limitations, theory limitations, and randomness, and will recommend approaches for reducing uncertainty and conveying the magnitude and nature of uncertainty to policymakers.

11. Mark Sagoff

I have comments on two sections, 1.2.1 and 1.2.2. Consider the first sentence in 1.2.1:

“The term ‘ecosystem’ describes the organisms in a given area interacting with their physical environment as a functional unit.” (lines 1-2)

This statement includes as an ecosystem any area whatsoever that is not biologically sterile. The statement entails that any place, however circumscribed, where organisms interact with their physical environment counts as an ecosystem. The clause “as a functional unit” adds nothing. How do you tell when organisms interacting with their physical environment do or do not constitute a “functional unit”?

According to Scripture, natural ecosystems were designed for the function of supporting life, i.e., providing ecosystem services (Genesis 1, 28; Matthew 26, 28). If we are not Creationists, however, then how do we characterize the sense in which natural ecosystems are functional units? What is their function? In what sense are they even units? The concept of organisms *interacting with each other and their physical surroundings* seems to be all that is meant by a *functional unit*. Organisms – unlike ecosystems – are functional units. They are shaped by random mutation and natural selection for the function of reproduction. Ecosystems, in contrast, are not units of selection and thus not units of any kind; they may be affected by evolutionary processes but they are not shaped or formed into units or systems by them. Absent intelligent design, there is no way to make sense of the idea that natural ecosystems are functional units.

The idea that natural ecosystems constitute “functional units” is a holdover from either Creationism or its secularized version, the Clementsian superorganism.

Mark Davis and Lawrence Slobodkin (2004) speak for every empirically-minded ecologist when they state that “ecological communities and ecosystems lack any intrinsic evolutionary or ecological purpose.” Natural ecosystems have no function; therefore, they are not functional units. “A community or ecosystem does not possess distinct boundaries nor does it have mechanisms that have evolved to regulate particular processes.” Davis and Slobodkin agree with Robert V. O’Neill (2001), therefore, that it is time to bury the ecosystem concept.

The document characterizes ecosystem services in a way that excludes nothing. For example, the room in which we meet will be heated or air-conditioned depending on the season. Are heating and air conditioning ecosystem services? Recall that ecosystems “encompass all organisms within the prescribed area, including humans, who are often the dominating element.” Well, air conditioning is definitely one way organisms, in this case, humans, interact with their physical environment. The building, the city, etc. are all ecosystems, so air conditioning is an ecosystem service. Likewise, grain produced by factory farms, bacon fabricated by CAFOs, etc. are all provisioning services of ecosys-

tems. Virtually any good can be construed as the result of organism-environment interactions and thus as an ecosystem service. We are talking about the value of everything.

Section 1.2.2

This section begins by stating correctly that while all values are *anthropogenic* (assigned by human beings) not all are *anthropocentric* (concerned with human well-being, satisfaction, or welfare). It would be useful to cite Amartya Sen (1977) as one among many economists who have recognized that non-anthropocentric or “commitment values” represent moral principles, aesthetic judgments, and religious convictions about what is good, right, beautiful, or sacred – and that these kinds of values make no claims about what will benefit anyone, provide satisfaction, or increase welfare. As Sen explains, “One way of defining commitment is in terms of a person choosing an act that he believes will yield a lower level of personal welfare to him than an alternative that is also available to him.”

Commitment values are plainly anthropogenic, since no other creature, as far as we know, acts on moral principle, for example. To act on moral principle, however, is precisely *not* to act for one’s own benefit; it is to make a principled choice may have nothing to do with one’s well-being but exemplify a commitment is to some other goal or standard. Economists sometime connect preference (i.e., willingness to pay) and welfare. The prevalence of non-anthropocentric or commitment values severs the connection – it drives a wedge – between preference and welfare.

I believe that the draft document is mistaken in defining existence value as an anthropocentric concept (line 32). Existence value is measured by contingent valuation (CV) instruments. Every study that has been performed has shown that responses to CV surveys are based almost entirely on non-anthropocentric values. Insofar as CV methods measure existence value, then, it is simply false – empirically not the case – that “what economists call ‘existence value’” arises because “people derive satisfaction from [the] existence” of some good. Rather, what economists call existence value arises because people believe the existence of some good is morally, spiritually, or aesthetically so important that they are willing to sacrifice some measure of their own welfare – or subjective satisfaction -- to protect it.

Economists recognize that ethical or non-anthropocentric considerations dominate anthropocentric ones in responses to CV surveys. Shkade and Payne (1994) state, “Our results provide an assessment of the frequency and seriousness of these considerations in our sample: they are frequent and they are significant determinants of WTP responses.” In another study, researchers found that existence value “is almost entirely driven by ethical considerations precisely because it is disinterested value” (Barbier et al. 1995). These economists acknowledge that “existence value has been argued to involve a moral ‘commitment’ which is not in any way at all self-interested.” They explain, “Commitment can be defined in terms of a person choosing an act that he believes will yield a lower level of personal welfare to him than an alternative that is also available to him.” As Tom Tietenberg (1994) observes, “people reveal strong

support for environmental resources even when those resources provide no direct or even indirect benefit.”

Every economist who has looked at the empirical evidence finds – because the evidence leaves no doubt – that existence value is a non-anthropocentric concept. In fact, not a single CV study has ever attempted to measure WTP for the satisfaction, benefit, or welfare change people think they would derive from the existence of some good. Recognizing perhaps intuitively that existence value is dominated by commitment or non-anthropocentric concerns, CV instruments always ask individuals for their WTP to protect a species, place, or whatever, which is often a considerable amount, not how much they would pay for an attendant benefit or satisfaction, which would probably be nothing because the benefit or satisfaction, if any, would be beside the point.

In CV and other instruments concerned with existence value, WTP does not measure – and never even attempts to measure – satisfaction, welfare change, or benefit. Existence value – contrary to the draft document – represents a non-anthropocentric value, that is, a preference that is based in moral belief not in personal benefit.

On lines 20-22 of the next page, the draft report states that economic valuation measures benefit in terms of WTP. We have just seen, however, that at least with respect to existence and other non-anthropocentric values, WTP does not correlate with or measure benefit. *How do we know that WTP ever measures benefit?* No experiment, no empirical evidence, indeed, nothing whatsoever shows that WTP measures benefit, welfare change, satisfaction, or well-being. As we have seen, studies of responses to CV studies indicate -- if anything -- an inverse relation to hold between WTP and perceived benefit.

Economists have no empirical evidence to show that any relation holds between WTP and benefit once basic needs are met. To support the empirical hypothesis that WTP varies with benefit, economists would have to measure benefit (welfare, well-being, etc.) independently – by some metric other than WTP – to see if in fact the benefit associated with a good correlates with the amount the individual is willing to pay for it. The empirical evidence shows conclusively that on any logically independent measure of benefit, well-being, etc., WTP *fails* to correlate with benefit. We know from scores of empirical studies that WTP (contrary to the draft report) does *not* measure benefit.

For example, R. Kerry Turner (1993) suggests, “Positive economic value—a benefit—arises when people feel better off, and negative economic value—a cost—arises when they feel worse off.” By using income as a surrogate for WTP, we can test whether people with more money (ergo more WTP) are “feel better off” or are happier than those with less, using subjective measures of satisfaction. The thesis that money does not buy happiness – that greater income does not correlate with greater perceived satisfaction once basic needs are met – is perhaps the most-tested and best-established thesis in social science research. Empirical studies overwhelmingly show that WTP does not correlate with the subjective satisfaction people gain from the goods that they consume. Nobody really believes that income and therefore WTP correlates empirically with happiness after

basic needs are met. A footnote touches upon this vast literature that shows the irrelevance of consumption beyond basic needs to perceived well-being.¹

In any case, the factual or empirical question whether WTP correlates with benefit in the sense of subjective well-being, satisfaction, or happiness, is irrelevant to economists and to economic theory. As Richard Posner (1981) has written, the “most important thing to bear in mind about the concept of value [in the economist’s sense] is that it is based on what people are willing to pay for something rather than the happiness they would derive from having it.” The relation between WTP and benefit is not an empirical one; it does not depend on or refer to evidence. The principle that WTP measures benefit is entirely a stipulated, definitional, or tautological one. Rick Freeman explains that economic theory defines “the benefit of an environmental improvement as the sum of the monetary values assigned to these effects by all individuals directly or indirectly affected by that action.” Similarly, Tom Tietenberg has written, “Total willingness to pay is the concept we shall use to define total benefits.”

Economic theory defines or measures “benefit” or “welfare change” in terms of willingness to pay. It then relies on WTP to measure benefit or welfare change. The terms “willingness to pay” and “benefit” mean exactly the same thing; they are just proxies or stand-ins for each other. Everybody really knows – or should know – this. The entire edifice of welfare economics rests on the idea that WTP measures value because value is measured by WTP. In short, economics has nothing to say about value. Willingness to pay measures only itself. Microeconomic theory cannot tell us why greater WTP correlates with greater value because it has no concept and pretends to have no concept of value other than WTP itself -- or than some concept, such as welfare or well-being, that turns out to be a mere proxy or stand-in for willingness to pay. Economics therefore is not and cannot be a normative science; it cannot get to the value of anything. This may be a fundamental problem for our committee.

