CCSP Synthesis and Assessment Product 4.4

SAP-4.4

Prospectus for

Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources

U.S. Climate Change Science Program

Lead Agency
Environmental Protection Agency

Contributing Agencies
Department of Agriculture
Department of Energy
National Aeronautics and Space Administration
National Oceanic and Atmospheric Administration
U.S. Geological Survey

31 July 2006

Agency Leads

Susan Julius
Environmental Protection Agency
William Hohenstein
Department of Agriculture
Jeff Amthor
Department of Energy
Jack Waide
U.S. Geological Survey
Woody Turner
National Aeronautics and Space Administration
Kenric Osgood
National Oceanic and Atmospheric Administration

For More Information

U.S. Climate Change Science Program
1717 Pennsylvania Avenue, NW, Suite 250
Washington, DC 20006 USA
+1.202.223.6262 (voice)
+1.202.223.3065 (fax)
http://www.climatescience.gov/

This prospectus has been prepared according to the *Guidelines for Producing Climate Change Science Program (CCSP) Synthesis and Assessment Products*. The prospectus was reviewed and approved by the CCSP Interagency Committee. The document describes the focus of this synthesis and assessment product, and the process that will be used to prepare it. The document does not express any regulatory policies of the United States or any of its agencies, or make any findings of fact that could serve as predicates for regulatory action.

Prospectus for Synthesis and Assessment Product 4.4

Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources

1. Overview: Description of Topic, Questions to be Addressed, and Audience

1.1. Introduction

The Strategic Plan of the U.S. Climate Change Science Program (CCSP) calls for the preparation of 21 synthesis and assessment products (SAPs) to support policymaking and adaptation decisions across the range of issues addressed by the CCSP (CCSP, 2003). Prepared through processes that are open and public, stakeholder participation is sought in order to provide an accurate and balanced presentation of the knowledge base for climate change decision support. The products follow guidelines issued on December 2, 2004. These and subsequent guidelines require that the SAPs be prepared in conformance with applicable provisions of the Information Quality Act (IQA) and the Federal Advisory Committee Act (FACA).

This prospectus outlines the content and approach for completing Synthesis and Assessment Product 4.4. "Preliminary review" in this context is the process of collecting and reviewing available information about known or potential adaptation options. The purpose of SAP 4.4 is to review management options for adapting to climate variability and change in the United States, and to identify characteristics of ecosystems and adaptation responses that promote successful implementation and that meet resource managers' needs.

SAP 4.4 addresses CCSP Goal 4—that is, "to understand the sensitivity and adaptability of different natural and managed ecosystems to climate and related global changes." SAP 4.4 also addresses a stated research need in Chapter 8 (section 8.3) of the CCSP Research Strategy: "How can climate-sensitive ecosystems and resources be managed to sustain ecosystem services in the context of multiple demands and changing environmental conditions?"

1.2. Topic and Content

Climate is a dominant factor influencing the distributions, structures, functions, and services of ecosystems. Changes in climate will interact with other environmental changes to affect biodiversity and the future condition of ecosystems (e.g., McCarthy *et al*., 2001; McCarty, 2001; Parmesan and Yohe, 2003). The extent to which ecosystem condition will be affected will depend on the degree of sensitivity of the ecosystem to changes in climate and the availability of adaptation options for effective ecosystem management.

Adaptation is defined as an adjustment in ecological, social, or economic systems in response to climate stimuli and their effects (McCarthy et al., 2001). SAP 4.4 will focus on management strategies for adapting to climate variability and change. The goal of these adaptation strategies is to reduce the risk of adverse outcomes through activities that increase the resilience of ecological systems to climate change (Turner *et al*., 2003; Tompkins and Adger,2004; Scheffer *et al*., 2001). In this context, resilience refers to the

amount of change or disturbance that can be absorbed by a system before the system is redefined by a different set of processes and structures (Holling, 1973; Gunderson, 2000; Bennett *et al*., 2005). Potential adverse outcomes of climate variability and change will vary for different ecosystems. The "effectiveness" of an adaptation option will thus be case-dependent and can only be measured against a desired ecosystem condition or natural resource management goal. Because changes in the climate system are likely to persist into the future regardless of emissions mitigation, adaptation is an essential response for future protection of climate-sensitive ecosystems.

Adaptation options for enhancing ecosystem resilience include changes in processes, practices, or structures to reduce anticipated damages or enhance beneficial responses associated with climate variability and change. In some cases, opportunities for adaptation offer stakeholders multiple benefit outcomes, such as the addition of riparian buffer strips that (1) manage pollution loadings from agricultural land into rivers designated as "wild and scenic" today and (2) establish a protective barrier to increases in both pollution and sediment loadings associated with future climate change.

