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4 EPA-SAB-ADV-05-00?

5
6 Mr. Stephen L. Johnson
7 Acting Administrator
8 U.S. Environmental Protection Agency
9 1200 Pennsylvania Avenue, NW
10 Washington, DC 20460

11
12 Subject: Advisory Review of EPA's Draft *Ecological Benefits Assessment*
13 *Strategic Plan*; An Advisory by the SAB Committee on Valuing the
14 Protection of Ecological Systems and Services
15

16 Dear Mr. Johnson:
17

18 The SAB would like to commend the Agency for preparing the draft *Ecological Benefits*
19 *Assessment Strategic Plan* and for providing it to the SAB's multi-disciplinary Committee on
20 Valuing the Protection of Ecological Systems and Services for review. The Board strongly
21 supports efforts to strengthen the science and analysis supporting decisions protecting ecological
22 resources.
23

24 The Board sees merit in many of the specific recommendations in the draft plan. The
25 effort to array issues across EPA's national program offices and identify potential actions
26 important to all of them shows impressive collaboration and information sharing. Indeed, many
27 of the recommendations in the draft plan, especially in the area of ecological assessment, are
28 innovative and creative.
29

30 More important, however, than any specific issues or actions, is the need for the Agency
31 to develop an expanded new framework for evaluating ecological effects of policies and linking
32 them to methods for measuring the economic benefits and non-economic considerations in
33 evaluating these policies. It is also important to develop a strategy for implementing this
34 framework and communicating its implications to Agency personnel and the general public. On
35 January 25, 2005, the Committee on Valuing the Protection of Ecological Systems and Services
36 was informed that the goal of the draft plan was "to advance EPA's ability to identify, measure,
37 value, and communicate the ecological benefits of its actions in order to improve EPA decision-
38 making at the national, regional and local levels." The SAB believes that it is a priority to assess
39 the benefits of ecological protection because life depends on the benefits ecosystems provide.
40 The Board believes that improvements in ecological benefit assessment are essential for the
41 success of EPA's Strategic Plan, where protecting "healthy communities and ecosystems" is one
42 of EPA's five major goals.
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6 structured to provide balanced, expert assessment of scientific matters related to problems facing
7 the Agency. This report has not been reviewed for approval by the Agency and, hence, the
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1. EXECUTIVE SUMMARY

The SAB commends the Agency for preparing the draft *Ecological Benefits Assessment Strategic Plan* and for providing it to the SAB's multi-disciplinary Committee on Valuing the Protection of Ecological Systems and Services for review. The Board strongly supports efforts to strengthen the science and analysis supporting decisions protecting ecological resources.

The Board sees merit in many of the specific recommendations in the draft plan. The effort to array issues across EPA's national program offices and identify potential actions important to all of them shows impressive collaboration and information sharing. More important, however, than any specific issues or actions, is the need for the Agency to develop an expanded new framework for evaluating ecological effects of policies and linking them to methods for measuring the economic benefits and non-economic considerations in evaluating these policies. It is also important to develop a strategy for implementing this framework and communicating its implications to Agency personnel and the general public.

The SAB provided the following specific advice to strengthen the plan:

- There is a need to identify more clearly the role of ecological benefits assessment in Agency decision-making.
- There is a need to revise the plan so it serves as a “roadmap” that links actions to the objectives of the plan.
- There is a need to adopt, communicate, and help implement a new integrated framework for assessing the benefits of ecological protection.
- The Agency should develop criteria and a process for prioritizing the many issues and actions that will be described in the draft document.
- The Agency should use the plan to design parallel tracks to ensure short-run results to improve analyses of ecological benefits and plan for long-run research.
- The Agency should take a more integrated approach to defining and presenting issues and actions.
- The Agency should further address the issue of uncertainty associated with ecological benefits to identify and quantify sources of uncertainty in estimating benefits under different approaches, and to link this identified need to an implementation plan.
- The Agency should build on existing data collection and method development efforts where possible, not start new ones.
- The plan would benefit from a strengthened discussion of how the ecological benefit assessment framework would involve the lay public and communicate with it.
- The plan should address institutional issues associated with improving ecological benefit assessments.
- The plan should be revised to discuss implementation mechanisms more specifically.
- The committee emphasizes the importance of developing support for the plan and viable mechanisms for making progress on the actions identified.

2. INTRODUCTION

2.1. Background

On January 25, 2005, the SAB Committee on Valuing the Protection of Ecological Systems and Services met to receive a briefing on an EPA draft document, *Ecological Benefits Assessment Strategic Plan* (EBASP or "the plan") and to provide an advisory review of that plan. The plan was authored by a cross-Agency workgroup, under the direction of an Agency steering committee. The stated goal of the plan was "to improve EPA's ability to identify, quantify, and value the ecological benefits of its activities, in order to provide decision-makers with a better basis for choosing among environmental policy options."

The Agency requested that the SAB committee address six charge questions:

Charge Question 1: "Given the audience¹ described in Section 1.4., does the Plan adequately address the objectives described in Section 1.1.?"²

Charge Question 2: "Are the issues described in Section 4 the most important ones that EPA should address to improve its ability to identify, quantify, and value the ecological benefits of its activities? If not, what issues should be added?"

Charge Question 3: Are there actions in Section 4 that are the most important for EPA to undertake at this time to improve its ability to conceptualize, identify, quantify, and value the ecological benefits of its activities? Do the actions respond to the identified issues? Are there actions that are missing?

Charge Question 4: Are there other actions you would recommend?

Charge Question 5: Are there specific research approaches, or research projects, on which the Agency should focus?

Charge Question 6: Is the proposed implementation plan adequate?

¹ Agency Description of Audience for Strategic Plan (Section 1.4)

- EPA managers and analysts who devote time or other resources toward basic or applied research in areas of ecology, related natural sciences and economics relevant to ecological benefit assessment.
- EPA analysts developing action plans to guide future investments in ecological benefits assessment.
- Researchers in academia, other federal agencies and members of public -- to inform about EPA's need and objectives

² Agency Statement of Objectives (Section 1.1)

- Describe technical and institutional issues that prevent the Agency from conducting accurate and comprehensive ecological benefit assessments.
- Direction for future research, data collection and development of analytical tools.
- Propose activities to foster increased collaboration and coordination among Agency's ecologists, economists, and other analysts in ecological benefits assessment.
- Propose institutional mechanisms to facilitate adaptive implementation of plan and adjustment to reflect scientific progress.

1 **2.2. Process for Developing this Advisory and the Structure of this Report**

2 The committee discussed the six charge questions at its face-to-face meeting on January
3 25, 2005. After the meeting a sub-committee of the full committee (writing group) developed a
4 draft document based on committee discussions and preliminary written comments provided by
5 members of the committee. The writing group prepared a draft for full committee discussion at a
6 public meeting held on April 13, 2005.

7
8 Because much of the advice provided by the committee pertained to multiple charge
9 questions, the structure of this report does not strictly mirror the six charge questions initially
10 presented to this committee. Instead, section 3, "Principal Recommendations" addresses charge
11 question 1 and parts of charge questions 2 and 3 as they pertain to prioritization of issues and
12 actions. Section 4, "Recommendations Regarding Proposed Issues and Actions," discusses
13 charge question 2, 3, 4 and 5 as they pertain to specific issues and actions discussed in the plan,
14 and additional issues and actions, including research projects, that the committee advises be
15 addressed. Section 5 addresses implementation issues raised in charge question 6. Appendix A
16 contains specific suggestions for changes in the text to strengthen the plan.

3. PRINCIPAL RECOMMENDATIONS

3.1. Identify More Clearly the Role of Ecological Benefits Assessment in Agency Decision-Making

The plan should recognize the importance of ecological benefits assessment in a variety of EPA decision contexts, including both national regulatory analysis as well as in the review and evaluation of local and regional environmental planning. The key question that needs to be addressed here is: why is it important to assess the benefits of protecting ecological systems and services? Section 1.2 focuses almost exclusively on its role in benefit-cost analysis to support national rulemaking, and Section 1.4 (Intended Audience) reflects this focus. However, the importance of ecological benefits assessment goes well beyond this, and the committee urges the Agency to think more broadly about how information about ecological benefits might be used to improve decisions in a variety of contexts. In addition, some decision contexts (e.g., regulatory analysis) require that benefits be expressed in dollar terms, while in other contexts having a single aggregate dollar value of benefits may not be appropriate or necessary. A broader recognition of the various contexts in which benefits information might be useful and the differing needs within those contexts would expand the plan's relevance and usefulness.

The plan should also reference the importance of benefits assessment in realizing the goals of the *2003-2008 EPA Strategic Plan; Direction for the Future* (EPA, 2002). It should provide the reader with a clear discussion of the need for identifying, quantifying, and valuing changes in ecosystem services. The committee advises the Agency to communicate through the plan the importance of ecological benefits and to convey the goal and the key elements of the plan in positive, direct terms. Rather than emphasizing historical and methodological hurdles, the message should be that the benefits of ecological protection are important to quantify, that life depends on some of the services of ecosystems, and that one of EPA's goals is to protect ecological resources. Language in the foreword, the initial paragraphs of the executive summary, and the introduction especially should be revised in this light.

In addition, the Committee advises that the Agency clarify that the scope of the plan is intended to include not just research, but also broader institutional and organizational changes needed to make progress in ecological benefit assessments. There is also a need to revise the plan to clarify that the scope was not limited to national benefit assessments and to state clearly that EPA regional needs for benefit assessments are to be addressed in the plan. It will be important to specify that regional analysts and managers are a potential audience for the plan and to involve them in future revisions and discussions about implementation.