Anyone who has read this far is likely to respond that our committee does not need more problems. After all, EPA wants useful advice about how to measure the value of ecosystem services. Executive Orders require cost-benefit accounting in most or many instances. My logical deconstruction of welfare economics is not helpful. What are needed are constructive suggestions.

I suggest that we can provide the useful recommendations EPA seeks if we drop the concept of WTP as a measure of value. Instead, we should define cost-benefit analysis on market price. Market price is a measure of the scarcity of a good relative to effective demand. The price of a good represents the most a supplier can charge – or the least a consumer must pay – for the next or marginal unit of a good in a competitive market. Thus, a very beneficial good, such as food or water, for which people may be willing to pay a great deal, may sell at a low price because the good is plentiful and easy to produce. A good that is far less beneficial, a bauble like a diamond, may carry a high price because it is scarce or difficult to provide. Price is a measure of scarcity not benefit.

I think cost-benefit analysis should be defined on market prices (scarcity measures) rather than on WTP (which measures only itself). We should think in terms of the minimum a person must pay for a good if it were provided competitively rather than in terms of the maximum he or she would be willing to pay if it were not. I take this view because economies that follow competitive price signals in the allocation of goods generally do much better on a series of macroeconomic criteria than planned or centrally managed economies that base allocation not on market prices (actual or hypothetical) but on a metric derived from social science. Rules like “to each according to his social rank” or “to each according to his need” ruin economies by substituting centralized planning for market competition. The rule “to each according to his maximum WTP” is no different.

I think we could do our job for EPA if we discussed how to measure the current or predicted scarcity of particular environmental services relative to demand. Economists do this sort of thing all the time in estimating future prices for natural resources, such as petroleum and other minerals, that trade in markets. If traders think a good like petroleum will remain plentiful in relation to demand – or that technology can cheaply provide substitutes – then the price will remain low. If scarcities loom or substitutes seem expensive, prices rise. Markets in future contracts reflect the best estimates. EPA wants some way to measure the scarcity of ecological goods that are not exchanged in markets. To help the agency, we would turn from the problem of valuation to that of allocation. We would no longer ask, “What is the value of x ?” We would ask, “At what price would x trade in a competitive market?” We should then think in terms of a general equilibrium defined by competition and not try to measure partial equilibriums for each good taken separately or seriatim. Prices help in allocation not in valuation. Prices tell us about the scarcity of goods relative to effective demand. They tell us nothing about the value of those goods – however one prefers to define “value.”

What EPA wants us to do, I believe, is to suggest how to attach surrogate or hypothetical market prices to environmental goods including services that markets for one reason or another fail to price competitively. I believe that if we keep focused on this task – which is to determine shadow prices not to measure maximum WTP – we can give EPA the advice and the recommendations it seeks. As long as we think in terms of competitive market prices and bury the concept of maximum WTP, I think we can make good progress. Let me back up a little to explain why this would be a good idea.

At the start, we should recognize that goods with non-anthropocentric value are to that extent to be treated as ends-in-themselves and not as merely as means of production. Accordingly, policy decisions that involve these goods must be made on political grounds. These goods are simply excluded from the production function and in that sense from economic exchange. Examples include kidneys, babies, Doug’s samovar, the battlefield at Gettysburg, etc. We remove these sacred objects from the production function as a matter of ethical principle, aesthetic judgment, religious conviction, or political necessity. This does not mean they are priceless but that we have decided politically that prices are not particularly relevant to their disposition.

All other assets, generally speaking, are best allocated according to price signals in competitive markets actual or hypothetical. We are now concerned with allocation not with valuation. We are therefore concerned with the dollar amount an incremental unit of a good would fetch in a market in which many suppliers compete for many buyers on the basis of quality and price. We have no interest at all in the impossible and needless task of determining the *maximum* amount an individual is willing to pay of that good – a question that could only arise in the context of monopoly not competition. Rather, we are concerned with the *minimum* amount that individual would have to pay a supplier for the marginal unit of the good given competitive offers from thousands of other suppliers and the availability of whatever substitutes are offered for sale. Prices are good for allocation not for valuation. Price measures scarcity not dependency.

Economists have developed all kinds of useful ways to attach shadow or surrogate-market prices to marginal units of goods that for one reason or another are not competitively priced in existing markets. It might be helpful if we reviewed these methods for users in EPA. These methods – to repeat -- have nothing whatever to do with determining the maximum amount people are willing to pay for this or that. Rather, they determine the minimum amount people would have to pay to get suppliers to produce the next unit of a good and sell it to them.

Our task is to identify products and services nature provides that would command significant amounts if they were priced competitively in efficient markets. Our job is not to remind the agency how dependent we are upon nature's services. It is to identify which of these services, if any, may become scarce enough to justify a shadow price.

I recognize that public policy distorts price signals for several goods nature provides. Consider arable or fertile land. Price supports for agricultural commodities have distorted cropland prices upward. Thus the price of arable land – already inconsiderable because the supply vastly exceeds the demand in the U.S. – is actually higher than it should be. Similarly, by subsidizing the fishing fleet, the U.S. government assures that society pays more to catch a fish than the price the fish can get dockside. Thus all the possible resource rent is more than dissipated. One might go natural resource by natural resource to show how thoroughly government policy has distorted prices – forestry probably being the most notorious example. Of course, resource economists do this sort of thing all the time. Our task is to determine which natural resources – including products or services nature provides – are not already thoroughly discussed in the literature of natural resource economics. Which of nature's free services is either scarce enough or likely to become so scarce relative to demand that it could sustain a price in a competitive market?

The Catskill Parable provides the perfect example – which is why it is cited so ubiquitously and pervasively – to illustrate the extent to which an important ecosystem service may become scarce and therefore command a price. According to the Parable, economic development in the Catskills watershed rendered scarce the cleansing or purification services natural ecosystems provide and on which New York City had relied to protect the quality of its water supply. As a result, the City spent over \$1 billion to

purchase the natural habitat and to retire development rights in order to protect and restore the natural cleansing capacity of undeveloped areas. This parable identifies a particular service natural ecosystems provide, shows how the service became scarce relative to effective demand, and then finds the price the City had to pay to maintain that service. The only problem with the example – compelling in every other way – is that it is a fiction. It would be better to find non-fictional examples of services nature provides such that these services 1) are or may become scarce relative to effective demand; 2) have no easy and inexpensive technological substitutes; and 3) are not already priced in competitive markets. Since we are working for US EPA, it would be best if these examples arose within the United States.

At earlier meetings, I conceded my inability to think of a single product or service nature provides that meets these criteria. I beg for help in coming up with examples.

I hope that you and the other members of the committee will consider these comments. I look forward to our meeting later this month.

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12. Kerry Smith

Comments Received as “redline” within document:

*Valuing the Protection of Ecological Systems and Services:
An Expanded and Integrated Approach (tentative title)*

1. INTRODUCTION AND BACKGROUND	64
1.1. SCOPE OF THIS REPORT AND ITS INTENDED AUDIENCE	64
1.2. THE IMPORTANCE OF VALUING ECOSYSTEMS AND THEIR SERVICES.....	65
2. ECOSYSTEM VALUATION AT EPA.....	70
2.1. POLICY CONTEXTS AT EPA WHERE ECOSYSTEM VALUATION CAN BE IMPORTANT	70
2.2. INSTITUTIONAL AND OTHER ISSUES AFFECTING BENEFITS ASSESSMENT AT EPA	71
2.3. AN ILLUSTRATIVE EXAMPLE OF ECOSYSTEM BENEFIT ASSESSMENT AT EPA	74
3. AN INTEGRATED AND EXPANDED APPROACH TO ECOSYSTEM VALUATION.....	80
3.1. CONTEXT AND SCOPE.....	81
3.2. ECOLOGICAL SERVICES TO BE INCLUDED.....	81
3.3. MEASURING BENEFITS	83
4. CONCLUSIONS AND RECOMMENDATIONS	86

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1. INTRODUCTION AND BACKGROUND

Scope of this Report and its Intended Audience

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The Science Advisory Board (SAB) Committee on Valuing the Protection of Ecological Systems and Services (C-VPES) began its work in 2003 on a project developed by the SAB to strengthen the Agency's analysis for protecting ecological resources. The SAB saw a need to complement the Agency's ongoing work in ecological science, ecological risk assessment, and ecological benefit assessment by offering advice on how EPA might better value the protection of ecological systems and services and how that information might better support decision making to protect ecological resources. In this project the SAB set the goals of assessing Agency needs and the state of the art and science of valuing protection of ecological systems and services and identifying key areas for improving knowledge, methodologies, practice, and research at EPA. Senior EPA managers supported the concept of this SAB project and participated in the initial background workshop that launched the work of the C-VPES. The committee is an interdisciplinary group of experts from the following areas: decision science, ecology, economics, engineering, philosophy, psychology, and social sciences with emphasis in ecosystem protection.¹³⁶ The committee sees its work as a three-year initiative.