A range of adaptation options are possible for many ecosystems, but a lack of information or resources may impede successful implementation. In some cases, managers may not have the knowledge or information available to them that they need to address climate change impacts. In other instances, managers may understand the issues and have the relevant information but lack resources to implement adaptation options. Furthermore, even with improvement in the knowledge and communication of available and emerging adaptation strategies, the feasibility and effectiveness of adaptation will depend on the adaptive capacity of the ecological system or social entity. Adaptive capacity is defined as "the potential or ability of a system, region, or community to adapt to the effects or impacts of climate change" (McCarthy *et al*., 2001). Depending on the management goals, there may be biological, physical, economic, social, cultural, institutional, or technological conditions that enhance or hinder adaptation.

Thus, increasing adaptive capacity will require information and tools that aid in (1) understanding the combined effects on ecosystems of climate changes and non-climate stressors, and consequent implications for achieving specific management goals; (2) applying existing management options or developing new adaptation approaches that reduce the risk of negative outcomes; and (3) understanding the opportunities and barriers that affect successful implementation of management strategies to address climate change impacts.

Synthesis and Assessment Product 4.4 will focus on ecosystems and resources in selected federally protected and managed areas that are considered to be more climate sensitive than others. Their protected status reflects the value placed on these ecosystems and resources by the American public. The management goals of these areas are representative of the range of goals and challenges faced by Federal and other resource management organizations across the United States. Adaptation in these areas will require an array of responses to ensure the achievement of management goals over a range of time scales.

Approximately one-third of the Nation's land base is managed by the Federal Government and administered by different agencies through a variety of management systems. The climate-sensitive systems examined in this report include ecosystems or resources in National Parks, National Wildlife Refuges, Wild and Scenic Rivers, marine protected areas, National Forest Systems, and the National Estuary Program. Other federally owned or managed systems that could qualify—such as Wilderness Preservation Areas, Biosphere Reserves, Research Natural Areas, Natural Estuarine Research Reserves, and Public Lands—were not selected because they are either a sub-category of the Federal systems already selected, or because the primary purpose of ownership is research, not resource management.

SAP 4.4 will begin with a review of (1) goals and practices for the selected federally protected and managed systems, (2) potential effects of climate variability and change on the attainment of those goals, and (3) adaptation options for increasing the resilience of natural resources to climate

variability and change. Knowledge of potential adaptation options for responding to climate variability and change may be informed by previous or current efforts to adapt to climate variability. Climate variability is defined as "the variations in the mean state and other statistics of climate on all temporal and spatial scales beyond that of individual weather events" (Houghton *et al*., 2001). Therefore, the review will draw on literature describing ecological and human responses to climate variability (i.e., intra-annual, interannual, and extreme events) in addition to climate change, to inform managers of the variety of options available to respond to climate variability and long-term climate change. Following the review will be a detailed assessment of the issues and challenges associated with implementation of adaptation options for six case studies within the selected management systems; these case studies will cover a variety of ecosystem types such as coral reefs, wetlands, rivers and streams, forests, and estuaries.

The SAP Lead Authors, in consultation with the Lead and Contributing Agency representatives, will consider the following criteria in evaluating and selecting potential case studies:

- Contains one or more ecosystem services or features that are protected by a management goal
- The management goal is sensitive to climate variability and change, and the potential impacts of climate variability and change are significant relative to the impacts of other changes
- Adaptation options are available to preserve a service or a physical or biological feature
- Adaptation options could be applied to other geographic regions or to other ecosystem types.

The report will also provide a synthesis of lessons learned from the case studies that are broadly relevant across geographic areas, ecosystem types, and management goals and methods. Therefore, when selecting the case studies, the Lead Authors will also consider the following desirable characteristics of the group of case studies:

- Addresses a reasonable cross section of important, climate-sensitive ecosystems and/or ecosystem services and features

2.) Addresses a range of adaptation responses (e.g., structural, policy, permitting)
3.) Distributed across the United States with a national constituency
4.) Attributes allow for comparison of adaptation approaches and their effectiveness across the individual case studies (e.g., lessons learned about research gaps and about factors that enhance or impede implementation).

1.3. General Approach

Individuals and members of Federal, State, tribal, and local governments and agencies—together with non-governmental organizations—are involved in managing ecosystems that may be affected by climate variability and change. The goal of this CCSP product is to provide useful information to these audiences on the state of knowledge regarding adaptation options for key, representative ecosystems and resources. To ensure that this goal is achieved, lead authors will engage both stakeholders and researchers in shaping the content of this report. The Coordinating Lead Author and chapter Lead and Contributing Authors will work with the lead and contributing agency representatives to obtain stakeholder input throughout the writing process. When the first drafts of each chapter are completed, a series of workshops will be held to engage stakeholders in reviewing the content and applicability of the information provided. A summary of the process for drafting SAP 4.4 is described below and in Section 5 of this prospectus:

- Conduct literature review
- Develop report outline including chapter content
  - Lead authors develop framework for report and individual chapters
  - Authors propose case studies
  - Lead and supporting agencies consult with each other and approve selected case studies
- Write first drafts of each chapter
  - Authors draft individual chapters and respond to the five key questions listed in Section 1.5
- Hold stakeholder workshops
  - Authors hold workshops with stakeholders to review and comment on report

  - Comments and authors' responses are recorded and made publicly available
  - Revise chapters based on stakeholder comments
- Submit completed chapters to EPA
- Complete draft final report
  - EPA prepares the final report, including the executive summary and preface
- Submit report to FACA panel for review.