Finally, the committee advises the Agency to clarify early in the structure of the report how the term "benefits" is used, and the types of benefits that are the focus of this effort. The recent Millennium Assessment reports (Millennium Ecosystem Assessment 2005; Millennium Ecosystem Assessment Board 2003) can provide guidance to the Agency on definitions. In addition, the committee recommends that a revised draft use the recent National Research Council (NRC) report, *Valuing Ecosystem Services* (NRC 2004), as a source and a model for

1 acknowledging the kinds of value that are amenable to capture through economic valuation
2 methods (the focus of much of this report) and the types of values that are not.
3

4 **3.2. Revise the plan so it serves as a "roadmap" that links actions to the objectives of the** 5 **plan**

6 To be strategic, the plan needs to address the following three questions: (a) what is the
7 current state-of-the art in ecological benefits assessment at EPA?; (b) what are the most
8 important current gaps in knowledge or institutional/procedural obstacles that limit the Agency's
9 ability to do effective ecological benefits assessment; and (c) how is the Agency planning to fill
10 the knowledge gaps or overcome the institutional/procedural hurdles over the next five or so
11 years? The draft report addresses these three questions to some extent. However, the committee
12 notes that the links between these questions are not clearly identified in the plan. Chapter 3 is a
13 brief introduction to the state-of-the-art in ecological and economic assessments, which
14 concludes with a call for an integrated benefits assessment process. Thus, the main "gap"
15 identified in this review is the lack of integration between ecological and economic assessment.
16 The committee agrees that this is a key gap. While this gap provides justification for some of the
17 issues/actions in Chapter 4, many of the issues/actions in Chapter 4 are unrelated to it. As a
18 result it is not clear how the implementation of the plan will help to address the gap. In addition,
19 the commitment to a multi-disciplinary approach in Chapter 3 is largely undone in Chapter 4,
20 where ecological and economic assessments are once again described as if they were activities
21 that could be undertaken separately. Most importantly, Chapter 4 provides a list of issues and
22 possible actions, not a roadmap. The most important action, "develop guidelines for planning
23 and conducting ecological benefits assessments," is buried in Section 4.2.1. This statement of a
24 goal, rather than a listing of issues and possible actions, should be the purpose of the strategic
25 plan.
26

27 The committee advises the Agency to review the current state-of-the-art in ecological
28 benefits assessment for the purpose of explicitly identifying the primary knowledge gaps or
29 obstacles (beyond the lack of integration), and then to link these gaps or obstacles to specific
30 issues/actions. This overview would allow readers to clearly see the relationship of planned
31 actions to desired objectives and needs. It is especially important to recognize the relationship
32 between planned research activities and improved capacity for conducting benefit assessments.
33 Such a roadmap will promote understanding of how components of the plan relate to its
34 objectives and also provide the basis for marking the Agency's progress in meeting its
35 objectives.
36

37 **3.3. Adopt, Communicate, and Help Implement a New Integrated Framework for** 38 **Assessing the Benefits of Ecological Protection**

39 The committee appreciates the ambitious scope of the draft plan. However, the plan
40 would be more effective as a document for its intended audience and as a guide to
41 implementation if it were organized more consistently around a comprehensive framework for
42 benefits assessment. Thus, the committee advises the Agency to build on the draft by adopting,
43 communicating, and implementing a framework for assessing the benefits of protecting

1 ecological systems as integrated units as well as the identifiable services they provide.
2 Considering ecosystem impacts in this way is expected to offer complementary strategies for
3 assessment and to assure that interdependencies across components of ecosystems are
4 recognized.

5
6 The draft plan does include Figure E-1, "Stylized representation of an integrated
7 ecological benefit assessment," which is a starting point for such a framework. The committee
8 sees a need, however, for EPA to improve this figure so that it can serve as a guide for
9 implementation and as a communication tool for the intended audiences (i.e., EPA managers and
10 analysts engaged in planning research and analysis supporting EPA decisions and researchers in
11 academia, other federal agencies and members of public). The figure displays roles for both
12 economics and ecology in the assessment process at various stages and the title includes the
13 word "integrated." However, the descriptions in the individual boxes are confusing. They do
14 not provide sufficient indication of the integration across multiple disciplines that is needed at
15 the various stages of the assessment process. The boxes seem to imply that management
16 decisions concerning both the character of endpoints to be considered in the assessment and the
17 strategies for addressing them are made early in the process (before the benefit assessment is
18 complete) and that activities associated with quantifying the "valuation" information enter the
19 process at the end, after the physical impacts have been assessed. What is needed instead is an
20 explicit recognition that the first stages of the benefits assessment process (the selection of
21 assessment endpoints) require ecologists, economists and other social scientists to work together
22 to identify not only the set of affected ecological endpoints (e.g., physical impacts) but also those
23 that are most important to society. Valuation can play a role not only in estimating the value of
24 changes in goods and services that would result from a given action (as depicted in Figure E-1),
25 but also in informing the strategic decisions associated with the design of the overall benefits
26 assessment. It can provide general information about the ecological goods and services that
27 seem to be most important to people and hence should be the focus of detailed valuation work in
28 the specific context of interest. In addition, it can help analysts and policy makers decide the
29 alternatives to be valued in the overall benefits assessment.

30
31 The Committee thus calls for a framework that: a) integrates ecological, economic and
32 other related assessments throughout a project; b) depicts the complexity and potential for
33 interaction effects within the process of benefits assessment; and c) identifies how stakeholders
34 relate to the ecological benefit assessment process. There are a number of existing frameworks
35 that could provide the basis for an approach that could be adopted here. Recent studies focusing
36 on ecological benefits assessment include the Millenium Assessment (Millennium Ecosystem
37 Assessment Board 2003) and the recent report by the National Research Council on ecosystem
38 valuation (National Research Council 2004).

39
40 In addition, the committee notes that ecological benefits assessment faces a challenge
41 similar to that faced by health scientists, economists, and other scientists after publication of *Risk*
42 *Assessment in the Federal Government* (NAS 1983), the NAS study of human health risk
43 assessment known as *The Redbook* and used at EPA. There is need to provide a framework that
44 is similarly compelling to provide an organizing logic to rationalize and organize the available
45 information on ecological benefits. This framework could also be a catalyst in motivating action
46 on addressing the components of the research where information is not available. Although the

1 plan refers to the Agency's *Guidelines for Ecological Risk Assessment* (EPA 1998) and derives
2 much of Figure E-1 from the basic paradigm in the *Guidelines*, it states that "ecological risk
3 assessments are designed to address different questions than those posed by ecological benefits
4 assessments" (p. 19). While the questions driving the assessments may be different, the need for
5 an integrated and logical approach to assessment is the same in both contexts. The problem
6 formulation stage, during which ecologists, economists, and other scientists need to consider
7 jointly the strategy that will be used for ecological assessment and measurement endpoints and
8 the metrics for valuation, provides a striking example of the need for an integrated, logic-based
9 approach. More generally, risk assessments involve characterizing the processes that give rise to
10 different types and levels of risks and allow identification of how different policies could alter
11 one or more constituent elements of those processes. This logic has allowed economic
12 assessment to consider the tradeoffs people would be willing to make to realize comparable risk
13 changes. While the strategy is far from perfect (e.g., the definitions of the events at risk and the
14 interdependencies among them have not been structured in ways that facilitate measuring
15 tradeoffs for interrelated sequences of activities), it has allowed greater coordination in activities
16 associated with preparing regulatory impact assessments and in designing research that attempts
17 to address the limiting assumptions of current methods. It provides an approach to assessment
18 that could be applied in the context of ecological benefit assessment as well. The Committee
19 advises the Agency to exploit the parallels between risk assessment and ecological benefit
20 assessment in developing an integrated framework within the Strategic Plan.

21
22 In calling for the Agency to develop a revised framework, the Committee also notes the
23 need for broader involvement by a variety of disciplines, whose expertise, methods, and data can
24 inform both the problem formulation stage and the economic valuation stage. Figure E-1
25 provided in the Agency's draft plan is bi-disciplinary in orientation, focused only on ecological
26 and economic assessment. There is need to acknowledge that a fuller range of sciences may be
27 necessary to assess the full range of values relevant to decision making. A framework that
28 allows for contributions from bio-physical, natural resource, health, psychological, social, and
29 political sciences is needed.

30 31 **3.4. Develop and Implement a Process for Prioritizing Issues and Actions.**

32 Given the advice summarized above concerning the need to develop an integrated
33 framework for benefit assessment and to clarify consistently the need for ecological benefits
34 assessment, the committee did not respond directly to charge questions two and three regarding
35 its view of priority issues and actions. Instead, the committee advises the Agency itself to
36 develop criteria and a process for prioritizing the 27 issues and 47 actions described in the draft
37 document. Such a process will be essential for implementing a revised strategic plan.