This report is intended to provide an overview of the committee's conclusions to date.¹³⁷ It is aimed at providing initial advice for strengthening the Agency's approaches for valuing the protection of ecological systems and services, facilitating their use by decision makers, and identifying the key research areas needed to strengthen the science base. The committee will prepare additional reports with more detailed advice at the

¹³⁶ The SAB Staff Office published a Federal Register Notice on March 7, 2003 (68 FR 11082-11084) announcing the project and called for the public to nominate experts in the following areas: decision science; ecology; economics; engineering; psychology; and social sciences with emphasis in ecosystem protection. The SAB Staff Office published a memorandum on August 11, 2003 documenting the steps involved in forming the new committee and finalizing its membership.

¹³⁷ The committee developed the conclusions in this report after multiple public meetings and workshops: a) an Initial Background Workshop on October 27, 2003 to learn the range of EPA's needs for science-based information on valuing the protection of ecological systems and services from managers of EPA Headquarters and Regional Offices; b) a Workshop on Different Approaches and Methods for Valuing the Protection of Ecological Systems and Services, held on April 13-14, 2004; c) an advisory meeting focused on support documents for national rulemakings held on June 14-15, 2004; d) an advisory meeting focused on regional science needs, in EPA's Region 9 (San Francisco) Office on Sept. 13, 14, and 15, 2004; and e) advisory meetings held on January 26-26, 2005 and April 12-13, 2005 to review EPA's draft *Ecological Benefits Assessment Strategic Plan* and to discuss economic and other methods for valuing the protection of ecological systems and services. The committee discussed a draft version of this report at a public meeting on (INSERT DATE).

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completion of the project.¹³⁸ However, given the importance of the committee's charge, it felt that it would be useful to the Agency to issue an initial report that would indicate the direction that the committee's work is taking and serve as a prelude to the subsequent committee report(s). These subsequent reports will further develop the concepts in this initial advisory report and provide more detailed discussion of issues, methods, and application. In particular, they will describe in more detail how different methods could be used more effectively to understand the benefits of the protection of ecological systems and services and how results of analyses could be better integrated and communicated to decision-makers.

This initial report focuses on the need for an expanded and integrated approach for valuing EPA's efforts to protect ecological systems and services. It provides advice to the Administrator, EPA managers, EPA scientists and analysts, and EPA staff across the Agency concerned with ecological protection. It adopts a broad view of EPA's work, which it understands to encompass national rulemaking, regional decision making, and programs in general that protect ecological systems and services. It focuses directly on EPA's contributions and impacts, however, and not on the general question of the value of ecosystems or ecological services in themselves. It outlines a call for EPA to expand and integrate its approach in important ways.

This report appears at a time when there is lively interest internationally, nationally, and at EPA itself in the issue of valuing the protection of ecological systems and services. Since the establishment of the SAB C-VPES major reports have been developed focusing on how to improve the characterization of ecological resources (Millennium Ecosystem Assessment 2005; Millennium Ecosystem Assessment Board 2003; National Research Council 2004; Pagiola, von Ritter, and Bishop 2004; Silva and Pagiola 2003) The committee's work has benefited from and will build upon those recent efforts. The C-VPES distinguishes its work from those efforts, however, in the following ways. The C-VPES focuses on EPA as an audience. The committee focuses specifically on how EPA can value its own contributions to the protection of ecological systems and services, so that the agency can make better decisions in its eco-protection programs. The C-VPES is inter-disciplinary and does not focus solely on economic methods or values. The committee will offer advice on several benefits assessment approaches and in each case will emphasize issues relevant to EPA policy and decision-making and address how the Agency could better characterize the benefits of ecological protection.

The Importance of Valuing Ecosystems and their Services

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The Concept of Ecosystem Services

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¹³⁸ The Committee has already issued a related advisory report on the Agency's draft *Ecological Benefits Assessment Strategic Plan* (EPA SAB, EPA-SAB-ADV-05-00X). This report complements the *EBASP* Advisory, and provides a discussion of an integrated framework alluded to in that report.

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The term “ecosystem” describes the organisms in a given area interacting with their physical environment as a functional unit. Ecosystems can describe organism-physical environment interactions in a woodlot, a watershed, or an extensive landscape. Ecosystems encompass all organisms within the prescribed area, including humans, who are often the dominant element. Processes that link organisms with their physical environment are considered ecosystem processes and include primary productivity and the cycling of nutrients and water. These processes in total describe the functioning of ecosystems. Processes that link organisms with each other, indirectly influencing flows of energy, water and nutrients, can also be considered ecosystem processes, such as pollination, predation and parasitism.

“Ecosystem services” is an anthropocentric concept denoting the ways, that humans derive enhancements to their well-being from the functioning of ecosystems. An operational categorization of ecosystem services has recently been proposed by the Millennium Ecosystem Assessment:

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a) **Provisioning services** (products obtained from ecosystems). These include food, fuelwood, fiber, biochemicals, genetic resources and fresh water. Generally these services are traded in the open marketplace.

b) **Regulating services** (benefits received from regulation of ecosystem processes). This category includes a host of pathways, that influence people in positive ways --they can be direct and indirect and stem from the presence and functioning of ecosystems. These include flood protection, human disease regulation, water purification, air quality maintenance, pollination, pest control and climate control. These services are generally not marketed but many have clear value to society and this value will increase for many of these services as the many dimensions of global change proceed.

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c) **Cultural services** (the nonmaterial benefits people obtain from ecosystems). Ecosystems contribute to the cultural, spiritual and aesthetic dimensions of people’s well being. They also contribute to establishing a sense of place.

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d) **Supporting services**. These are the processes that maintain ecosystem functioning such as: soil formation, primary productivity, biogeochemistry, and provisioning of habitat. They all affect human well-being, but generally indirectly through their support of the provisioning, regulating and cultural service functions.

Although there are different ways in which ecosystem services can be categorized, the committee feels that the approach adopted in the Millennium Assessment is a useful approach for conveying the concept of ecosystem services and the broad array of functions and processes ecosystem services include. The ecosystem service concept is useful in many ways. First, it is a concept that is readily grasped by society, since it relates directly to human well-being. Secondly, it provides a tool for evaluating the impacts of human actions in terms of the resulting changes in the amount or qualities of the services these systems provide. “Ecosystem health” can then be defined in terms of

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the output and sustainability of services. When defined this way, the concept of ecosystem health relates directly to the mechanisms that lead ecosystems to enhance human well being. However, life on earth can be revered and protected independent of human well being. As discussed below, the committee recognizes that ecosystems can be make contributions, not only because of the human-based services they provide.

.2.2 The Concept of Value

The term value can have different meanings in different professional contexts. In economics it has a very specific meaning that derives from the idea that people's choices serve to define tradeoffs that are sometimes referred to as values. This concept of value as implied by a individual's choice is by definition anthropogenic. However, as noted above, not all conceptual frameworks used to define values are *anthropocentric*. When people talk about environmental values, the values of nature, or the values of ecological systems and services, they may have different things in mind. People have moral, economic, religious, aesthetic, and other values, all of which can affect their thoughts, attitudes, and actions toward nature in general or, more specifically, ecosystems and the services they provide.

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The most basic philosophical distinction in values is the distinction between means and ends. To value something as a mean is to value it for its usefulness in helping to realize or bring about some thing or state of affairs that is valued in its own right or as an end. Things valued for their usefulness as means in this sense are said to have instrumental value. Of course, it would not make sense to value anything instrumentally or as a means unless there was at least one thing or state that was valued for its own sake or as an end. Things valued as ends are sometimes said to have intrinsic value.¹³⁹ If intrinsic value applies to things other than human beings or human experiences, then this conception of value is non-anthropocentric. Some people defend a non-anthropocentric conception of value or goodness (Goodpaster 1978; Rolston III 1991; Taylor 1986). However, others argue that only human beings or human experiences have intrinsic value, thereby defending an anthropocentric conception of value (Glover 1984; Sidgwick 1901; Williams 1994).

Ecological systems have instrumental value to the extent that they provide useful services. Some people also claim, however, that an ecological system may have value independently of the services it provides, i.e., its very existence has value. This claim can mean several different things. If it means that the existence of an ecological system is valuable because people derive satisfaction from its existence independent of specific uses they may make of it services, then it has what economists call "*existence value*." This concept is anthropocentric. In addition, it has been labeled as a kind of instrumental

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¹³⁹ There is controversy over the meaning of intrinsic value that we will not try to resolve here (Korsgaard 1996). Many people take intrinsic value to mean that the value of something is inherent in that thing. Some philosophers have argued that value or goodness is a simple non-natural property of things (see Moore 1903 for the classical statement of this position), and others have argued that value or goodness is not a simple property of things but one that supervenes on the natural properties to which we appeal to explain a thing's goodness (this view is defended by, among others, contemporary moral realists; see (Brink 1989; McDowell 1985; Sayre-McCord 1988; Sturgeon 1985).