At the point that SAP 4.4 is submitted to the FACA panel, it enters the review phase described in Section 6 of this prospectus. The review process for this report will be consistent with the guidelines for preparing CCSP synthesis and assessment reports.

1.4. Audience and Intended Use

The primary audience for SAP 4.4 is resource and ecosystem managers at the Federal, State, and local level, tribes, non-governmental organizations, and others involved in protected area management decisions. SAP 4.4 will inform resource/ecosystem managers on the types of decisions that are sensitive to climate variability and change, the types of adaptation options available for supporting resilience to climate variability and change, and approaches for implementing adaptation options. Scientists, engineers, and other technical specialists will be able to use the information in SAP 4.4 to set priorities for future research and to identify decision-support needs and opportunities. SAP 4.4 will also support tribes and government agencies at the Federal, State, and local level in the development of policy decisions that promote adaptation and increase society's adaptive capacity for ecosystems and species within protected areas.

1.5. Questions to be Addressed

SAP 4.4 will summarize the present state of scientific understanding of the potential for adaptation interventions to help decisionmakers avoid adverse ecological outcomes associated with climate variability and change. The focus will be on the management of federally protected and managed lands and their resources, using case studies to illustrate how adaptation is or may be used to achieve management goals in the face of climate variability and change. The questions below describe the issues to be addressed in SAP 4.4.

1. *What are the management goals in the selected systems, upon what ecosystem characteristics do these goals depend, what are the stressors of concern, what are the management methods currently being used to address those stresses, and how could climate variability and change affect attainment of management goals?*

The SAP will begin with a literature review of specified management goals for the selected ecosystems on federally protected and managed lands and the management principles or frameworks employed to reach targeted goals. Natural resource management goals are commonly expressed in terms of maintaining ecosystem integrity, achieving restoration, preserving ecosystem services, and protecting wildlife and other ecosystem characteristics. The achievement of management goals is thus dependent on our ability to protect, support, and restore the structure and functioning of ecosystems.

Changes in climate may affect ecosystems such that management goals are not achieved. The identified management goals from the literature review will be analyzed for their sensitivity to climate variability and change, and to other stressors present in the system that may interact with climate change.

Adaptive responses to climate variability and change reduce the risk of failing to achieve management goals. The review will describe adaptation theories and frameworks from the scientific and management literature. Adaptation theories may be based on studies that focus on climate variability or long-term climate change. Possible adaptation theories and frameworks will then be linked to the climate-sensitive goals identified in each system. Potential adaptive responses include modification of existing management actions and new approaches intended solely to address the impacts of climate variability and change.

2. *For selected case studies, what is the current state of knowledge about management options that could be used to adapt to the potential impacts of climate variability and change?*
   - *What are the specific management goals?*
   - *What is our current knowledge of the condition and stresses for the system?*
   - *What methods are currently used to meet management goals and how are they implemented?*
   - *If adaptation is used, to what is it adapting, and what new information is being incorporated into management plans?*
   - *What information about the natural adaptive capacity of the ecosystem is being used in current management methods?*
   - *What are the opportunities or constraints that help or hinder the implementation of management strategies/methods?*
   - *How effective have those management methods been thus far in reaching stated management goals?*
   - *How could climate variability and change alter the effectiveness of current management practices?*
   - *How could management practices be altered or supplemented to address climate variability and change impacts?*

These questions will be addressed using six case studies to demonstrate adaptation approaches for ecosystems and resources on federally protected and managed lands. For the purposes of this SAP, a case study is a place-based exemplary illustration of adaptation methods or approaches to climate variability and change. Each case study will also discuss how recommended adaptation concepts, frameworks, or specific approaches may be applied to other ecosystem types or geographic regions with similar goals and climate change stresses. For example, if the resilience of one ecosystem type such as coral reefs may be enhanced through establishing a network of protected areas, a case study on coral reefs could enumerate how other types of ecosystems may benefit from a similar approach.

3. *Looking across the case studies, what are the factors that affect the successful implementation of management actions to address impacts from climate variability and change?*

The case studies in this report will reflect a cross section of climate-sensitive ecosystems and adaptation responses. This provides the opportunity to compare and contrast the different approaches to adaptation and assess the factors that affect their successful implementation. Factors affecting success may include ecosystem characteristics, management goals, and technical and scientific limitations. Challenges to implementation may be associated with different organizational scales, operational trade-offs, cost/benefit considerations, social/cultural factors and planning requirements (i.e., elements that determine the human component of adaptive capacity). An improved understanding of how these and other factors affect the success of adaptation responses is required to ensure the future protection of climate-sensitive ecosystems and resources.