38
39 The committee notes that the draft plan described a history of meetings and workshops
40 focused on ecological benefits, where experts identified issues and recommended solutions to the
41 problems raised. These interactions, however, do not substitute for a focused effort in the
42 Agency to set priorities. Although such meetings and workshops are essential to solicit broad
43 input from the various professional communities, their findings are not sufficient to establish an
44 organization's priorities in a strategic plan. The plan, apparently deliberately, stops short of
45 setting any priorities. The current draft identifies "considerations for prioritizing Agency

1 actions” in Chapter 5 on Implementation, but states that it has not outlined a specific set of
2 priorities. Without this, however, the plan does not offer what is claimed -- a “roadmap for an
3 incremental and sustained effort” to improve ecological benefits assessment. If the plan is to be
4 a roadmap and provide direction for future research or resource allocation, then considerations
5 for prioritization should drive the discussion of issues/actions rather than follow it. Rather than
6 identifying a wide range of possible actions that might be of interest (a “wish list”), it needs to
7 identify the gaps/issues/actions that are most crucial in advancing the Agency’s ability to
8 conduct meaningful ecological benefits assessment. This does not mean that the plan must
9 specify priorities within program offices, but rather that it should set broad priorities that would
10 provide guidance to specific program offices when setting program-specific priorities.
11

12 Committee members discussed a variety of possible criteria for the Agency to use in
13 setting priorities across actions and several possible processes to use. In addition to those
14 suggested in Text Box 3 of the draft plan (p. 61), other possible criteria suggested by the
15 committee include the extent to which the proposed research would reduce uncertainty and
16 whether the proposed actions would contribute substantially to the Agency’s ability to assess
17 non-use benefits. Whatever criteria and process the Agency chooses, the committee advises that
18 the Agency describe them explicitly in a revised strategic plan, so that the reader can understand
19 how and why the decisions were made.
20

21 **3.5. Design parallel tracks to ensure short-run results and plan for long-run research**

22 The committee advises the Agency to retain a dual focus in the strategic plan: 1) actions
23 designed to make short-term progress where there is ability to integrate information on the value
24 of ecosystem services and to have that information appear quickly in Regulatory Impact
25 Analyses or other documents supporting Agency decisions, and 2) actions that contribute to a
26 long-term research agenda to build over time the knowledge needed for comprehensive benefit
27 assessments. Although a dual focus is challenging, members saw benefits in selecting near-term
28 priority actions, where success could be measured and build enthusiasm for longer-term efforts.
29 Members note that EPA’s air and water legislation impose a schedule for revisiting regulations
30 within certain timeframes. This schedule could impose a structure for ongoing planning for
31 integrated ecological benefits assessment at the national and regional scales that would have
32 practical results for improving high-priority benefit analyses and advance the science in general.

33 **3.6. Summary of responses to charge questions addressed in this section**

34 Charge Question 1: Given the audiences described in Section 1.4., does the Plan
35 adequately address the objectives described in Section 1.1.?”

36 Response: The plan partially addresses the objectives, although there is a need: 1) to
37 identify more clearly the role of ecological benefits assessment in Agency decision-making; (2)
38 to revise the plan so it serves as a “roadmap” that links actions to the objectives of the plan; (3)
39 to adopt, communicate, and help implement a new integrated framework for assessing the
40 benefits of ecological protection; (4) to develop and implement a process for prioritizing issues
41 and actions; and (5) to design parallel tracks to ensure short-run results and plan for long-run
42 research.
43

1 Charge Question 2: Are the issues described in Section 4 the most important ones that
2 EPA should address to improve its ability to identify, quantify, and value the ecological benefits
3 of its activities? If not, what issues should be added? Charge Question 3: Are there actions in
4 Section 4 that are the most important for EPA to undertake at this time to improve its ability to
5 conceptualize, identify, quantify, and value the ecological benefits of its activities? Do the
6 actions respond to the identified issues? Are there actions that are missing?
7 Response: The committee does not identify priority issues and actions in this report and
8 instead advises the Agency itself develop criteria and a process for prioritizing the many issues
9 and actions that will be described in the draft document.

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4. RECOMMENDATIONS REGARDING PROPOSED ISSUES AND ACTIONS

Given the general advice summarized above, the committee limited its advice on the proposed issues and actions in the draft plan to the topics below.

4.1. Define and present issues and actions in ways that highlight an integrated scientific approach

As noted above, the committee commends the Agency for proposing an "integrated ecological benefit assessment" in the draft plan and advised that such an approach called for an integrated definition and presentation of issues and actions in the Executive Summary and throughout the plan. However, the draft report presents issues/actions primarily along disciplinary lines (ecological vs. economic issues). A more integrated approach would organize issues/actions in a way that emphasizes the need for an interdisciplinary approach. The committee notes, for example, that the need to establish baselines (section 4.5.1 of the draft plan under "Analyzing Ecological Changes") was not unique to ecological condition and indeed cannot even be addressed in isolation from social and economic conditions. The committee advises that it would be more consistent with an integrated approach to involve ecologists, economists, and other scientists jointly in the problem formulation stage to characterize baselines and project changes in ecological and social conditions in a coordinated way for any given decision. Similarly, the committee notes that social systems that help to define "ecological benefits" are as dynamic as the ecological systems that determine the endpoints to which benefits are linked. Immigration and aging, for example, produce shifts in demographics that affect demand for ecological services. Therefore, the committee advises the Agency to project and evaluate socio-economic factors in coordination with ecological changes. Coordinated monitoring of ecological and social outcomes would seem to be essential for: a) confirming that socio-economic effects of ecological changes (endpoints) were accurately projected by the prior benefits assessments; b) ascertaining whether wants and needs of society were changing separately or in interaction with ecological changes (potentially changing what constitutes "ecological benefits"); and c) determining whether social responses to regulations and/or changed environmental conditions were feeding back in productive or destructive ways affecting the targeted ecological concerns (a concern addressed at the end of section 4.6.1 of the draft plan).

The committee advises that a similarly integrated approach should be taken regarding comparative studies of different methods. The committee advises the Agency to integrate its approach to conducting comparative studies of alternative ecological indicators (section 4.5 of the draft plan) not only with its assessment of the contributions and limits of economic assessment methods (section 4.6), but also with assessment of other methods described in the draft as "supplemental methods" (section 4.7).

1 **4.2. Articulate more clearly the role for alternative methods as part of an integrated**
2 **approach**

3 Given that some sources of value cannot be captured through economic valuation, and the
4 practical issues that make it difficult to quantify and to monetize even those values amenable to
5 capture through economic methods, the committee supports the plan's call for further
6 investigation of what are termed "supplemental" methods in the report as "alternative" methods.
7 At this point in time, the committee is still discussing the nature, scope, relative utility, and
8 possible contributions of such methods and intends to provide guidance on the use of these
9 methods in a future committee report.

10
11 At this stage, the committee advises the Agency not just to pilot and evaluate
12 supplemental or hybrid approaches alone, as described in section 4.7 of the draft plan, but rather
13 consider their role as part of an information package. The committee advises the Agency to
14 include an action that will call for the use of ecological, economic and other methods to support
15 decision making and a systematic evaluation of the usefulness and limitations of those methods
16 as part of the analytical information provided to decision makers. Results from each method or
17 class of methods that measure different concepts should be identified separately to avoid
18 confusion that might arise from the close parallels in the labeling of the underlying
19 methodologies. The committee notes that a specific action might be needed to explore how to
20 package multiple kinds of information in an understandable package for managers that would
21 "get the most out of the information we have" and appropriately characterize the limitations of
22 the data and knowledge available.

23
24 The committee also advises the Agency to be more precise in the draft plan in discussing
25 the limits of current data, methods, and knowledge. The draft plan currently states that data
26 limitations constrain what can be done or that more data are needed on particular issues (p.12,
27 line 33, page 13, line 4, and *passim*). However, these terms seem to be used both to refer to
28 situations where data are inadequate and where knowledge or understanding is lacking. These
29 situations are very different. In the case of a lack of knowledge or understanding, new research
30 is needed to advance the science. There is no guarantee that a certain investment in research will
31 provide the needed new understanding. This certainly is the case with regard to some of the
32 challenges related to ecological benefit assessment. However, in other cases, there may be
33 adequate understanding and methodologies, but the Agency does not have adequate data for the
34 particular systems of interest. It could be relatively straightforward in these cases to collect new
35 data. The committee advises the Agency to distinguish between these two very different
36 situations in the discussion of limits of methods and data.

37 **4.3. Uncertainty and expert elicitation**

38 The committee also is providing comments related to section 4.2.3 in the draft plan,
39 "Addressing Uncertainty in Ecological Benefits Assessment." The committee suggests that the
40 section would benefit from the discussion in the NRC report on judgment and uncertainty and
41 that several additional action items might be suggested by that report. Committee members also
42 advise that the revised plan include an activity to explore what role expert elicitation might play
43 in addressing uncertainties associated with ecological benefit assessments at EPA. Some
44 members limited this suggestion to expert elicitation interactions where economists, ecologists,

1 and relevant health, behavioral, and social scientists would be asked to respond to a set of
2 technical questions (e.g., dose-response relationships) for which there was high uncertainty in
3 benefit assessments. Experts would provide a sufficient number of responses to document the
4 degree of certainty in their reported judgments. The results of these types of exercises can be
5 analyzed statistically to check for certain consistency parameters. This approach would use
6 experts for a certain limited set of questions for which their technical knowledge and judgment
7 were sought. Other members suggested that it might be appropriate to elicit experts' knowledge
8 and value judgements on highly uncertain questions related to ecological value, along with the
9 knowledge and value judgments of lay persons, as background for decision makers. These cases
10 should be distinguished from technical expert elicitations. The processes need to identify
11 whether experts are summarizing their technical judgments based on the "science" -- be it
12 ecological, economic, or other relevant science -- versus personal assessments of value, where
13 there is no clear basis in the literature for their judgments.

14 **4.4. Build on existing efforts where possible; don't start new ones**

15 In discussing the actions identified in the draft plan, the committee emphasizes the
16 importance of utilizing and building upon existing data collection and analysis efforts. The
17 committee commends the Agency for the action item (p. 32) to increase coordination of long-
18 term, large-scale data collection efforts within the Agency. Members, however, identified
19 several additional actions they believe should be included in a revised plan. The committee
20 advises the Agency to evaluate the data provided by Environmental Monitoring and Assessment
21 Program (EMAP) and the Agency's related Regional Vulnerability Assessment (ReVA) Tool.
22 The plan should include an action to determine the utility and potential of these data to address
23 the benefits of protecting ecological systems and services.