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value, since it is based on the premise that the existence of the species or ecological system is one of many things that generate human satisfaction, and that the various things that contribute to human satisfaction are potentially substitutable. Some people, however, claim that an ecological system may have intrinsic value of its own, and that we should protect it for its own sake. If the explanation of this claim refers to reasons that are independent of the contribution that the existence of an ecological system can make to human well-being, then this claim of intrinsic value should be understood in a non-anthropocentric sense.

This committee recognizes that there are many possible conceptual bases for defining value derived from ecosystems and the services they provide. Thus, throughout this report, when the term "value" is used we will endeavor to distinguish the conceptual basis used to define value. This broad conceptualization allows the discussion to include values predicated on their contributions to human society (broadly defined), as well as those based on an ethical, religious, or biocentric notion of intrinsic value.

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Related to the concept of value are the concepts of "benefits" and "valuation." Both of these terms are relative to a specific change. In this report, the change of interest is the change in the state of an ecosystem or the flow of services it provides stemming from an actual or proposed action by EPA. Thus, the term "ecosystem benefits" refers to the tradeoff people would be prepared to make to assure a change in the "amount" of an ecological system and/or its services. This formulation assumes a positive change in the system or in the services it provides. Analogously, a reduction in benefits, for example from damages to an ecosystem, can be viewed as a cost.

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Similarly, the term "valuation" will refer to the process of characterizing or measuring benefits using various methods and techniques. For example, economic valuation measures benefits in terms of the amount people are willing to pay (WTP) to ensure an ecological improvement or the amount people are willing to accept (WTA) to forego the improvement.¹⁴⁰ A social/psychological assessment method might present the same ecological change and ask people to rate the importance of achieving (or preventing) that change relative to a selection of changes in a number of other (potentially competing) social goals. An ecological approach might assess the value of the targeted change in terms of the magnitude of its effect on biodiversity or some other indicator of ecological health based on the consensus that ecological health is important to human/social well-being. To the extent these assessments focus on changes that are directly relevant to people then they are based on an anthropocentric view of the importance of ecosystems. In this context concern about ecological systems is based on their contribution to human well-being. However, the frameworks differ in terms of the means by which the importance of ecosystem changes is expressed. In the economic conception of importance it is gauged by the extent to which the targeted ecological change can then be explicitly represented in a traded off measure. Economic assessments claim the most explicit

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¹⁴⁰ A large literature exists on the use of economic valuation methods to estimate the value of changes in environmental quality. For a comprehensive description of these methods, see Freeman (1993).

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method for comparing the assessed tradeoffs between ecological improvements with changes in other goods or services that also contribute to human well-being. The social/psychological methods generally settle for a relative measure of the value of the targeted ecological change and largely constrain tradeoff implications to options and circumstances that are closely related to the set of alternatives explicitly presented in the assessment. Ecological assessments might restrict tradeoff implications to the biosphere. (this goes too far and offers an implicit but unacceptable characterization of the other approaches as having equal standing as concepts of benefits for use in RIA's under 12866)

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Deleted: In all cases, the ultimate purpose of the valuation process is to characterize or measure the benefits (or costs) associated with an ecological change in a way that provides useful information about these benefits to policymakers and the public at large. The committee plans to discuss these methods, what they may offer analysts and decision makers at EPA in capturing different kinds of benefits, and their limitations and related issues in a future report.

1.2.3 The Importance of Assessing Ecosystem Benefits

Given the important role that ecosystems play in supporting life on earth and providing goods and services that people value, changes in the state of these systems or the flow of services they provide can have important implications. This importance has been increasingly recognized by many, both within the U.S. and internationally. The recent study by the National Research Council and the Millennium Ecosystem Assessment are indicative of this growing recognition.

Many EPA actions (e.g., regulations, rules, programs, policy decisions) affect the state of ecosystems and the flow of services derived from them. EPA actions can either lead to changes in the conditions of ecosystems (improvement or deterioration) or prevent changes that would otherwise have occurred. These impacts can occur both at a relatively small, local scale as well as more broadly at a national scale. Yet, to date, ecosystem impacts have received relatively limited consideration in EPA policy analyses. Failure to consider these impacts as fully as possible can lead to distorted policy decisions, particularly in regulatory contexts where benefits are being compared to costs. In many cases, the result will be an under-valuation of (or failure to fully recognize) the benefits of EPA actions aimed at protecting the environment. This can occur, for example, when actions are evaluated based primarily on their impacts on human health, without a recognition of potentially important ecosystem impacts.

Valuing the changes in ecological systems and services that result from EPA policies or programs is challenging for a number of reasons. Major challenges include: a) understanding the many sources of value that ecosystems generate, b) predicting the ecological impacts of alternative EPA actions, and expressing those predictions in the temporal and spatial scale most appropriate for decision-making, c) linking those impacts to changes in the dimensions of ecosystems or the service flows that people value, d) developing methods and techniques that can be used to characterize and/or measure the value of protecting ecological systems and services so that they may be incorporated or properly reflected in environmental decisions and policies, e) aggregating to a national level using local or regional studies from regions with different ecological and/or economic characteristics, and f) finding measures or means of representing ecological values that are commensurable with values of non-ecological changes caused by EPA actions, such as human health. Despite these challenges, it is imperative that EPA

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improve its ability to assess ecosystem benefits to ensure that ecological impacts are adequately considered in the evaluation of EPA actions.

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ECOSYSTEM VALUATION AT EPA

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There are several different contexts in which EPA policy decisions have ecological impacts and hence in which the need for ecosystem benefits assessment will arise. In addition, when assessing benefits, EPA must operate within a set of institutional, legal, organizational and practical constraints that affect this process at the Agency. Thus, EPA has specific needs in this regard that must be recognized and addressed. These needs arise in different parts of the Agency for different purposes and for different audiences. Some of the needs present structured requirements for valuing protection of ecological systems and services, while needs in other contexts are less prescriptive.

Policy Contexts at EPA Where Ecosystem Valuation Can be Important

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The most prescriptive requirements are for national rule making. Benefit assessments are required for national rulemaking by two of EPA's governing statutes (the Toxic Substances Control Act and the Federal Insecticide, Fungicide and Rodenticide Act) and by Executive Order 12866 for "significant regulatory actions". The circular on "Regulatory Analysis" issued by the Office of Management and Budget (OMB) in September 2003, *OMB Circular A-4*, identified key elements of a regulatory analysis for such "economically significant rules." One of these elements is an evaluation of the benefits and costs of a proposed regulatory action and the main alternatives identified. The circular provided general guidance on how to provide monetized, quantitative, and qualitative information to fully characterize benefits and EPA itself has developed initial guidance for ecological benefit assessment (U.S. Environmental Protection Agency 2000). In developing its draft *Ecological Benefits Assessment Strategic Plan* and in discussions with the committee (U.S. Environmental Protection Agency Science Advisory Board 2003), EPA identified the need for improved models and methods to help implement the requirements of the circular. The Agency identified needs both to expand methods and data for economic valuation through benefit-cost or cost-effectiveness analysis and to explore other assessment methods to provide information on ecological effects that are currently un-monetized and assigned an implicit value of \$0. Managers seek approaches that are "sound, credible, and scientifically supportable" as well as flexible, affordable, and able to be implemented within the time constraints required by rulemaking (U.S. Environmental Protection Agency Science Advisory Board 2004).

EPA's regional offices, although generally not responsible for national rule-making, are responsible for several kinds of decisions and activities where the benefits of ecological protection come into question:

- Priority setting for regional action, such as targeting projects for wetland restoration and enhancement or identifying critical ecosystems or ecological resources for regional attention
- Setting Supplemental Environmental Protection (SEPs) penalties for enforcement cases where those penalties involve protection of ecological systems and services

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- Choice of options for Superfund and Resource Conservation and Recovery Act (RCRA) cleanups that could take ecological benefits into account
- Review of Environmental Impact Statements prepared by other federal agencies to comply with the National Environmental Protection Act
- Assisting state and local governments and other federal Agencies with protecting lands and land uses, where assessment of the value of protection options could help decision-makers make better-informed decisions.

Regions seek low-cost methods that can be implemented quickly to inform "place-based" decisions. They seek methods that provide information on the value of ecological services; ecological diversity; conservation opportunities and threats; sustainability; and historical and cultural values associated with ecological systems or parts of ecosystems at the watershed or landscape scale. Regions experience the need to communicate the value of ecological protection as they collaborate with other federal agencies and with government partners at the local, state, and regional levels.

EPA's need to communicate the value of its ecological protection programs has two dimensions: 1) a retrospective dimension, because assessments focus on the value of EPA's current and past protection efforts and 2) a prospective dimension, because such assessments are meant to inform decisions about future EPA programs and priorities.