The set of case studies will also provide an opportunity to identify and assess circumstances under which adaptation options complement current management goals. Examples include win-win strategies that improve current management systems and increase the resilience of ecological systems to climate variability and change; bet-hedging strategies that reduce ecological risks across a broad range of climate change scenarios; adaptive management plans that would incorporate systematic monitoring and climate change information; and voluntary or incentive-based programs that could involve public recognition, financial support, cost sharing, or cost leveraging to encourage incorporating adaptation for climate change into multipurpose projects. Understanding the potential applications and benefits of such strategies enhances their attractiveness to decisionmakers and increases the likelihood of their implementation.

4. *For each case study, how should we define and measure the environmental outcomes of management actions and their effect on the resilience of ecosystems to climate variability and change?*

The set of case studies provides an opportunity to synthesize information and assess the effectiveness of different

management actions for increasing the resilience of ecosystems to climate variability and change. At one level, the effectiveness of an adaptation action could be evaluated simply based on the success of implementing the management action. More importantly, however, the effectiveness of adaptation must reflect the longer term effect on the ecosystem. At this level, the measure of effectiveness will require not only the consideration of individual management actions, but also the cumulative effects of multiple actions on an environmental outcome or management goal of concern. Assessing the environmental outcomes of adaptation will require monitoring and assessment over potentially long periods of time as climate changes. For each case study, authors will propose a method or methods for monitoring and measuring environmental outcomes of the planned or implemented adaptation actions.

5. *What are the research priorities that will provide decisionmakers with the information and tools they need to protect climate-sensitive ecosystems and resources?*

Providing decisionmakers with the information and tools they need to protect ecosystems will require a diverse knowledge of how to improve adaptive capacity and resilience to climate variability and change. Given the breadth and complexity of this subject, it is important to identify and prioritize the need for new information, tools, models, and approaches to adaptation to guide future research and theoretical adaptations to climate variability and change that could be analyzed or field-tested. This includes research to identify the information and type of decision-support tools most useful to decisionmakers; to improve existing approaches and develop new approaches to adaptation in different ecosystems; to improve methods to evaluate the effectiveness of alternative adaptation options; and to understand and improve adaptive capacity of specific sensitive ecosystems and human communities.

2. Contact Information and Roles

The Environmental Protection Agency (EPA) is the lead agency for this synthesis and assessment product. Other agencies committed to contributing to this product are the Department of Agriculture (USDA), Department of Energy (DOE), National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), and U.S. Geological Survey (USGS). As the lead agency, EPA will use its guidelines for implementing the Information Quality Act and for meeting the requirements of the Federal Advisory Committee Act. EPA is also responsible for coordinating the acquisition of the authors' time as needed for this project, except for those authors that are employed by Federal agencies. Designated points-of-contact follow:

CCSP Agency	Agency Leads
EPA	Susan Julius, Jordan West, Britta Bierwagen, Tom Johnson, Chris Pyke julius.susan@epa.gov west.jordan@epa.gov bierwagen.britta@epa.gov johnson.thomas@epa.gov pyke.chris@epa.gov
USDA	William Hohenstein, Bryce Stokes whohenst@mailoce.oce.usda.gov bstokes@fs.fed.us
DOE	Jeff Amthor jeff.amthor@science.doe.gov
NASA	Woody Turner, Ed Sheffner woody.turner@nasa.gov esheffne@hq.nasa.gov
NOAA	Kenric Osgood, Ned Cyr kenric.osgood@noaa.gov ned.cyr@noaa.gov
USGS	Jack Waide jwaide@usgs.gov

3. Chapter Lead Authors, Coordinating Author, and Expert Reviewers: Required Expertise

As the lead agency for SAP 4.4, EPA will be responsible for compiling and synthesizing the contributions from the

Chapter Lead Authors listed in this prospectus. This includes guiding the entire project, assembling the final report—including harmonizing all of the writing contributions and editing the document for consistency and clarity—preparing the Preface and Executive Summary, and responding to reviewer comments on the document for each round of reviews. When the report enters the review phase, EPA will work with the Coordinating Author and the Chapter Lead and Contributing Authors to develop responses to comments from public and scientific reviews and will formally document all responses.

The lead agency is also responsible for preparing a list of nominees for Chapter Lead Authors based on interest in this product and a record of accomplishments in the relevant fields of expertise. The final report will undergo a FACA committee review as well as all other reviews called for in the CCSP guidelines.