24
25 The committee notes the need for actions to make use of data collected outside EPA.
26 Coordination of long-term, large-scale data collection efforts is a topic that has received
27 enormous consideration, both in the scientific literature and in the organization of research
28 programs of other agencies, e.g., U.S. Agriculture, Department of the Interior, National Science
29 Foundation, and U.S. Department of Energy. The committee advises the Agency to note the
30 extent of the information already available and include an action committing the Agency to
31 evaluate its potential use of these data. The committee specifically advises the Agency to benefit
32 from the 20-year and continuing NSF-sponsored Long-Term Ecological Research (LTER)
33 program with its long-term databases and its focused work on regional data and to explore the
34 potential for using data to be generated by the National Ecological Observatory Networks
35 (NEON) for assessing ecological benefits.

36
37 The committee also advises that the plan include actions to build not just on the data but
38 also on the analytical work conducted outside the Agency. Specific areas where EPA could
39 benefit in an ongoing way from interactions with other organizations include: development of
40 generic ecological endpoints for benefits assessments; design of monitoring programs;
41 assessment of existing monitoring programs; and identification of ecosystem processes most
42 relevant to assessments. The committee advises the Agency to benefit from the ongoing work of
43 the Millennium Ecosystem Assessment and the Heinz Foundation and not to duplicate their
44 efforts.

1 **4.5. Specific advice regarding issues and actions related to analyzing ecological changes**

2 The committee notes that section 4.5 of the draft plan was very well written and
3 thorough. The issues selected were the most important and the actions were appropriate, and
4 some quite innovative. Additional suggestions noted below provide some additional advice for
5 actions to be considered for inclusion in a revised plan.

6
7 The committee notes action items calling for a catalog of population models (section
8 4.5.2, p. 45) and a catalogue of ecosystem process models (p. 47). It agrees that a catalog or
9 annotated inventory of models would be a reasonable beginning step. But it emphasizes the
10 importance of constructing a decision framework for deciding the applicability and limitations of
11 existing models for specific use in ecological benefit assessment and for developing and
12 applying new models. The committee advises the Agency to include in its revised plan an action
13 to identify a decision algorithm for deciding on proper models for different decision contexts and
14 testing their appropriateness.

15
16 The committee notes that some of the actions identified related to new research are
17 general and not linked to specific needs. Further guidance to units that will develop Requests for
18 Proposals and fund research should be specified in the plan or specifically noted as a task to be
19 addressed in implementation plans.

20 **4.6. Specific advice regarding issues and actions related to estimating monetary values of**
21 **ecological changes**

22 The committee advises the Agency to provide an organizing framework for its
23 discussions in section 4.6 of the draft plan. Figure 7.1 of the NRC report, which identifies
24 connections between ecosystem structure and function, services, policies, and values and Table
25 4-1 in the NRC report, which matches valuation techniques with types of valuation [with
26 modifications suggested by recent literature eliminating the problematic distinctions between
27 "direct" and "indirect" methods (Freeman 2003)], could be usefully incorporated into the EPA
28 report.

29
30 Committee members also suggest that the discussion of valuation studies in section 4.6
31 would benefit from an action calling for expanded discussion of methodologies. In addition to
32 focus groups, there are numerous approaches (formative research) to improving survey
33 methodology that would benefit the Agency, including: individual interviewing approaches;
34 verbal protocols (think-aloud, read-aloud protocols of individuals doing surveys); and combined
35 individual and group interview approaches. The committee advises the Agency to consult
36 behavioral scientists (psychologists in particular, also judgment and decision making
37 researchers), survey methodologists and organizational behavioral researchers (for firm-level
38 responses to proposed actions) in the development of questions that provide the information used
39 in methods to recover individual tradeoffs that are associated with valuation exercises and data
40 collection instruments.

1 **4.7. Address how the public will be involved in ecological benefit assessment and improve**
2 **communication with the lay public**

3 As discussed in section 3.1 of this report, the C-VPESSE advises the Agency to adopt a
4 general framework and use it to implement strategic changes in the Agency's approach to
5 ecological benefit assessment. One of the elements important to that framework is how
6 stakeholders relate to ecological benefit assessment. The committee notes that one of the key
7 audiences and constituents in ecological benefit assessments is largely missing in the draft
8 strategic plan. Other than a brief section on page 36 focused on behavioral responses to different
9 types of regulatory strategies, there is little recognition that the interested and affected public has
10 a role to play. The committee advises the Agency to consider issues and actions related to how
11 the public may be involved in assessing ecological benefits.

12 **4.8. Address institutional issues and identify actions to improve analyses supporting**
13 **decision making**

14 Based on information provided by the Agency, the committee understands that the scope
15 of the draft plan is broader than research and is meant to encompass needed "advancements and
16 changes to make progress in ecological benefit assessments beyond the research domain." Given
17 that goal, the committee envisions the plan as necessarily providing "parallel tracks to ensure
18 short-run results and plan for long-run research," as discussed in section 3.4 above. To plan for
19 short-run results, the committee advises the Agency to revise the strategic plan to identify more
20 clearly the chief operational hurdles faced by the Agency in conducting ecological benefit
21 assessments. Issues associated with staffing limitations, human resource needs, the time
22 constraints on development of ecological benefit assessments, and the legal requirements and
23 procedural issues associated with Information Collection Requests and their review are several
24 issues that are relevant to the development of improved benefit assessments and need to be
25 addressed in the plan. A successful strategic plan will identify those issues and provide actions
26 to address them.

27 **4.9. Summary of responses to charge questions addressed in this section**

28 Charge Question 2: Are the issues described in Section 4 the most important ones that
29 EPA should address to improve its ability to identify, quantify, and value the ecological benefits
30 of its activities? If not, what issues should be added?

31 Charge Question 3: Are there actions in Section 4 that are the most important for EPA to
32 undertake at this time to improve its ability to conceptualize, identify, quantify, and value the
33 ecological benefits of its activities? Do the actions respond to the identified issues? Are there
34 actions that are missing?

35 Charge Question 4: Are there other actions you would recommend?

36 Charge Question 5: Are there specific research approaches, or research projects, on which
37 the Agency should focus?

38
39 Response: Overall, the committee advises the Agency to take a more integrated approach
40 to defining and presenting issues and actions. There is a need to explore and evaluate alternative
41 methods as part of an integrated approach. A revised plan should describe how research and
42 revised practice will evaluate alternative methods for measuring ecological benefits. The

1 committee also identifies the need for the Agency to address the issue of uncertainty associated
2 with ecological benefits, to identify and quantify sources of uncertainty in estimating benefits
3 under different approaches, and to link this identified need to an implementation plan. In
4 addition, the Committee advises the Agency to consider how expert judgments regarding the
5 ecological importance and stakeholder judgments of the social consequences of changes can
6 inform ecological benefits assessments. It emphasizes the importance of building on existing
7 data collection and method development efforts where possible, not starting new ones. It
8 provides some specific advice regarding issues and actions related to analyzing ecological
9 changes and estimating the tradeoffs people would be willing to make to assure that
10 improvements are realized (or deterioration in services is avoided). It notes that the plan would
11 benefit from a strengthened discussion of how the ecological benefit assessment framework
12 would involve the lay public and communicate with it and how the Agency would address
13 institutional issues associated with improving ecological benefit assessments.
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5. IMPLEMENTATION PLAN

Charge Question 6 asked the committee to address the following question: "Is the proposed implementation plan adequate?" After discussing the detailed information provided in the plan, the committee provided the advice below as a response.

5.1. Incorporate more specific discussion of mechanisms for implementation

The committee notes that the discussion of implementation mechanisms provided in the draft strategic plan was very brief and was supplemented substantially by information provided to them in a briefing by Dr. Wayne Munns on January 25, 2005. Dr. Munns noted that the Agency had envisioned that the strategic plan would be implemented through four principal mechanisms: Program Office action plans; action plans in the Office of Policy, Economics and Innovation; Office of Research and Development multi-year plans; and the extra-mural grant program, Science to Achieve Results (STAR), and other collaborations. The committee advises the Agency to include a clear discussion of these mechanisms in the revised plan, so that readers can understand how responsibilities will be assigned for different actions and the time-lines associated with different actions.

The committee also asks the Agency to include a discussion in the revised draft plan of the incentives and motivations that will move the plan forward.

5.2. Vision, communication, and implementation are key

The committee emphasizes the importance of developing support for the plan and viable mechanisms for making progress on the actions identified. The committee advises that each action or set of actions should have a senior manager identified as a "Champion" to help insure that it does not get left behind or forgotten as the Agency undergoes changes. The committee views the plan as important and cautions that the coordination mechanisms described in the draft plan do not describe how decisions will be made, how conflicts will be resolved, and how priorities will be set. Establishing a forum for tracking progress on the plan will not be a sufficiently strong mechanism to achieve effective and efficient implementation without leadership support for the goals of the plan.

The committee believes that the benefits of ecological protection are important to characterize and quantify and are important to EPA's achieving its overall goal of protecting human health and the environment. Successful implementation of the plan depends in great part on effective communication about its goals and about the new framework for ecological benefits assessment that a revised plan should include.

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REFERENCES

EPA. 2003-2008 *EPA Strategic Plan; Direction for the Future*.

Environmental Protection Agency. 1992. *Framework for Ecological Risk Assessment*. EPA/630/R-92/001.

Environmental Protection Agency. 1998. *Guidelines for Ecological Risk Assessment*. EPA/630/R-95/002F.

Environmental Protection Agency Science Advisory Board. 2001. *Improved Science-Based Environmental Stakeholder Processes*. EPA-SAB-EC-COM-01-006.

Freeman, A.M. III. 2003. *The Measurement of Environmental and Resource Values: Theory and Methods*. 2nd Edition ed. Washington, D.C.: Resources for the Future.

Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-being: Synthesis*. Washington, D.C.: Island Press.