The need to assess the ecological benefits of policy options is woven into most of the Agency's decisions, including the assessment of ecological protection programs . Program assessments are mandated for EPA, as they are for all agencies of the executive branch, by the Government Performance and Results Act of 1993. As part of that assessment, OMB requires EPA to periodically identify its strategic goals and describe both the social costs and budget costs associated with them. EPA's Strategic Plan for 2003-2008 described the current social costs and benefits of EPA's programs and policies under each strategic goal area for the year 2002 (U.S. Environmental Protection Agency 2003). This analysis repeatedly points out that EPA lacks data and methods to quantify the ecological benefits associated with the goals in its strategic plan.

In addition, the Government Performance Results Act of 1993 established requirements for assessing the effectiveness of federal programs. Part of that assessment involves assessing the outcomes of programs intended to protect ecological resources. EPA must report annually on its progress in meeting program objectives linked to strategic plan goals and must engage periodically in an in-depth review [through the Program Assessment Rating Tool (PART)] of selected programs to identify their net benefits and to evaluate their effectiveness in meeting meaningful, ambitious program outcomes. Characterizing ecological benefits associated with EPA programs is a necessary part of the program assessment process.

Institutional and Other Issues Affecting Benefits Assessment at EPA

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The committee recognizes that ecological benefits assessment at EPA must be conducted within a set of institutional, legal, organizational, and practical constraints that

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affect what is and can be done to incorporate ecosystem values into policy evaluations. In an effort to better understand these issues and their implications for the committee's charge, the committee conducted a series of interviews with Agency staff.¹⁴¹ The interviews were focused on the process of developing benefit analyses for Regulatory Impact Assessment (RIA) for rulemaking and the relationship between EPA and the Office of Management and Budget. However, many of the questions raised are equally applicable to strategic planning, performance reviews, regional analysis, and other situations in which the agency is called upon to assess the value of ecosystems. Below are some key observations made by the committee based on those interviews.

EPA Program Offices responsible for new rules initiate, finance, and administer the process for developing ecological benefit assessments. The development of a new rule – including definition of the rule itself, options to be weighed, and the assessment of impacts arising from the rule – involves much more than scientific assessment. Political negotiations and legal analysis arguably dominate the process. EPA has a formal rule-development process with several stages, each which impose demands on the Agency and the Agency also develops rules to meet court-imposed deadlines.

Several aspects of these imposed constraints deserve emphasis. First, despite the commonality of the underlying rule-development process, it is clear that there is no single way in which ~~analysts within the Agency assess the tradeoffs people would be prepared to make to enhance ecosystems~~. Practices vary considerably across program offices, reflecting differences in mission, in-house expertise, etc. Program offices have different statutory and strategic missions. The organization, financing, and skills of the program offices differ enormously. The National Center for Environmental Economics (NCEE) is the Agency's centralized reviewer of economic analysis within the agency.¹⁴² However, the primary expertise and development of the rules resides within the program offices.

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Secondly, the timing of the process largely determines the kinds of analytical techniques that are employed. This is related to court-imposed deadlines on the rule process, as well as intervening requirements related to the collection and analysis of new data. The scientific community is used to much longer time horizons for their analyses. They are also used to the idea that a new rule should call for the collection of new kinds of data. Unfortunately, collecting new data poses a significant bureaucratic problem for the Agency. To collect original data, the Agency must submit an Information Collection Request, which is reviewed within the Agency and by OMB. This hurdle alone can add

¹⁴¹ These interviews were conducted by one Committee member, Dr. James Boyd, in conjunction with the Designated Federal Officer, Dr. Angela Nugent, over the period September 22, 2004 through November 23, 2005. In seven sets of interviews, Dr. Boyd spoke with staff from the Office of Policy, Economics and Innovation, Office of Water, Office of Air and Radiation, Office of Solid Waste and Emergency Response.

¹⁴² NCEE is typically brought in by the program offices to both help design and review RIAs. NCEE can be thought to provide a centralized "screening" function for rules and analysis before they go to OMB. NCEE is actively involved in discussions with OMB as rules and supporting analysis are developed and advanced.

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significant drag to the assessment process. With perhaps a year or two at most to conduct a study, this kind of review significantly limits the kind of analysis the Agency can conduct.

A third issue is the role of the Office of Management and Budget (OMB) in defining or directing ecosystem valuation exercises at EPA. It was difficult for the committee to ascertain the EPA-OMB relationship precisely.¹⁴³ EPA has been given explicit guidance by OMB in the Circular A-4, which the committee views as a reasonable document on its own because of its call for a full characterization of the impacts of different policy options and inclusion of language calling for characterization of benefits that cannot be monetized or cannot be quantified (Office of Management and Budget 2003)¹⁴⁴. However, the implications of some sections of the Circular, particularly relating to the treatment of benefits that cannot be readily monetized, remain somewhat ambiguous. For a benefit or cost that cannot be expressed in monetary terms, the Circular instructs Agency staff to “try to measure it in terms of its physical units,” or, if this is not possible either, to “describe the benefit or cost qualitatively.” However, little guidance is provided on how this should be done. Instead, the Circular urges regulators to “exercise professional judgment in identifying the importance of non-quantified factors and assess as best you can how they might change the ranking of alternatives based on estimated net benefits.”

[\(I have trouble with this description OMB provides oversight --it is NOT a court;\)](#)It is clear that the Agency views the OMB as a kind of “court” that reviews its analysis. In front of this “court,” methods that have been accepted in the past create incentive for the use of the same or similar methods in the future. The thinking seems to be “if it made it through OMB once, it will make it through again.” There appears to be a pronounced tendency to use “off-the-shelf” methods to avoid problems with OMB. [I don't agree -- there are time constraints and EPA has its own guidelines for economic analysis](#) This creates a bias toward the *status quo* and a reluctance to explore new or innovative approaches. To this end, the committee sees the need to strike an appropriate balance between the use of established methods and the possible need to innovate in an effort to conduct more comprehensive and defensible benefit assessments for use in decision making and evaluation.

[While a summary of interviews --this is a confused view of the process](#)A related issue involves RIA review by external parties. The Agency does not take a standardized

¹⁴³ OMB responded to written questions, but declined to be interviewed by Dr. Boyd. EPA staff were informed that their formal responses to all questions, including the OMB-EPA interview were to be documented as part of the Committee report and this is likely to have had a chilling effect on the discussions.

¹⁴⁴ eg., see pp.27 “If monetization is impossible, explain why and present all available quantitative information” and. pp “If you are not able to quantify the effects, you should present any relevant quantitative information along with a description of the unquantified effects, such as ecological gains, improvements in quality of life, and aesthetic beauty.”

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approach to RIA review.¹⁴⁵ EPA staff and managers reported that peer review was focused only on “novel” elements of an analysis. This raises the question of how the Agency (and perhaps OMB) defines “novel.” Moreover, the novelty standard actually creates a clear incentive to avoid conducting novel analyses (however defined). It is clearly cheaper and quicker to avoid review altogether. The committee advises the Agency to consider whether there is a role for a standing expert body that can bring consistency to the review of analysis, avoid duplication of review, and be sensitive to timing and resource constraints.

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Finally, the committee notes the importance of organization of assessment science within the Agency. Currently, the Agency relies upon a variety of offices to develop assessments, with varying degrees of reliance on other offices (e.g., NCEE) or outside assistance.¹⁴⁶ It is not clear which work better than others. In addition, it is not clear how different programs integrate social science and biophysical science.¹⁴⁷

[Not based on the discussion I have read! VKS](#)

Do we want to advocate a “ecosystem services valuation paradigm” and/or development of a set of guidelines for doing ecosystem valuation? Relationship to risk assessment paradigm/guidelines??? See more on this in footnote below.

An Illustrative Example of Ecosystem Benefit Assessment at EPA

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In an effort to better understand the current state of ecosystem valuation at EPA, the committee examined in detail one specific case where benefit assessment was undertaken, namely, the *Environmental and Economic Benefits Analysis* that EPA prepared in support of new regulations for Concentrated Animal Feeding Operations (CAFOs) (U.S. Environmental Protection Agency 2002).^{148,149} The Agency indicated

¹⁴⁵ In some cases, review panels are appointed, in others not. In some cases, contractors are called upon to manage the review. In other cases, Program Offices themselves manage the review process.

¹⁴⁶ Another issue that relates to the organization of science within the Agency is the availability and location of data to support ecosystem valuation. The choice of methods is clearly related to the practical availability of data across the Agency. It is important that data that are housed within individual program offices are made public and readily shared with other offices.

¹⁴⁷ One anecdote is that Dr Boyd was able to speak with only one ecologist during the interviews designed (in part) to interview a set of ecologists. Economists in the agency were not able to identify ecologists to interview, for example. It also became clear that simple “counts” of professional background can be deceptive. What the agency terms an “ecologist” is not necessarily what the scientific community would call an ecologist.