3.1. Role and Required Expertise of Chapter Lead Authors

The writing team will include seven Chapter Lead Authors who will be responsible for directing the writing and content of specific chapters and ecosystem case studies described in Section 1.2 of this prospectus. The Chapter Lead Authors will invite Contributing Authors, as necessary, to participate in the development of the chapters and ecosystem case studies. Contributing Authors will be responsible for pre-determined portions of the case studies relating to one or more of the topic areas to be addressed by the Chapter Lead Authors. The Chapter Lead Authors and their Contributing Authors will be responsible for preparing the initial draft of each chapter of the report. Chapter Lead Authors will be responsible for the quality and accuracy of all graphics and written contributions to EPA, including any information or analysis required to synthesize the underlying studies on which the product is based.

Chapter Lead Authors should be accomplished writers and have technical backgrounds in at least one field relevant to adaptation for, or restoration of, ecosystems. Each Chapter Author must have produced or managed the production of a report or article that informs our understanding of adaptation for ecosystems to the impacts of climate change and climate variability, or have extensive experience managing or making decisions about responses of ecosystem to climate variability and change.

3.2. Role and Required Expertise of Coordinating Author

The Coordinating Author will work with EPA to organize and coordinate the activities of the seven Chapter Lead Authors as they develop and draft the content of each chapter, as they design and execute the six stakeholder meetings, and as they respond to stakeholder, public, and expert peer review comments. The Coordinating Author will serve as the facilitator in any meetings with the Chapter Lead Authors and will be responsible for harmonizing the approach and content of each chapter.

The Coordinating Author should be an accomplished writer and have a technical background in at least one field relevant to adaptation for, or restoration of, ecosystems. The Coordinating Author should also have experience managing the production of a scientific synthesis report involving authors from government and academic institutions, and engaging stakeholders in the synthesis process.

3.3. Role and Required Expertise of FACA Review Committee

EPA will convene a Federal Advisory Committee composed of 10 independent reviewers. This committee will function under the requirements of the Federal Advisory Committee Act. As a FACA committee, the Review Committee's deliberations related to substantive matters will take place in an open public forum. At the conclusion of each of the Review Committee's deliberations, they will prepare a collective written review of all comments in the form of a report that will be made available to the public (see Section 6 for more discussion of the review process). Meetings of

the FACA Review Committee (including conference calls and face-to-face meetings) will be announced in the Federal Register Notice no less than 15 days in advance of the meeting. The FACA Review Committee will represent the interests of the scientific community and other members of the intended audience, both in terms of reviewing the substance of the material included in the product and the quality of the writing. The Committee will provide an independent scientific review to ensure that the report accurately represents the state of the science and conveys the interests and needs of the environmental/natural resource and ecosystems management communities in preventing and responding to environmental impacts on the Nation's climate-sensitive ecosystems.

The expert reviewers will have experience in studying, managing, and implementing ecosystem protection strategies. In selecting FACA members, EPA will consider candidates with experience in ecological/ecosystem science, wildlife ecology, landscape ecology, systems ecology, biogeography, environmental sciences, social sciences, forestry, fisheries, land and water management, watershed science, and marine ecology. To ensure independence and avoid conflicts of interest, reviewers will not be employees or recent contractors or grantees of the lead agency. In addition, no member of the FACA Review Committee will participate as part of this product's writing team.

3.4. Nominees for Chapter Lead Author and Coordinating Author

Chapter Lead Authors and the Coordinating Author have been nominated by the sponsoring agency to participate in the overall coordination of SAP 4.4 preparation. These nominees were identified based on past records of interest and accomplishments in conducting research and advising academic and government panels on one or more of the following areas: climate variability and change impacts on ecosystems (including on federally owned or managed lands); management methods (including on federally owned or managed lands and waters); ecosystem restoration; large scale syntheses of scientific research and management responses for environmental impacts to sensitive ecosystems and resources; guidance documents on managing for resilience; collaboration with resource managers to produce scientific publications and translate them into popular publications that connect the science with its application; and social dimensions of managing ecological resources. Past contributions to relevant scientific assessments, success in peer-reviewed proposal funding competitions, and publication records in refereed journals are additional measures used in the selection process. The Chapter Lead Authors selected on the basis of these criteria are listed below. Biographical information is presented in Appendix A.

Chapter Lead Author Nominees

Jill Baron	USGS and Colorado State University *National Parks*
Linda Joyce	USDA Forest Service and Colorado State University *National Forests*
Brian Keller	NOAA *Marine Protected Areas*
Margaret Palmer	University of Maryland *Wild and Scenic Rivers*
Charles Peterson	University of North Carolina *National Estuaries*
TBD	*National Wildlife Refuges*
Peter Kareiva	The Nature Conservancy *Synthesis*

Coordinating Author Nominee

Bill Dennison	University of Maryland

Comments are welcome. These Chapter Lead Authors will be assisted by Contributing Authors who have specific assignments based on their scientific expertise. Contributing Authors may be nominated through July 10, 2006. To do so, please contact Susan Julius at the Environmental Protection Agency, 1200 Pennsylvania Ave, NW, Mail Code 8601N, Washington, DC 20460, 202-564-3394 (julius.susan@epa.gov). Nominations should include a current CV and a list of publications.