Millennium Ecosystem Assessment Board. 2003. *Ecosystems and Human Well-being; A Report of the Conceptual Framework Working Group of the Millennium Ecosystem Assessment*. Washington, DC: Island Press.

National Research Council. 2004. *Valuing Ecosystem Services; Toward Better Environmental Decision-Making*. Washington, D.C.: The National Academies Press.

APPENDIX A: SPECIFIC SUGGESTIONS FOR CHANGES

Executive summary: The committee sees the need to revise the executive summary to eliminate jargon and vague language.

Page 4, Text Box 1, first item. This should be revised to read “Ecosystem functions or processes”. Ecological functions or processes include much more than is mentioned here. For instance, population dynamics, plant-animal interactions, etc. The definition provided focuses specifically on ecosystem processes.

Page 4: There is no mention of time anywhere, e.g., CBA over what time frame?

Page 12, lines 19-20: Could one not estimate changes in some cases rather than measuring them?

Page 13, lines 1-2: Should one consider the potential consequences of an action on, say, a keystone species, even if one cannot measure?

Page 19, lines 21-22: Ecological risk assessment and ecological benefits are not totally different.

Page 21, Figure 2: There is no feedback or risk communications implied here, but it is implied on page 26, lines 7-8.

Figure 4: The second and third boxes should be switched. How can one assess the effects of management actions before assessing the exposure and responses to the stressors to be managed?

Page 26, line 1: There are domains other than economics such as cultural values, etc.

Page 27, lines 17-26: Redundant.

Page 28, box 2: Redundant.

Page 32, line 43: What does “signal to noise ratio” mean here?

Page 55, lines 9-10: Should mention that a non-government panel (USEPA 1990-c) came up with totally different priorities.

Page 44. Although any definition is theoretically possible, the term “population” is usually not used to describe biomass.

Page 61. There is also a somewhat disturbing (and we believe unintended) commentary on the relative “ethics” of economists and ecologists. In text box 3 the plan suggests under the heading, “Opportunity for collaboration across disciplines,” “in view of the analytical and (sometimes) ethical divide between ecologists and economists and the importance of collaboration, actions

1 that involve economists and ecologists working closely together on a particular aspect of the
2 ecological benefits assessment process are highly valued.” This statement appears to imply that
3 one of the two groups is less “ethical” in some professional sense and the other will help in
4 “policing” these lapses in ethical behavior. We don’t believe this was the intention of the
5 discussions, but it could be easily interpreted that way. We believe the intention was to note that
6 there are there are legitimate differences in ethical perspectives that sometimes lie behind
7 disagreements between ecologists and economists on some issues. Clarification of this issue
8 would be helpful.
9

APPENDIX B: BIOSKETCHES

Dr. William Ascher

Dr. William Ascher (Ph.D., Political Science, Yale University) is the Donald C. McKenna Professor of Government and Economics at Claremont McKenna College, where he also serves as Vice President and Dean of the Faculty. His research covers environmental and natural resource policymaking, evaluation and forecasting methodologies, and policymaking processes in developing countries. As the Director of the Duke University Center for International Development Research, he led workshops on the valuation of environmental services for the UN Food and Agriculture Organization and several national governments. He also undertook World Bank-funded research on the valuation of oil and mineral assets. His most recent books are *Why Governments Waste Natural Resources* (1999), *The Caspian Sea: A Quest for Environmental Security* (ed. with Natalia Mirovitskaya, 2000), and *Guide to Sustainable Development and Environmental Policy* (ed. with Natalia Mirovitskaya, 2001). He has also published two books on political-economic forecasting: *Forecasting: An Appraisal for Policymakers and Planners* (1978), and *Strategic Planning and Forecasting* (with William Overholt, 1983). He served on the Advisory Group on the Future of Science, U.S. House of Representatives Subcommittee on Science, Committee on Science, Space and Technology.

Dr. Gregory R. Biddinger

Dr. Gregory R. Biddinger is the Environmental Program Coordinator for ExxonMobil Biomedical Sciences, Inc. In his current position he has two primary responsibilities 1) strategic planning related to the environmental aspects of ExxonMobil's business and 2) development of methods and application of Natural Land Management strategies on ExxonMobil's current and former operating properties. He regularly represents ExxonMobil on matters of wildlife conservation and ecological restoration. Dr. Biddinger has practiced professionally as an environmental scientist for over 25 years. He received a doctoral degree from Indiana State University in Life Science (Ecology/Physiology) and post-doctoral training in Ecotoxicology at Cornell University. His experience ranges from the design and implementation of strategic environmental business planning processes for ExxonMobil, to the design and establishment of ecotoxicological testing facilities for Cornell University and the Illinois Environmental Protection Agency. He has been very active in development and review of Ecological Risk Assessment methods, and in drafting international standards related to Ecotoxicology, Risk-Based Corrective Action, Environmental Management and Greenhouse Gas Accounting. Dr. Biddinger has served on the U.S. EPA SAB Ecological Processes and Effects Committee (EPEC). In addition to his work on the U.S. EPA SAB committees, he has been active in numerous expert panels and peer reviews for U.S. EPA, Organisation for Economic Co-operation and Development and Society for Environmental Toxicology and Chemistry. His other professional activities have included chairmanships with the American Society for Testing and Materials, American Chemistry Council and International Standards Organization technical committees. Dr. Biddinger was the founding chair of the Society of Environmental Toxicology and Chemistry (SETAC) Ecological Risk Assessment Advisory Group (1992-2002). Dr. Biddinger is a founding editor of the SETAC journal *Integrated Environmental Assessment and Management*. His publications cover the areas of aquatic toxicology of inorganic arsenic,

1 phthalate esters, chemical dispersants, and the use of microcosms in estimation of tropic transfer
2 of contaminants. Dr. Biddinger has also published and edited proceedings on ecological risk
3 assessment and risk management, including such topics as the ecological risks of contaminated
4 sediments, decision support systems, sustainable environmental management, integrated
5 environmental decision-making and Landscape ecology and Wildlife Habitat Evaluation.

6
7 **Dr. Ann Bostrom**

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9 Dr. Ann Bostrom (B.A., University of Washington; M.B.A., Western Washington
10 University; Ph.D. in Public Policy Analysis, Carnegie Mellon University; Fulbright graduate
11 studies and Lois Roth Endowment award, Stockholm University; postdoctoral studies in
12 Engineering and Public Policy, Carnegie Mellon University; postdoctoral studies in cognitive
13 aspects of survey methodology, American Statistical Association/National Science
14 Foundation/Bureau of Labor Statistics award) is an Associate Professor in the School of Public
15 Policy and Associate Dean for Research in the Ivan Allen College at the Georgia Institute of
16 Technology. Her research focuses on mental models of hazardous processes (how people
17 understand and make decisions about risks), and is currently funded by the National Science
18 Foundation, and the U.S. Environmental Protection Agency in the areas of air pollution,
19 children's environmental health, and seismic risk. She co-authored Risk Communication: A
20 Mental Models Approach (Cambridge University Press, 2001), with M. Granger Morgan, Baruch
21 Fischhoff, and Cynthia J. Atman. Dr. Bostrom served as program director for the Decision Risk
22 and Management Science Program at the National Science Foundation from 1999-2001 and is on
23 the editorial boards of Risk Analysis and the Journal of Risk Research. She is a former Councilor
24 of the international Society for Risk Analysis, a past Chair of its Risk Communication Specialty
25 group, and received its Chauncey Starr award for a young risk analyst in 1997. Dr. Bostrom is a
26 past member of the executive committee of the U.S. EPA Board of Scientific Counselors, has
27 served on National Research Council, Transportation Research Board, and Institute of Medicine
28 committees, and has consulted for other organizations on risk communication.

29
30 **Dr. James Boyd**

31
32 Dr. James Boyd has been a Fellow in the Energy and Natural Resources division of
33 Resources for the Future (RFF) since 1992. He received his Ph.D. from the Public Policy and
34 Management Department of the Wharton Business School at the University of Pennsylvania in
35 1993 and has been a Visiting Professor at the Olin Business School Washington University, St.
36 Louis. He is currently Director of RFF's Energy and Natural Resources Division. Dr. Boyd's
37 work is in the fields of environmental regulation and law and economics, focusing on the
38 economic analysis of environmental liability law and environmental institutions. Work relevant
39 to the panel includes research on the development of indicators to assess the social value of
40 ecosystems. The work's overarching goal is the development and evaluation of economically
41 sound approaches to ecosystem evaluation, in order to make judgments regarding the relative
42 value of different ecosystems.

43
44 **Dr. Robert Costanza**

1 Dr. Robert Costanza is the Gund Professor of Ecological Economics and Director of the
2 Gund Institute for Ecological Economics at the University of Vermont. Prior to moving to
3 Vermont in August 2002, he was director of the University of Maryland Institute for Ecological
4 Economics, and a professor in the Center for Environmental Science, at Solomons, and in the
5 Biology Department at College Park. Dr. Costanza received his Ph.D. from the University of
6 Florida in 1979 in systems ecology, with a minor in economics. He also has a Masters degree in
7 Architecture and Urban and Regional Planning from the University of Florida. Dr. Costanza is
8 co-founder and past-president of the International Society for Ecological Economics (ISEE) and
9 was chief editor of the society's journal: Ecological Economics from its inception until 9/02. He
10 continues to serve as founding editor of the journal. He currently serves on the editorial board of
11 eight other international academic journals. He is past president of the International Society for
12 Ecosystem Health. In 1982 he was selected as a Kellogg National Fellow, in 1992 he was
13 awarded the Society for Conservation Biology Distinguished Achievement Award and in 1993
14 he was selected as a Pew Scholar in Conservation and the Environment. In 1998 he was awarded
15 the Kenneth Boulding Memorial Award for Outstanding Contributions in Ecological Economics.
16 In 2000 he received an honorary doctorate in natural sciences from Stockholm University. He
17 has served on the Scientific Steering Committee for the LOICZ core project of the IGBP; the
18 U.S. EPA National Advisory Council for Environmental Policy and Technology (NACEPT); the
19 National Research Council Board on Sustainable Development, Committee on Global Change
20 Research; the National Research Council, Board on Global Change; the US National Committee
21 for the Man and the Biosphere Program, and the National Marine Fisheries Service Committee
22 on Ecosystem Principles. Dr. Costanza's research has focused on the interface between
23 ecological and economic systems, particularly at larger temporal and spatial scales. This includes
24 landscape level spatial simulation modeling; analysis of energy and material flows through
25 economic and ecological systems; valuation of ecosystem services, biodiversity, and natural
26 capital; and analysis of dysfunctional incentive systems and ways to correct them. He is the
27 author or co-author of over 300 scientific papers.