¹⁴⁸ The Committee reviewed and critically evaluated the Environmental and Economic Benefits Analysis at its June 15, 2004 meeting. As stated in the Background Document for SAB Committee on Valuing the Protection of Ecological Systems and Services for its Session on June 15, 2004, the purpose of this exercise was “to provide a vehicle to help the Committee identify approaches, methods, and data for characterizing the full suite of ecological ‘values’ affected by key types of Agency actions and appropriate assumptions regarding those approaches, methods, and data for these types of decisions.” The Committee based its review on EPA’s final benefits report (EPA 2002) and a briefing provided by the EPA Office of Water staff. During the June meeting, members of the Committee divided into two workgroups. The workgroups

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that this analysis was typical of other EPA regulatory analyses of ecological benefits in form and general content. [\(I don't completely agree with this characterization of typical\)](#)

Because the proposed new CAFO rule constituted a “significant regulatory action” under Executive Order 12866, EPA was required to assess the costs and benefits of the rule.¹⁵⁰ EPA identified a wide variety of potential “use” and “non-use” benefits as part of its analysis.¹⁵¹ Using various economic valuation methods, EPA provided monetary quantifications in its CAFO report for seven environmental benefits.¹⁵² Approximately eighty-five percent of the monetary benefits quantified by EPA were attributed to recreational use and non-use of affected waterways. According to Agency staff, EPA’s analysis was driven by what it could monetize. EPA focused on those benefits for which data were known as available for quantification of both the baseline condition and the likely changes from the proposed rule, and translation of those changes into monetary equivalents. EPA’s final benefits assessment provides only a brief discussion of the benefits that it could not monetize. The benefits table in the Executive

each worked independently and reported their findings to the combined Committee. The leaders of the two working groups then prepared a consolidated summary of comments from the two workgroups.

¹⁴⁹ In December 2000, EPA proposed a new CAFO rule under the federal Clean Water Act to replace 25-year-old technology requirements and permit regulations (66FR 2959). EPA published its final rule in December 2003 (68 FR 7176). The new CAFO regulations, which cover over 15,000 large CAFO operations, reduce manure and wastewater pollutants from feedlots and land applications of manure and remove exemptions for stormwater-only discharges.

¹⁵⁰ Prior to publishing the draft CAFO rule in December 2000, EPA spent two years preparing an initial assessment of the costs and benefits of the major options. After releasing the draft rule, EPA spent another year collecting data, taking public comments, and preparing assessments of new options. EPA published its final assessment in 2003. An intra-agency team at EPA, including economists and environmental scientists in the Office of Water, Office of Air and Radiation, Office of Policy Economics and Innovation, and Office of Research and Development, worked on the benefit assessment. EPA also worked with the U.S. Department of Agriculture in developing the assessment. Dr. Christopher Miller of EPA’s Office of Water estimated that EPA spent approximately \$1 million in overall contract support to develop the benefit assessment. EPA spent approximately \$250,000-\$300,000 on water quality modeling as part of the assessment.

¹⁵¹ The potential “use” benefits included in-stream uses (commercial fisheries, navigation, recreation, subsistence, and human health risk), near-stream uses (non-contact recreation, such as camping, and nonconsumptive, such as wildlife viewing), off-stream consumptive uses (drinking water, agricultural/irrigation uses, and industrial/commercial uses), aesthetic value (for people residing, working, or traveling near water), and the option value of future services. The potential “non-use” values included ecological values (reduced mortality/morbidity of certain species, improved reproductive success, increased diversity, and improved habitat/sustainability), bequest values, and existence values.

¹⁵² These benefits were recreational use and non-use of affected waterways, protection of drinking water wells, protection of animal water supplies, avoidance of public water treatment, improved shellfish harvest, improved recreational fishing in estuaries, and reduced fish kills.

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Summary listed a variety of non-monetized benefits¹⁵³ but designated them only as “not monetized.” EPA represented the aggregate effect of these “substantial additional environmental benefits” simply by attaching a “+B” place-holder to the estimated range of total monetized benefits. Although the Executive Summary gave a brief description of these “non-monetized” benefits, the remainder of the report devotes little attention to them.

Although much effort was invested in the CAFO benefits assessment, the assessment illustrates a number of limitations in the current state of ecosystem valuation at EPA. [I am not sure how I would characterize the actual effort that went into the benefits component --](#)

First, EPA’s analysis and report focused nearly exclusively on meeting the requirements as described in Executive Order 12866. This may not be surprising since the Executive Order provided the reason for preparing the analysis and report. However, when EPA prepares a benefit assessment specifically to comply with Executive Order 12866, the Agency need not limit itself to the goals and requirements of the Executive Order. The Executive Order does not preclude EPA from adopting broader goals. The Executive Order provides merely that EPA shall conduct an “analysis” and “assessment” of the “benefits anticipated from the regulatory action” and, “to the extent feasible, a quantification of those benefits.” By adopting a narrow focus, the report failed to consider or reflect the broader purposes that a benefit assessment can serve. Environmental benefit assessments, such as the CAFO study, can serve a variety of important purposes, including helping to educate policy-makers and the public more generally about the benefits that stem from EPA regulations. [RIA are intended to focus on the specifics of the regulation being assessed --I have difficulty](#)

Second, as noted above, in implementing the Executive Order, the CAFO analysis did not provide the full characterization of ecological benefits using quantitative and qualitative information, as required by the OMB Circular A-4. Instead, the report focused on a limited set of environmental benefits, driven primarily by the ability to monetize these benefits using generally accepted models and existing value measures (benefit transfer).¹⁵⁴ These benefits did not include all of the major environmental benefits that the new CAFO rule would likely generated, nor all of the benefits that

¹⁵³ These include eutrophication of estuaries; reduced pathogen contamination of drinking water supplies; reduced human and ecological risks from hormones, antibiotics, metals, and salts; improved soil properties from reduced over-application of manure; and “other benefits”.

¹⁵⁴ EPA apparently conducted no new economic valuation studies (although a limited amount of new ecological research was conducted) and did not consider the possible benefits of developing new information where important benefits could not be valued in monetary terms based on existing data. The CAFO report emphasizes EPA’s predisposition toward conservative benefits estimates and identifies the lack of adequate data and/or models meeting EPA standards of quality as a basis for truncating the CAFO analysis. [Most of the situations have neither the time or the resources for neww primary research!](#)

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generated public support for the new rule.¹⁵⁵ The Circular requires that a benefit assessment identify and characterize all the important benefits of the proposed rule, not simply those that can be monetized. By focusing only on a narrow set of benefits, the CAFO analysis and report understates the benefits of the rule change and distorts the rationale supporting the final rule.¹⁵⁶ An unfortunate effect of this presentation is to suggest to readers that the monetized benefits constitute the principal justification for the CAFO rule.¹⁵⁷ Although in this case the focus on monetized benefits did not affect the outcome of the regulatory review, it is certainly possible that in a different context, this conservative approach to benefits assessment (based only on easily monetized benefits) could inadvertently undermine support for a rule that would be justified based on a more inclusive characterization of benefits.

Third, the monetary values for many of the emphasized benefits were estimated through highly leveraged benefit transfers that were generally based on dated studies conducted in contexts quite different from the CAFO rule application.¹⁵⁸ [Constrained by resources and time--not a matter of choice](#) This was undoubtedly driven to a large extent by time, data, and resource constraints, which make it very difficult for the Agency to conduct new surveys or studies and virtually force the Agency to monetize benefits using existing value estimates. However, reliance on dated studies in quite different contexts raises questions about the credibility or validity of the monetary benefit estimates. This is particularly true when values are presented as point estimates, without adequate recognition of the underlying limitations, due to uncertainty and data quality.

¹⁵⁵ For example, while the report notes the potential effects of discharging hormones and other pharmaceuticals commonly used in CAFOs into drinking water sources and aquatic ecosystems, the nature and possible ecological significance of these effects is not adequately developed or presented. Similarly, the report does not adequately address the well-known consequences of discharging TMC precursors into drinking-water sources.

¹⁵⁶ One of the benefits of monetary benefit estimates obviously is the ease of aggregating them by simple arithmetic. However, the Committee does not believe that reporting that a rule produced a total of “218.9 million dollars in annual benefits” is necessarily more useful, meaningful, or defensible for environmental policy than reporting, for example, the achievement of a “10% reduction in the pollution of over 129,000 miles of streams and rivers, 3.2 million acres of lakes and ponds, and 2,800 square miles of estuaries.”

¹⁵⁷ In the case of this CAFO rule, 97% of the monetized benefits arise from recreation (boating, swimming and fishing) and from private well owners’ willingness to pay for water quality, estimated using contingent valuation or travel cost methods.

¹⁵⁸ EPA used estimates based on a variety of public surveys in its benefit transfer efforts, including: a national survey (1983) that determined individuals’ willingness to pay for changes in surface water quality relating to water-based recreational activities (Section 4 of the CAFO Report); a series of surveys (1992, 1995, 1997) of willingness to pay for reduced/avoided nitrate (or unspecified) contamination of drinking water supplies (Section 7); and several studies (1988, 1995) of recreational fishers’ values (travel cost, random utility model) for improved/protected fishing success related to nitrate pollution levels in a North Carolina estuary (Section 9).