4. Stakeholder Interactions

Individuals, tribes, and members of Federal, State, and local governments and agencies—together with non-governmental organizations and individuals—are involved in research and the management of ecosystems that may be affected by climate variability and change. Stakeholders include (1) those who wish to consider options for reducing the risk of negative ecological outcomes associated with climate variability and change; (2) researchers who study global change impacts on ecosystems and topics relevant for adaptation to climate variability and change impacts (e.g., ecosystem restoration, sustainability); (3) science managers from the physical and social sciences who develop long-term research plans based on the information needs and decisions at hand; and (4) tribes and government agencies at Federal, State, and local levels who develop and evaluate policies, guidelines, procedures, technologies, and other mechanisms to improve adaptive capacity for specific types of adaptation options.

The goal of this CCSP product is to provide useful information on the state of knowledge regarding adaptation options for key, representative ecosystems and resources. To ensure that we achieve this goal, we will engage both stakeholders and researchers in shaping the content of this report. EPA, the Coordinating Author, and the Chapter Lead and Contributing Authors will work with the lead and contributing agencies to obtain stakeholder input throughout the writing process using a variety of means (e.g., e-mail, phone calls, face-to-face meetings, etc.). When the first drafts of each chapter are completed, a series of workshops will be held with stakeholders to engage them in reviewing the content and applicability of the information provided in SAP 4.4. Chapter Lead and Contributing Authors will incorporate stakeholder comments in the revisions of their chapters before the drafts are submitted to EPA.

In preparing this draft prospectus, careful consideration has been given to the feedback received from stakeholders at the December 2002 Climate Change Science Program Planning Workshop for Scientists and Stakeholders. In addition, other recent developments have been reflected. For example, comments on research priorities received from the scientific community at the February 2004 CCSP Ecosystems Interagency Working Group Conference guided the selection of questions to address in this product. This community will also be used to obtain reviews of the product outline and draft report. Additional reviews may be sought from other academics and practitioners from State and local governments, non-governmental organizations, and other stakeholder groups who are not represented by the February 2004 Workshop participants or the workshops referenced above.

5. Drafting Process

A comprehensive literature review will be conducted to provide background material and to help guide the selection of case studies. EPA and the Coordinating and Chapter Lead Authors will review and comment on the results and receive copies of all articles, reports, and other materials covered in the literature review. Then Chapter Lead Authors will develop a framework for each of the chapters and propose case studies based on the selection criteria and characteristics described in Section 1.2 of this prospectus. The proposed case studies will be vetted with EPA and collaborating agencies. These chapters and case studies will respond to the five key questions listed in this prospectus (see Section 1.5). Chapter Lead Authors and Contributing Authors will draft individual chapters using their chosen method for communication (e.g., face to face, e-mail, teleconference, etc.).

Once the chapters have been drafted, a series of workshops will be held with the Coordinating Author and the Chapter Lead and Contributing Authors, EPA, and stakeholders to review and comment on the structure and content of each chapter. These comments will be recorded and provided to the authors to help in any required re-drafting of the chapters. Authors will also record their responses to comments from the workshop participants. Plans and assignments for producing the final versions of each chapter will be made before the end of the workshop.

Authors will submit their finished chapters to EPA. EPA will then prepare the final report using contractor support for graphics and editing. EPA will also write the executive summary and preface to the report. Once EPA completes the report, it will be submitted to an independent FACA panel for review. The process for this report will be consistent with the guidelines for preparing CCSP synthesis and assessment reports.

6. Review Process

There will be a number of opportunities for both expert peer review and public comment. The time table for these reviews appears in Section 9 of this prospectus. Product 4.4 will be reviewed according to the process outlined in the *Guidelines for Producing CCSP Synthesis and Assessment Products*: (1) a first draft, upon clearance by CCSP, will be released publicly and will undergo a public review and an expert, scientific review by an independent FACA review panel convened by EPA (public review comments will be provided to the FACA panel prior to their review), and with a record of all FACA review committee's comments provided to the public in the form of a report; (2) a second draft, reflecting the comments received from the FACA review panel and the public, will be made available on the CCSP web site, along with a document describing the disposition of comments; (3) this second draft will undergo a second FACA peer review and the FACA committee will prepare a report of their collective comments that will be made available to the public; (4) a third draft will be prepared in response to comments received from the FACA peer review, along with a document describing the disposition of comments, and will undergo final review and approval through the CCSP and the National Science and Technology Council. This will constitute the final report.