28 29 **Dr. Terry C. Daniel**

30
31 Dr. Terry C. Daniel is Professor of Psychology and Natural Resources at the University
32 of Arizona. He received his B.S., M.S., and Ph.D. in Psychology at the University of New
33 Mexico, where he was a Ford Foundation Career Scholar and a University Fellow. Professor
34 Daniel is a Fellow in the American Psychological Association (Population and Environmental
35 Psychology), has served as a member of the Advisory and Founding Committees for the Udal
36 Institute for Public Policy Studies, and as an International Adjunct Professor in Behavioral
37 Sciences at the University of Melbourne, Australia. He is a member of the editorial boards for
38 Society and Natural Resources, Journal of Environmental Psychology, and Landscape and Urban
39 Planning. Professor Daniel received the National Environmental Education Foundation Gifford
40 Pinchot Award in 1993 for outstanding contributions to natural resources management education.
41 Research has focused on the development and application of methods for quantifying
42 relationships between bio-physical features of natural environments and human perception and
43 judgement of environmental quality. Specific areas of research include: aesthetic and recreational
44 impacts of forest management; effects of air pollution on perceived visual air quality in National
45 Parks and Wilderness Areas; effects of environmental/ecological information on public
46 perception and acceptance of environmental change; and roles for environmental data

1 visualization and computer simulation in evaluating public response to environmental
2 management policies. areas of research include: aesthetic and recreational impacts of forest
3 management; effects of air pollution on perceived visual air quality in National Parks and
4 Wilderness Areas; effects of environmental/ecological information on public perception and
5 acceptance of environmental change; and roles for environmental data visualization and
6 computer simulation in evaluating public response to environmental management policies.

7
8 **Dr. A. Myrick Freeman III**

9
10 Dr. A. Myrick Freeman III is Research Professor of Economics at Bowdoin College. In
11 2000 he retired from teaching after 35 years. Dr. Freeman received his Ph.D. and M.A. in
12 economics from the University of Washington and his B.A. in economics from Cornell
13 University. He has been on the faculty at Bowdoin since that time and has served as chair of
14 the economics department and Director of the Environmental Studies Program there. He has also
15 held appointments as Visiting College Professor at the University of Washington and Robert M.
16 La Follette Distinguished Visiting Professor at the University of Wisconsin-Madison and as a
17 Senior Fellow at Resources for the Future, a research organization in Washington, DC. Dr.
18 Freeman's principal research interests are in the areas of applied welfare economics, benefit-cost
19 analysis, and risk management as applied to environmental and resource management issues.
20 Much of his work has been devoted to the development of models and techniques for estimating
21 the welfare effects of environmental changes such as the benefits of controlling pollution and the
22 damages to natural resources due to releases of chemicals into the environment. He has authored
23 or co-authored eight books including Air and Water Pollution Control: A Benefit-Cost
24 Assessment, and The Measurement of Environmental and Resource Values: Theory and
25 Methods, now in its second edition. He has also published more than 70 articles and papers in
26 academic journals and edited collections. Dr. Freeman has been a member of the Board on
27 Toxicology and Environmental Health Hazards of the National Academy of Sciences and has
28 served as a member of the Advisory Council on Clean Air Compliance Analysis, the Clean Air
29 Science Advisory Committee (consultant) and the Environmental Economics Advisory
30 Committee of the U.S. Environmental Protection Agency Science Advisory Board.

31
32 **Dr. Domenico Grasso, Chair, Committee on Valuing the Protection of Ecological Systems
33 and Services**

34
35 Dr. Domenico Grasso is Dean of the College of Engineering and Mathematics at the
36 University of Vermont, Burlington. Prior to holding this position, he was the Rosemary Bradford
37 Hewlett Professor and Founding Director of the Picker Engineering Program at Smith College.
38 As an environmental engineer who studies the ultimate fate of contaminants in the environment
39 and develops new techniques to destroy or otherwise reduce the risks associated with these
40 contaminants to human health or natural resources, he focuses on molecular scale processes that
41 underlie the nature and behavior of contaminants in environmental systems. He holds a B.Sc.
42 from Worcester Polytechnic Institute, an M.S. from Purdue University and a Ph.D. from The
43 University of Michigan. He is a registered Professional Engineer in the states of Connecticut and
44 Texas, and was Professor and Head of Department in Civil & Environmental Engineering at the
45 University of Connecticut prior to joining Smith. He has been a Visiting Scholar at UC-Berkeley,
46 a NATO Fellow, and an Invited Technical Expert to the United Nations Industrial Development

1 Organization in Vienna Austria. He is a Diplomat of the American Academy of Environmental
2 Engineers, a Past-President of the Association of Environmental Engineering & Science
3 Professors, and Editor-in-Chief of Environmental Engineering Science. He has authored more
4 than 100 technical papers & reports, including four chapters and two books, and his research
5 work is supported by Federal, state and industrial organizations.

6
7 **Dr. Dennis H. Grossman**
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9 Dr. Dennis H. Grossman is the Vice President for Science at NatureServe, a non-profit
10 conservation organization working throughout the Western Hemisphere. He holds a B.S. in
11 ecology from the University of Wisconsin (1976), an M.S. in Plant Ecology from the University
12 of Wisconsin (1982), and a Ph.D. in Plant Ecology from the University of Hawaii (1991). Prior
13 to working at the Conservancy, Dr. Grossman was Chief Ecologist at The Nature Conservancy
14 for 12 years after working as a Research Fellow at the Environment and Policy Institute of the
15 East-West Center in Honolulu. Dr. Grossman has worked extensively with vegetation science,
16 ecology, and conservation biology projects across the Upper Midwest, California, and Hawaii as
17 well as in India and Indonesia. These projects include the inventory, data management and
18 analysis, classification, mapping, conservation ranking and conservation planning for terrestrial,
19 freshwater and coastal-marine communities. Dr. Grossman was a principal developer of the
20 National Vegetation Classification System for the United States that is currently endorsed as an
21 inter-agency standard by the Federal Geographic Data Committee. He has published numerous
22 articles on ecological classification and conservation and currently manages numerous projects
23 associated with the implementation of these methods. Dr. Grossman is a member of the
24 Ecological Society of America and the Society for Conservation Biology, and serves Vegetation
25 Subcommittee of the Federal Geographic Data Committee and on the executive committee of the
26 ESA Panel for Vegetation Classification.

27
28 **Dr. Geoffrey Heal**
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30 Dr. Geoffrey Heal is the Paul Garrett Professor of Public Policy and Corporate
31 Responsibility and Professor of Economics and Finance at Columbia Business School and
32 Professor in the School of International and Public Affairs. He is a member of the Executive
33 Committee of the Columbia Earth Institute. Dr. Heal earned a First Class Honors Degree,
34 Cambridge University, U.K. Major in Economics and Minor in Physics (1966). He completed his
35 graduate studies in Economics and Mathematics at University of California, Berkeley, 1966-67.
36 He earned his Ph.D. in Economics at Cambridge University (1968). Dr. Heal's area of expertises
37 and research include: Economic theory, General equilibrium theory, Economics of insurance and
38 reinsurance and of risk-management, Economics of natural and environmental resources,
39 Interface between economics and the natural sciences with respect to environmental issues. He
40 has served as Chair of the National Academy – National Research Council Committee on the
41 Valuation of the Services of Aquatic and Related Terrestrial Ecosystems. He is also the
42 Commissioner of the Pews Ocean Commission, Director of the Union of Concerned Scientists
43 and the Beijer Institute of Ecology and Economics of the Royal Swedish Academy of Sciences
44 and a member of the President's Committee on Science and Technology (PCAST) Panel on
45 Biodiversity and Ecosystems. Dr. Heal is also a member and Ex-President, Association of
46 Environmental and Natural Resource Economists.

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2 **Dr. Robert J. Huggett**

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4 Dr. Robert J. Huggett is an independent consultant and Professor Emeritus at the College
5 of William and Mary in Williamsburg, VA, where he was a faculty member for 20 years. Dr.
6 Huggett served as Vice President for Research and Graduate Studies at Michigan State
7 University from 1997 to 2004. Before that, he was Assistant Administrator for Research and
8 Development at the U.S. Environmental Protection Agency from 1994 to 1997. He earned an
9 M.S. in Marine Chemistry from the Scripps Institute of Oceanography at the University of
10 California at San Diego and a Ph.D. in Marine Science at William and Mary. As a scholar, Dr.
11 Huggett has studied the fate and effects of hazardous chemicals in aquatic environments,
12 publishing more than 90 articles. His work has had important effects on international
13 environmental policy and he has been very active in research and policy organizations at the
14 national and international level. While he was at the EPA, he served as Vice Chair of the
15 Committee on Environment and Natural Resources and Chair of the Subcommittee on toxic
16 substances and solid wastes, both of the White House Office of Science and Technology Policy.
17 He also founded the EPA 100 million dollar per year STAR Competitive Research grants
18 program and the 3 million dollar per year STAR Graduate Fellowship program. He presently
19 serves on the Board Research Committee of the American Chemistry Council and on the Board
20 on Environmental Studies and Toxicology of the National Research Council, National Academy
21 of Sciences.