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Fourth, EPA apparently did not engage in a detailed and systematic effort at the outset to model the rule's ecological impacts. The report presents only a simple conceptual model that traces outputs (a list of pollutants in manure – Exhibit 2-2 in the CAFO report) through pathways (Exhibit 2-1) to environmental and human health effects.¹⁵⁹ This model provided useful guidance, but was not sufficiently detailed to assure an adequately comprehensive and balanced analysis of the rule's ecological impacts. As a consequence the analysis was unduly directed by Agency presumptions (or discoveries) about the availability of relevant data and the likely opportunities to quantify effects precisely and to link and monetize associated benefits. This was undoubtedly driven in part by the time pressures of putting together the regulatory impact analysis. However, without a detailed and comprehensive modeling effort at the outset, EPA had insufficient insight into the potential benefits that needed to be analyzed and valued. Developing integrated models of relevant ecosystems at the outset of a valuation project would also help in identifying important secondary effects, which frequently may be of even greater consequence or value than the primary effects.¹⁶⁰

Fifth, the CAFO analysis clearly demonstrates the challenges of conducting ecological benefit assessments at the national level.¹⁶¹ National rule-makings inevitably require EPA to generalize away from geographic specifics, both in terms of ecological impacts and associated values. However, it is possible (and desirable) to make use of intensive case studies (e.g., individual watersheds, lakes, streams, estuaries) in support of the national-scale analyses. Existing and ongoing research at local and regional scales offers more detailed data and models that could be better exploited, both to fill in gaps and to systematically validate the national-scale analyses. Systematically performing and documenting comparisons to intensive study sites could indicate the extent to which the national model needs to be adjusted for local/regional conditions and could provide data for estimating the range of error and uncertainty in the projected national-scale effects.

Sixth, although EPA invited public comment on the draft CAFO analysis as required by Executive Order 12866, there is no indication in the draft CAFO report that EPA consulted with the public during its analysis to help it identify, assess, and prioritize the

¹⁵⁹ Although EPA later prepared more detailed conceptual models of the CAFO rule's impact on various ecological systems and services, EPA did not prepare these models until after the Agency finished its analysis.

¹⁶⁰ Contamination of estuaries, for example, might negatively affect fisheries in the estuary (a primary effect) but might have an even greater impact on offshore fisheries that have their nurseries in the estuary (a secondary effect).

¹⁶¹ The goal of EPA's analysis was a national level assessment of the effects of the CAFO rule. This involved the effects of approximately 15,000 individual facilities, each contributing pollutants across local watersheds into local and regional aquatic ecosystems. A few intensive case studies were mentioned in the report and used to calibrate the national scale models (e.g., NWPCAM, GLEAMS), but there was no indication that these more intensive data sets were strategically selected or used systematically for formal sensitivity tests or validations of the national-scale model results.

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effects and values addressed in its analysis, nor is there discussion in the final CAFO analysis of any comments received on the draft CAFO analysis. Early public involvement could play a valuable role in helping the Agency both a) identify all of the systems and services impacted by the proposed regulations and b) determine the regulatory effects that are likely to be of greatest value. This would ensure that the benefits assessment includes the most important impacts.

Finally, while EPA in its analysis and report appropriately emphasized the importance of using outside peer-reviewed data, methods, and models, EPA did not seek to peer review its application of them or its integration of these components in deriving benefit values for the CAFO rule. Once again, this is undoubtedly due in part to time and resource constraints. However, peer review, especially early in the process, would help EPA staff identify relevant and available data, models, and methods to support its analysis, and provide encouragement, direction, and sanction for more vigorous and effective pursuit of ecological and human wellbeing effects associated with the proposed rule. The general idea is to have individual components of the analysis (e.g., watershed modeling, air dispersal, human health, recreation, aesthetics) each reviewed, as well as a more general review of the overall analytic scheme.

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AN INTEGRATED AND EXPANDED APPROACH TO ECOSYSTEM VALUATION Formatted: Bullets and Numbering

The CAFO example discussed above highlights a number of limitations to the current state of ecosystem valuation at EPA. The committee's analysis points to the need for a comprehensive, integrated approach to valuing the ecological impacts of EPA actions, one that focuses on the impacts of most concern to people and integrates ecological analysis with valuation. This section describes a proposed framework, based on the committee's deliberations to date. A more detailed discussion of the methods that could be used to implement this framework and the issues that arise in doing so will be provided in a subsequent committee report. The goal in this report is simply to provide an organizing framework to guide the more detailed discussion regarding implementation.

A key feature of the framework outlined here is that it integrates ecological analysis with valuation. This integration needs to occur both at an early stage (in the identification of the impacts that matter) and at a later stage (when estimating the value of impacts). Thus, instead of having ecologists work independently initially to estimate ecological impacts and then "pass the baton" on to economists or other social scientists to value those impacts, it envisions collaborative work across disciplines to ensure that the analysis focuses on the impacts that are of greatest concern and that the ways in which these impacts are defined and measured are informative during the selection and, if necessary, design of the valuation techniques/methods. Such a framework requires a committed dialog among the relevant bio-physical, ecological, and social/economic scientists and analysts. The various disciplines must reach out to establish useful and credible links to each other. This interaction should commence at the beginning of the process and continue until the completion of the analysis. Ecological models need to be developed, modified, or extended to provide usable inputs for value assessments. Likewise, valuation methods and models need to be developed, modified, or extended to address important ecological/bio-physical effects that are currently underrepresented in value assessments.

In addition, the framework envisions the use of a variety of methods to characterize and measure importance of changes in ecosystem, including economic methods, social/psychological assessments, and ecological approaches. The suite of methods to be used will vary with the specific policy context, due to differences across contexts in: a) information needs, b) the underlying sources of value being captured; c) data availability; and d) methodological limitations. The framework should serve as a guide to EPA staff as they conduct RIAs and seek to implement the provisions of Circular A-4 (including the provisions relating to benefits that are not readily quantified or monetized), as well as in regional decision-making and program assessment.

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The proposed framework has three main components: a) identify the context and scope of the benefit assessment, b) identify the ecological services that will be considered in the assessment, and c) characterize, represent or measure those impacts in bio-physical, human, and/or monetary terms. This proposed framework would parallel the

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Agency's Framework for Ecological Risk Assessment (U.S. Environmental Protection Agency Risk Assessment Forum 1992) and ultimately be merged with it as part of a broader framework for ecological assessment.

Context and Scope

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As noted above, ecological benefit assessment can play a key role in a number of different decision contexts, including national rule-making, local/regional decision-making, and program evaluation. There is a need to formulate the benefit assessment problem within the specific EPA context. These contexts differ not only in the required scale for the analysis (e.g., national vs. local) but possibly also in the type of information measuring importance of the changes that is needed, i.e., whether it requires that benefits be characterized or measured in terms of bio-physical impacts, or the resulting impacts on humans, or both.

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The information needed for a given policy decision will in turn depend on the decision approach to be used in evaluating alternatives. On needs to distinguish measure of importance from what is needed to meet the requirements of 12291 or 12866. Importance can be evaluated in a variety of ways and reported as added information with measures of economic tradeoffs. The rule to be used could be dictated by statute, regulation, or executive order, or could be determined by the EPA staff. Possible approaches include measurement of (expected) net present value (based on cost-benefit analysis), characterization of the (expected) cost of meeting a given goal (cost-effectiveness), consideration of the implications of a safe minimum standard, or of the precautionary principle, or of a moral or rights-based rule based on intrinsic value. If a strict cost-benefit rule is to be used in a rule-making context, aggregate dollar values of benefits (and costs) are needed. don't agree this is feasible on the same terms as economic benefits

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Decisions about the ecological services to be included in the analysis should be based on an assessment of the impacts that are likely to be most important, depending on both the magnitude and bio-physical importance of the effect and the resulting impact on humans.

3.2.1 Identifying Potentially Important Bio-Physical Impacts. The bio-physical impacts of a given EPA action can be identified at different levels. These include the individual level, the population level, the community level, the ecosystem level (union of biological populations with their surrounding physical environment), and the level of the global biosphere. Ecological science is organized according to these scales. For the purposes of ecological benefits assessment, ecological impacts correspond to changes in functions or services provided by the ecosystem, as described above. Living organisms supply goods and services that differ across all levels of organization, from the individual to the ecosystem or global biosphere. For example, the service provided by an individual animal unit is different from the service provided by a given animal population.

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Many types of ecological models exist at various levels (e.g., population, community, ecosystem, biosphere) to predict impacts of perturbations on ecosystems. Some have been developed for specific contexts (species, geographic locations) while others are more general. In some cases “off-the-shelf” models may be available, while in others existing models may need to be modified or new models developed. **(what should we say about the current state of ecological modeling???** We need the committee to discuss and come to some agreement about this.)

In identifying possible impacts, it is important to consider their full range, including both primary and secondary effects, adequately accounting for uncertainty (incomplete information), (in)stability of the system (including the effect of random shocks or management errors and the system’s resilience), heterogeneity within a population or ecosystem, heterogeneity across populations or ecosystems, and dynamic changes in the ecosystem over time. Ecosystems are complex, highly variable systems with many interacting parts. They are subject to both natural and anthropogenic disturbances that can propagate through the system in ways that are difficult to predict. The complexity, variability, and potential instability of the systems need to be considered when identifying impacts with the greatest ecological significance.