The expert peer review process will engage the independent scientific reviewers formed as a FACA committee by EPA. The public is invited to nominate independent scientific reviewers to the FACA review committee. Nominations should be e-mailed to Susan Julius (julius.susan@epa.gov) by July 10, 2006. Nominations must include CVs and publications listings. The expert review process will involve one or more face-to-face meetings of the FACA Review Committee in compliance with the Federal Advisory Committee Act and with the requirements for peer review from the Office of Management and Budget Final Information Quality Bulletin for Peer Review ("OMB Peer Review Bulletin"), issued December 16, 2004. Each Expert FACA Reviewer will review the document as a whole.

The major objectives of this FACA Committee are to provide advice and recommendations on: (1) the scope of the report; (2) the methods used to synthesize the results and conclusions; (3) the veracity of the literature cited; and (4) determination of whether the report's conclusions are supported by the literature. Specific and detailed review charges will be developed and provided to the Committee to guide the review process.

When the first draft is released to the FACA committee, the report will also be released for public comment. The public comment period will last at least 45 days. Notice of the public comment period will be disseminated on the CCSP web site, in the Federal Register, and through other publications, web sites, and means as appropriate to the product to encourage wide public participation in the review. At the conclusion of the public review period, comments will be submitted to the FACA review panel for their consideration. Following the public and expert review, EPA and the Coordinating Author and Chapter Lead and Contributing Authors will revise the draft product by incorporating comments and suggestions from the reviewers, as deemed appropriate. EPA and the Coordinating and Chapter Lead Authors will prepare a document detailing the disposition of all comments. This second draft and document detailing the disposition of all comments will be submitted to the FACA expert panel for a second review.

The EPA and the Chapter Lead and Contributing Authors will prepare a third draft of the product, taking into consideration the FACA expert panel's comments. EPA and the Chapter Lead and Contributing Authors will also prepare a document

detailing the disposition of all comments from the second FACA review. Once revisions are complete, EPA will determine that the product has been prepared in accordance with the Information Quality Act (including ensuring objectivity, utility, and integrity as defined in 67 FR 8452), and will submit the synthesis and assessment product to the CCSP Interagency Committee for approval. If the CCSP Interagency Committee determines that further revisions are necessary, their comments will be sent to the lead agency for consideration and resolution by the lead and contributing agencies and the Coordinating and Chapter Lead Authors.

If the CCSP Interagency Committee review determines that no further revisions are needed and that the product has been prepared in conformance with the *Guidelines for Producing CCSP Synthesis and Assessment Products* (see <http://www.climatescience.gov/library/sap/sap-guidelines.htm>), they will submit the product to the National Science and Technology Council for clearance. Clearance will require the concurrence of all members of the Committee on Environment and Natural Resources. Comments generated during the National Science and Technology Council review will be addressed by the CCSP Interagency Committee in consultation with the lead and contributing agencies and the Chapter Lead and Contributing Authors.

7. Related Activities, Including Other National and International Assessment Processes

This CCSP product will build on previous Intergovernmental Panel on Climate Change (IPCC) assessments (e.g., First, Second, and Third Assessment Reports), the U.S. National Assessment, the Millennium Ecosystem Assessment, the Arctic Climate Impact Assessment, and National Research Council reports [e.g., *Global Environmental Change: Research Pathways for the Next Decade* (1999), *Science Priorities for the Human Dimensions of Global Change* (1994), *Hydrologic Science Priorities for the U.S. Global Change Research Program: An Initial Assessment* (1999)]. It is expected that this CCSP product will provide input to future IPCC assessments, the United Nations Framework Convention on Climate Change National Communication on vulnerability and adaptation assessments, and the United Nations Convention on Biological Diversity.

8. Communications: Proposed Method of Publication and Dissemination of the Product

The lead agency will produce and release the completed product using the standard format for all CCSP synthesis and assessment products. The final product and the comments received during the expert review and public comment period will be posted on the CCSP web site. Once the National Science and Technology Council has cleared the document, the product will be prepared for both web and hardcopy dissemination. Final report production and layout will be managed by professional and technical editors and writers. The number of hardcopies and the distribution process will be determined as part of the development of this product.

A communications plan will be developed by the lead and contributing agencies along with the Coordinating Author and the Chapter Lead and Contributing Authors. This plan will cover the review and distribution of the product. Venues will be pursued—such as professional conferences and workshops for ecosystems and environmental resource managers—to alert stakeholders to the assessment process and findings, and invite them to participate in the public comment period.

9. Proposed Timeline

The following schedule is proposed for the development of CCSP Product 4.4, with the final product completed by December 2007. Maintaining this schedule is contingent on approval of the prospectus as well as the various review processes described above.