22
23 **Dr. Douglas MacLean**

24
25 Dr. Douglas MacLean is Professor of Philosophy at the University of North Carolina
26 Chapel Hill. He is also Director of the Parr Center for Ethics and has appointments in both the
27 Carolina Environmental Program and the Program for Peace, War, and Defense. He received his
28 B.A. from Stanford University and his Ph.D. in philosophy from Yale University. His previous
29 positions include senior research scholar and director of the Institute for Philosophy and Public
30 Policy at the School of Public Affairs of the University of Maryland College Park and Professor
31 and Chair of the Department of Philosophy at the University of Maryland Baltimore County.
32 From 1999-2001 he was the Distinguished Visiting Professor of Ethics at the U.S. Naval
33 Academy. His research interests are in ethics, political philosophy, decision and risk analysis,
34 military ethics, and philosophical issues in public policy. His current research focuses primarily
35 on philosophical issues in decisions about risk, technology, and the environment, and the
36 philosophical implications of the psychology and culture of decision making. He has written
37 extensively on these topics. Dr. MacLean has served as an advisor or consultant to a number of
38 government agencies, including: the National Science Foundation, the National Endowment for
39 the Humanities, the U.S. Environmental Protection Agency, the U.S. Congress Office of
40 Technology Assessment, the U.S. Nuclear Regulatory Commission, and the Departments of
41 Energy and Agriculture.

42
43 **Dr. Harold A. Mooney**

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45 Dr. Harold A. Mooney holds the Paul S. Achilles Professorship in Environmental
46 Biology at Stanford University. He received his PhD from Duke University in 1960 and was an

1 Associate Professor at the University of California in Los Angeles until 1968 when he came to
2 Stanford. His research on the carbon balance of plants has provided a major theoretical
3 framework for ecophysiological studies, and has been instrumental in the incorporation of
4 physiological understanding to studies of ecosystem processes. This work has also led to several
5 lines of research on the nature of interactions of plants with their biotic environment, and has
6 provided an objective measure for evaluating many of the current theories of plant-animal
7 interaction. He has demonstrated that convergent evolution takes place in the properties of
8 different ecosystems that are subject to comparable climates, and has pioneered in the study of
9 the allocation of resources in plants. He has worked in many of Earth's diverse ecosystems,
10 including the arctic-alpine, the mediterranean-climate scrub and grasslands, tropical wet and dry
11 forests, and the deserts of the world. He is currently engaged in research on the impacts of global
12 change on terrestrial ecosystems, especially on productivity and biodiversity, and is also
13 examining those factors that promote the invasions of non-indigenous plant species. In recent
14 years he has been involved in organizing international activities through which he brought
15 together people from many diverse disciplines to address topics that promise to contribute
16 substantially to the advancement and integration of ecology. Most recent of these are the
17 programs on A Global Strategy for Invasive Species and on the Ecosystem Function of
18 Biodiversity, both sponsored by the Scientific Committee on Problems of the Environment
19 (SCOPE). Through these efforts and his lengthy publication record of over 400 scientific books,
20 papers, and articles, he has developed bridges between physiological ecology and other areas of
21 ecology, and he has explored the contributions that ecologists can make toward resolving the
22 growing problems of global habitability. Among his many honors, he was elected to the National
23 Academy of Sciences, the American Academy of Arts and Sciences, and the American
24 Philosophical Society.

25
26 **Dr. Louis F. Pitelka**

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28 Dr. Louis Pitelka is a professor at the Appalachian Laboratory of the University of
29 Maryland Center for Environmental Science. Research at the Appalachian Laboratory covers
30 terrestrial and freshwater ecology with an emphasis on landscape and watershed ecology. Dr.
31 Pitelka also currently is serving a two-year term as Science Advisor for the U.S. Department of
32 Agriculture Competitive Grants Program. He received a B.S. in zoology from the University of
33 California at Davis and a Ph.D. in biological sciences from Stanford University. Before moving
34 to the University of Maryland in 1996, he held positions at Bates College, the National Science
35 Foundation, and the Electric Power Research Institute. Dr. Pitelka's areas of expertise include
36 plant ecology, ecosystem ecology, and global change. His research activities have ranged from
37 studies of the population biology of forest understory herbs to the responses of terrestrial
38 ecosystems to climate change. Dr. Pitelka has served on numerous planning, coordinating, and
39 review committees for both national and international organizations. He is a member of the
40 Department of Energy's Biological and Environmental Research Advisory Committee. He served
41 five years on the Scientific Steering Committee of the Global Change and Terrestrial Ecosystems
42 (GCTE) core project of the International Geosphere-Biosphere Program (IGBP), and was chair
43 of GCTE in 2003. From 1995 through 2000 Dr. Pitelka was editor-in-chief of Ecological
44 Applications and now is on the editorial boards of Oecologia and Frontiers in Ecology and the
45 Environment. In 2003 he served as President of the Association of Ecosystem Research Centers.

1 **Dr. Stephen Polasky**

2
3 Dr. Stephen Polasky holds the Fesler-Lampert Chair in Ecological/ Environmental
4 Economics at the University of Minnesota. Dr. Polasky is a faculty member of the Department of
5 Applied Economics and of the Department of Ecology, Evolution and Behavior and the
6 interdisciplinary Conservation Biology Program. He received his Ph.D. in economics from the
7 University of Michigan in 1986. Prior to coming to Minnesota he held faculty positions in the
8 Department of Agricultural and Resource Economics at Oregon State University and the
9 Department of Economics at Boston College. He was the senior staff economist for environment
10 and resources for the President's Council of Economic Advisers 1998-1999. He served as
11 associate editor and co-editor for the Journal of Environmental Economics and Management
12 from 1996 to 2002. He served as a member of the National Research Council Committee on
13 Assessing and Valuing Services of Aquatic and Related Terrestrial Ecosystems and serves as Co-
14 Chair for Core Project 3: Developing the Science of Conservation and Sustainable Use of
15 Biodiversity for DIVERSITAS. His research interests include biodiversity conservation and
16 endangered species policy, integrating ecological and economic analysis, game theoretic analysis
17 of natural resource use, common property resources, and environmental regulation.

18
19 **Dr. Paul Risser**

20
21 Dr. Paul Risser currently serves as Chancellor of the Oklahoma Higher Education
22 System. Previously he served as President of Oregon State University (7 years), President of
23 Miami University (3) years, and 6 years as Vice President for research and then Provost at the
24 University of New Mexico. His bachelors degree in biology is from Grinnall College and his
25 M.S. and Ph.D. in botany and soils is from the University of Wisconsin. He is a fellow of the
26 American Association for the Advancement of Science and of the American Academy of Arts
27 and Sciences. Dr. Risser's research has focused on ecosystem analysis, ranging from the
28 physiological ecology of single species to mathematical models of entire ecosystems, especially
29 as they respond to management. Dr. Risser has chaired and served on numerous committees for
30 the National Science Foundation, National Research Council, and other state and federal
31 agencies. He is the past president of the Ecological Society of America, American Institute of
32 Biological Sciences, and of the Southwestern Association of Naturalists.

33
34 **Dr. Holmes Rolston**

35
36 Dr. Holmes Rolston is University Distinguished Professor of philosophy at Colorado
37 State University. He has written six books, acclaimed in critical notice in both professional
38 journals and the national press. The more recent are: Genes, Genesis and God (Cambridge
39 University Press, 1999), Science and Religion: A Critical Survey (Random House, McGraw Hill,
40 Harcourt Brace), Philosophy Gone Wild (Prometheus Books), Environmental Ethics (Temple
41 University Press), and Conserving Natural Value (Columbia University Press). He has edited
42 Biology, Ethics, and the Origins of Life (Jones and Bartlett, Wadsworth). He has written chapters
43 in eighty other books and over one hundred articles. He is past-president of the International
44 Society for Environmental Ethics and has served on the Board of Governors of the Society for
45 Conservation Biology. He serves on the Advisory Board, American Association for the
46 Advancement of Science, Program of Dialogue on Science, Ethics, and Religion. Rolston has

1 served as a consultant with over two dozen conservation and policy groups, including the U. S.
2 Congress and a Presidential Commission. He is a member of the Working Group on Ethics of the
3 World Conservation Union (IUCN). He is a founder and the associate editor of Environmental
4 Ethics, a refereed professional journal now in its seventeenth year, and on the editorial board of
5 Zygon: Journal of Science and Religion, Public Affairs Quarterly, Environmental Values, The
6 South African Journal of Philosophy / Suid-Afrikaanse Tydskrif vir Wysbegeerte, Socijalna
7 Ekologija (Zabreg, Croatia), the International Journal of Wilderness, and Conservation Biology.
8 He serves on a half dozen other editorial boards. He has been a recipient of NEH and NSF
9 awards. He won the Pennock Award for Distinguished Service at Colorado State University, the
10 Dean's Award for Creativity and Excellence in the Humanities, and has been named University
11 Distinguished Professor. He holds a B.S. from Davidson College, a Ph.D. from the University of
12 Edinburgh in Theology and Religious Studies, an M.S. in the Philosophy of Science from the
13 University of Pittsburgh, and a Doctor of Letters from Davidson College, 2002.