3.2.2 Identifying What Matters to People. For benefit assessments based on anthropocentric values, it is important to identify early in the process what people care about, i.e., which ecological services or functions are important to them. For example, are individuals likely to value the re-introduction of native grasses into a marshland, or would they be just as happy with non-native grasses that perform similar ecological functions and aesthetic appeal? Is animal waste disposal a concern to people primarily because of the recreational opportunities lost due to the resulting deterioration in water quality, or are they primarily concerned about other impacts? The range of services that are the focus of the benefits assessment needs to include the services people care most about. don’t agree --confusing benefits transfer with benefit measurement

Information about what matters to people can be obtained in a variety of ways. Examples include survey information (from past surveys or surveys conducted specifically for the benefit assessment) or the results of previous valuation studies. In addition, early public involvement¹⁶² or use of focus groups or workshops comprised of representative individuals from the affected population and relevant scientific experts can help to identify relevant or potentially important ecological services for the specific context of interest. **(Add something about group processes here?)**

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In eliciting information about what matters to people, it is important to bear in mind that what people say they care about depends on both their preferences and their

¹⁶² This could include either a robust public involvement process following Administrative Procedures Act requirements (e.g., FR publication), or some other public involvement process [see EPA’s public involvement policy, (U.S. Environmental Protection Agency Office of Policy 2003) and the SAB report on science and stakeholder involvement (U.S. Environmental Protection Agency Science Advisory Board 2001)].

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information, i.e., the extent to which they are informed about an ecological system and the services it provides. Survey respondents or even members of a focus group may have preferences that are representative of the general population but may not be fully informed. Expressions of what is important (e.g., in surveys) can change with the amount of information provided. Collaborative interaction between analysts and public representatives can ensure that respondents have sufficient information when expressing preferences. **(Add something about constructed preferences here?)**

The information about those ecosystem functions and services that are important to people and potentially impacted significantly should then be integrated to select the services to include in the assessment. As noted above, this requires a collaborative effort and dialogue among analysts from a variety of disciplines early on in the valuation process.

Measuring Benefits

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Given the services to be included in the assessment, the impact of the EPA action on those services needs to be characterized and, when possible, measured or quantified. To measure impact on humans, the bio-physical measures of ecological impact need to be translated into their effects on the goods and services provided by those ecosystems to humans. These impacts can be measured in non-monetary terms (e.g., population affected, duration of effect, etc.) or, in contexts where benefits are to be compared directly to costs, in monetary terms if possible.

Estimating bio-physical impacts requires information about the ecological production function for the services being considered. This allows an estimation of the *change* in the level of services that could result from a given EPA action or policy. (e.g., percent reductions/avoidances of pollution in streams and lakes, reduced/avoided eutrophication of estuaries, reduced risk from the introduction of hormones and antibiotics into aquatic systems, improved/protected quality of community drinking water sources). As when selecting the services to be considered, in estimating the effect of a given action on those services, it is crucial to account for the complexity of ecosystems. In particular, predicted changes need to account for the interconnectedness of ecosystems, uncertainty about how the systems operate, possible instability of the system (including the effect of random shocks or management errors and the system's resilience), heterogeneity within a population or ecosystem, heterogeneity across populations or ecosystems, and dynamic changes in the ecosystem over time. This complexity and the associated uncertainty underscore the importance of presenting ranges rather than point estimates of values when possible.

In some contexts (e.g., endangered species) where bio-physical impacts are the primary concern, the benefit assessment can end with quantification of the impact of the EPA action on these bio-physical indicators. However, when EPA policies are to be evaluated in terms of impact on humans, the bio-physical effects must be translated into the corresponding impacts on the flow of goods and services that humans value. First and foremost, this requires that the output from the ecological impact assessment be in a

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form that can be used as an input in estimating the importance of the change in ecosystem services. Again, this requires that ecologists work closely with other disciplines to ensure that the ecological assessment is designed from the start with this requirement in mind.

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To translate bio-physical impacts into human benefits, it is necessary to project how ecosystem changes will affect humans through changes in the flow of the goods and services they provide. The extent of the impact on humans can be measured in non-monetary terms using a variety of metrics, such as the number and characteristics of the people/communities affected, the number significantly affected, the likely symptoms avoided or reduced, and the duration of the impact.

Estimation of impact on humans in terms of the extent of exposure or similar measures is crucial in three possible ways. no this is misleading. Second, even in contexts where monetary measures of value are sought, the human benefits captured by information on exposure or symptoms need to be translated into their monetary equivalents. This requires an understanding of those impacts on humans before this translation can occur. Third, in some cases where monetary values are sought, it may not be possible to monetize all benefits due to data or methodological constraints. In these cases, there may be a tendency simply to “ignore” the benefits that cannot be monetized. Using methods that defensibly report the magnitude and human significance of such effects, rather than ignoring them, would allow the policymakers to draw their own conclusions regarding the associated potential value or benefit. Thus, in all of these cases, estimates of the impact of the ecosystem change on human populations are needed.

Deleted: First, in some contexts, decisions based on moral or religious principles (e.g., protection of children’s health) may look directly to these measures as indicators of the appropriate policy choice

In contexts where monetary metrics are sought and the necessary data and methods exist, the impact of the ecosystem change on the provision of services to human populations can be translated into a monetary equivalent of that change using standard economic valuation techniques to determine the tradeoffs that people are willing to make. Economic or monetary methods for valuing changes are relatively well-developed. They are designed to estimate the benefit or cost of a given change in ecological services using a willingness-to-pay or willingness-to-accept measure of the utility equivalent of that change. These methods have been applied to the valuation of ecosystem services in a number of studies that have produced results that are useful for policy evaluation. However, as in the CAFO study, monetary valuation methods have generally been applied to a relatively narrow set of services. In some cases, these might not have been the services that people are most concerned about protecting. There is a need to expand the range of services to which economic valuation is applied.

As with ecological impacts, in estimating the values of impact on humans in either monetary or non-monetary terms, it is necessary to address cross-cutting issues such as uncertainty (randomness, level of information), dynamics, scale (temporal, geographic), and heterogeneity (spatial variability, heterogeneity across people). In subsequent reports, the committee will assess the challenges of uncertainty arising out of data limitations, theory limitations, and randomness, and will recommend approaches for

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reducing uncertainty and conveying the magnitude and nature of uncertainty to policymakers.

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CONCLUSIONS AND RECOMMENDATIONS

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[to be added]

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¹ Many empirical studies find that money does not buy happiness – or that preference-satisfaction does not correlate with perceived well-being after basic needs are met. See, for example, Robert Samuelson, *The Good Life and Its Discontents: The American Dream in the Age of Entitlement* (New York: Knopf, 1997), e.g., p. 56; R. E. Lane, *The Market Experience* (New York: Cambridge University Press, 1991); and Michael Argyle, “Causes and Correlates of Happiness,” in Daniel Kahneman, Ed Diener and Norbert Schwarz (eds). *Well-Being: The Foundations of Hedonic Psychology* (New York: Russell Sage Foundation 1999), pp. 353-373. See also, Richard Easterlin, “Does Economic Growth Improve the Human Lot?” in *Nations and Households in Economic Growth: Essays in Honor of Moses Abramovitz*, ed. Paul David and Melvin Reder (New York: Academic Press, 1974); Richard Easterlin, “Will Raising the Incomes of All Increase the Happiness of All?” *Journal of Economic Behavior and Organization* 27 (1995), pp. 35–47; David G. Myers, *The Pursuit of Happiness: Who is Happy and Why?* (New York: Avon, 1993). Researchers consistently find that among people who are not poor, rising

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income correlates with unhappiness due to higher divorce rates (Clydesdale, T.T., “Family behaviors among early U.S. baby boomers: Exploring the effects of religion and income change, 1965–1982 *Social Forces* 76(1997), pp. 605–635); greater stress (Thoits, P. and M. Hannan, “Income and psychological distress: The impact of an income-maintenance experiment,” *Journal of Health and Social Behavior* 20(1979), pp. 120–138); depression (Diener, E., Sandvik, E., Seidlitz, L., & Diener, M, “The relation between income and subjective well-being: Relative or absolute? *Social Indicators Research*, 28, 253-281); and many other reasons (Brickman, P., D. Coates and R. Janoff-Bulman, “Lottery winners and accident victims: Is happiness relative?” *Journal of Personality and Social Psychology* 36 (1978), pp. 917–927). Robert Frank argues that “gains in happiness that might have been expected to result from growth in absolute income have not materialized because of the ways in which people in affluent societies have generally spent their incomes.” Robert Frank, “How Not to Buy Happiness,” *Daedalus* 133(2) (Spring 2004): 69-79. Frank argues quite plausibly that subjective well-being or satisfaction does not correlate with how much one paid for a good but with the kind of good it is. The classic study of consumer dissatisfaction – the fact that the more you pay for a good the greater is your resentment when the purchase disappoints – is A. O. Hirschman’s *Exit, Voice, and Loyalty* (Harvard University Press, 1970).