14 15 **Dr. Joan Roughgarden**

16
17 Dr. Joan Roughgarden spent her early childhood in the Philippine Islands and Indonesia.
18 She majored in biology and philosophy at the University of Rochester, and received a Ph.D. in
19 theoretical ecology from Harvard University. She is Professor of Biological Sciences at Stanford
20 University, and author, coauthor or editor of six books and over 120 papers in academic journals.
21 Her books as sole author include: Theory of Population Genetics and Evolutionary Ecology
22 (Macmillan), Primer of Ecological Theory (Prentice Hall), Anolis Lizards of the Caribbean
23 (Oxford University Press) and most recently, Evolution's Rainbow: Diversity, Gender and
24 Sexuality in Nature and People (University of California Press). She founded and directed the
25 Earth Systems Program at Stanford, and was awarded for service to undergraduate education.
26 She has also supervised over 30 doctoral and postdoctoral students. She has served on science
27 advisory committees for marine protected areas in the Channel Islands National Marine
28 Sanctuary. She has been a member of grant-review panels for the National Science Foundation
29 and the Department of Energy, and has been an editor of the American Naturalist, Oecologia and
30 the Journal of Theoretical Population Biology. Joan lives in San Francisco where she has also
31 serve on citizen advisory committees for recreation, parks, and natural areas. Her current
32 research links ecology with economic theory.

33 34 **Dr. Mark Sagoff**

35
36 Dr. Mark Sagoff is Senior Research Scholar in the Institute for Philosophy and Public
37 Policy at the School of Public affairs at the University of Maryland, College Park, and has
38 published widely in journals of law, philosophy, and the environment. He was named a Pew
39 Scholar in Conservation and the Environment in 1991. He served from 1994-1997 as President
40 of the International Society for Environmental Ethics. For the academic year 1998-99, Dr. Sagoff
41 was awarded a fellowship at the Woodrow Wilson International Center for Scholars. He is a
42 Fellow of the Hastings Center and in 2000 he was elected a Fellow of the American Association
43 for the Advancement of Science. Dr. Sagoff has an A.B. from Harvard and a Ph.D. (Philosophy)
44 from the University of Rochester, and he has taught at Princeton, the University of Pennsylvania,
45 the University of Wisconsin (Madison), and Cornell before coming to the University of
46 Maryland. Dr. Sagoff served on the Committee on Noneconomic and Economic Value of

1 Biodiversity, Board on Biology, Commission on Life Sciences, National Research Council,
2 1997-99, is Coeditor of the Journal of Policy Analysis and Management, and belongs to the
3 editorial boards of various journals in ethics, the life sciences, and public policy.
4

5 **Dr. Kathleen Segerson**
6

7 Dr. Kathleen Segerson is professor and head in the Department of Economics at the
8 University of Connecticut. Prior to coming to the University of Connecticut, Professor Segerson
9 was an assistant professor of Natural Resource Economics at the University of Wisconsin. She is
10 currently a co-editor of the Ashgate Studies in Environmental and Natural Resource Economics,
11 and a member of the editorial board of the International Yearbook of Environmental and
12 Resource Economics and Contemporary Economic Policy. She has previously served as a co-
13 editor and an associate editor of the American Journal of Agricultural Economics and an
14 associate editor of the Journal of Environmental Economics and Management. She has also
15 served as Vice-President and a member of the Board of Directors of the Association of
16 Environmental and Resource Economists (AERE), and on several other subcommittees for
17 AERE and the American Agricultural Economics Association (AAEA). Dr. Segerson's research
18 focuses on the incentive effects of alternative environmental policy instruments, with particular
19 emphasis on the application of legal rules and principles to environmental problems. Specific
20 research areas include: the impact of legal liability for environmental damages in a variety of
21 contexts, including groundwater contamination, hazardous waste management, and workplace
22 accidents; land use regulation and the takings clause; voluntary approaches to environmental
23 protection; the impacts of climate change on U.S. agriculture; and incentives to control nonpoint
24 pollution from agriculture. Dr. Segerson received a BA degree in mathematics from Dartmouth
25 College in 1977 and a PhD in agricultural and natural resource economics from Cornell
26 University in 1984.
27

28 **Dr. Paul Slovic**
29

30 Dr. Paul Slovic is president of Decision Research and a professor of psychology at the
31 University of Oregon. He studies human judgment, decision-making, and risk analysis, and has
32 published extensively on these topics. Dr. Slovic received a B.A. degree from Stanford
33 University, an M.A. and Ph.D. degree from the University of Michigan, and an honorary
34 doctorate from the Stockholm School of Economics. He is past president of the Society for Risk
35 Analysis and in 1991 received its Distinguished Contribution Award. In 1993, Dr. Slovic
36 received the Distinguished Scientific Contribution Award from the American Psychological
37 Association, and in 1995 he received the Outstanding Contribution to Science Award from the
38 Oregon Academy of Science. Dr. Slovic has served on numerous advisory committees of the
39 National Research Council/National Academy of Sciences including the committees that wrote
40 "Risk Assessment in the Federal Government: Managing the Process" (1983) and
41 "Understanding Risk: Decision Making in a Democratic Society" (1996).
42

43 **Dr. V. Kerry Smith**
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45 Dr. V. Kerry Smith is University Distinguished Professor and Director, Center for
46 Environmental and Resource Economic Policy in the Department of Agricultural and Resource

1 Economics at North Carolina State University as well as a University Fellow in the Quality of
2 the Environment Division of Resources for the Future. Since October 2000 he has been a
3 member of the U.S. EPA's Advisory Council on Clean Air Compliance Analysis and in 2001 he
4 was a member of the Arsenic Rule Benefits Review Panel of EPA's SAB. Dr. Smith received his
5 A.B. and Ph.D. in Economics from Rutgers University. He presented the Frederick V. Waugh
6 Lecture for the American Agricultural Economics Association (AAEA) in 1992 and at the 2002
7 AAEA annual meeting he was named an AAEA Fellow. In 2004 he was elected a member of the
8 National Academy of Sciences. Dr. Smith is a member of the American Economic Association,
9 the Southern Economic Association, the Association of Environmental and Resource
10 Economists, and several other professional associations. He has also held editorial positions with
11 the Journal of Environmental Economics and Management, Land Economics, Review of
12 Economics and Statistics, and other professional journals. His research interests include non-
13 market valuation of environmental resources, role of public information in promoting private risk
14 mitigation, non-point source pollution and nutrient policy, and the linking of ecological and
15 economic models.

16
17 **Dr. Robert N. Stavins**

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19 Dr. Robert N. Stavins is the Albert Pratt Professor of Business and Government,
20 Chairman of the Environment and Natural Resources Faculty Group at the John F. Kennedy
21 School of Government, Harvard University, and Director of the Environmental Economics
22 Program at Harvard University. He is a University Fellow of Resources for the Future, Past
23 Chairman of the Environmental Economics Advisory Committee of the U.S. Environmental
24 Protection Agency's (EPA) Science Advisory Board, Director of the University-wide
25 Environmental Economics Program at Harvard University; and a Member of: the Board of
26 Directors of Resources for the Future; EPA's Clean Air Act Advisory Committee, the
27 Intergovernmental Panel on Climate Change (IPCC), the Board of Directors of the Robert and
28 Renée Belfer Center for Science and International Affairs, the Executive Committee of the
29 Harvard University Committee on Environment (UCE), the Board of Academic Advisors of the
30 AEI-Brookings Joint Center for Regulatory Studies. He serves on Editorial Boards of The
31 Journal of Environmental Economics and Management, Resource and Energy Economics, Land
32 Economics, Environmental Economics Abstracts, B.E. Journals of Economic Analysis & Policy,
33 and Economic Issues. He is also a contributing editor of Environment, and was formerly a
34 member of the Board of Directors of the Association of Environmental and Resource
35 Economists. Professor Stavins' research has focused on diverse areas of environmental
36 economics and policy, including examinations of: policy instrument choice under uncertainty;
37 competitiveness effects of regulation; design and implementation of market-based policy
38 instruments; diffusion of pollution-control technologies; and depletion of forested wetlands. His
39 current research includes analyses of: technology innovation; environmental benefit valuation;
40 political economy of policy instrument choice; and econometric estimation of carbon
41 sequestration costs. Professor Stavins directed Project 88, a bi-partisan effort co-chaired by
42 former Senator Timothy Wirth and the late Senator John Heinz, to develop innovative
43 approaches to environmental and resource problems. He continues to work closely with public
44 officials on matters of national and international environmental policy. He has been a consultant
45 to the National Academy of Sciences, several Administrations, Members of Congress,
46 environmental advocacy groups, the World Bank, the United Nations, the U.S. Agency for

1 International Development, state and national governments, and private foundations and firms.
2 Prior to coming to Harvard, Stavins was a staff economist at the Environmental Defense Fund;
3 and before that, he managed irrigation development in the middle east, and spent four years
4 working in agricultural extension in West Africa as a Peace Corps volunteer.
5

6 **Dr. Barton H. Thompson, Jr.**
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8 Dr. Barton H. Thompson, Jr., is Vice Dean and Robert E. Paradise Professor of Natural
9 Resources Law at Stanford Law School, a Senior Scholar (by courtesy) at the Stanford Institute
10 for International Studies, and a member of both the Core Faculty and Executive Committee of
11 Stanford University's Interdisciplinary Graduate Program in Environment and Resources. He
12 received an A.B. in Economics from Stanford University in 1972, an M.B.A. from the Stanford
13 Graduate School of Business in 1976, and a J.D. from Stanford Law School in 1976. He has been
14 a member of the Stanford faculty since 1986. Professor Thompson's research focuses on the
15 interdisciplinary analysis (with an emphasis on economics, law, and cognitive psychology) of
16 environmental and natural resource policies and the formulation of innovative tools and
17 approaches for addressing environmental and natural resource issues. He has written several
18 articles on the opportunities for and barriers to investments in ecosystem services and co-
19 organized a workshop conference at Stanford University in November 2000 on Protecting
20 Ecosystem Services: Science, Economics, and Law.
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