2006

June	Prospectus posted on CCSP web site for public comment (30 days)
July	Final prospectus posted on CCSP web site
Aug	Author teams begin preparation of draft report
Oct	All stakeholder workshops completed

2007

Jan	EPA completes the first draft; it is released for public comment (45-day review period) and submitted to FACA review panel
Apr	FACA review panel meets to consider first draft
Aug	EPA completes response to review panel and public comments and prepares second draft; second draft submitted to FACA review panel and made available to the public along with the documentation of the disposition of comments
Oct	FACA review panel meets to consider second draft
Dec	EPA completes response to review panel and prepares third (final) draft to submit to CCSP Interagency Committee and the National Science and Technology Council

References

Bennett, EM, GS Cumming, GD Peterson. 2005. A systems model approach to determining resilience surrogates for case studies. *Ecosystems* **8**: 945-957.

Burkett, VR, DA Wilcox, R Stottlemyer, W Barrow, D Fagre, J Baron, J Price, JL Nielsen, CD Allen, DL Peterson, G Ruggerone, T Doyle. 2005. Nonlinear dynamics in ecosystem response to climate change: Case studies and policy implications. *Ecological Complexity*. In press.

Easterling, DR, GA Meehl, C Parmesan, SA Chagnon, TR Karl, LO Mearns. 2000. Climate extremes: Observations, modeling, and impacts. *Science* **289:** 2068-2074.

Gunderson, LH. 2000. Ecological Resilience - In Theory and Application. *Annual Review of Ecology and Systematics*, **31**: 425-439.

Holling, CS. 1996. Engineering resilience versus ecological resilience. In *Engineering Within Ecological Constraints* (Schulze, P.C., ed.), pp. 31–43, National Academy Press.

Hughes, JB, GC Daily, PR Ehrlich. 1997. *Science* **278:** 689-692.

McCarthy, JJ, O Canziani, NA Leary, DJ Dokken, KS White (eds.). 2001. Climate Change 2001: Impacts, Adaptation and Vulnerability. IPCC Working Group II. Cambridge University Press, Cambridge, pp 451-485.

McCarty, JP. 2001. Ecological consequences of recent climate change. *Conservation Biology* **15:** 320-331.

McLaughlin, JF, JJ Hellmann, CL Boggs, PR Ehrlich. 2002. Climate change hastens population extinctions. PNAS 99:9, pp. 6070-6074.

Parmesan, C, TL Root, MR Willig. 2000. Impacts of extreme weather and climate on terrestrial biota. *Bull. Am. Meteor. Soc*. **81:** 443-450.

Parmesan, C and G Yohe. 2003. A globally coherent fingerprint of climate impacts across natural systems. *Nature* **421:** 37-42.

Sala, OE, FS Chapin III, JJ Armesto, R Berlow, J Bloomfield, R Dirzo, E Huber-Sanwald, LF Huenneke, RB Jackson, A Kinzig, R Leemans, D Lodge, HA Mooney, M Oesterheld, NL Poff, MT Sykes, BH Walker, M Walker, DJ Wall. 2000. Global biodiversity scenarios for the year 2100. *Science* **287:** 1770-1774.

Scheffer, M, S Carpenter, JA Foley, C Folke, B Walker. 2001. Catastrophic shifts in ecosystems. *Nature* **413:** 591-596.

Tompkins, EL and WN Adger. 2004. Does adaptive management of natural resources enhance resilience to climate change? *Ecology and Society* **9** (2): 10 [online] http://www.ecologyandsociety.org/vol9/iss2/art10.

Turner, BLI, RE Kasperson, PA Matson, JJ McCarthy, RW Corell, L Christensen, N Eckley, JX Kasperson, A Luers, ML Martello, C Polsky, A Pulsipher, A Schiller. 2003. A framework for vulnerability analysis in sustainability science. Proceedings of the National Academy of Sciences US 100, 8074-8079.

Warren, MS, JK Hill, JA Thomas, J Asher, R Fox, B Huntley, DB Roy, MG Telfer, S Jeffcoate, P Harding, G Jeffcoate, SG Willis, JN Greatorex-Davies, D Moss, CD Thomas. 2001. Rapid responses of British butterflies to opposing forces of climate and habitat change. *Nature (London)* **414:** 65-69.

Appendix A. Biographical Information for Nominated Authors

Jill Baron, USGS and Colorado State University
Dr. Jill S. Baron is an ecosystem ecologist with the U.S. Geological Survey, and a Senior Research Ecologist with the Natural Resource Ecology Laboratory at Colorado State University. Her recent interests include applying ecosystem concepts to management of human-dominated regions, and understanding the biogeochemical and ecological effects of climate change and atmospheric nitrogen deposition to mountain ecosystems. Dr. Baron has numerous publications and awards, including achievement awards for her work from the National Park Service, U.S. Geological Survey, and USDA Forest Service, and the Department of Interior Meritorious Service Award in 2002. She has been a member of the Governing Board of the Ecological Society of America, serves on several Science Advisory Boards, has given testimony to Congress on western acid rain, and is an associate editor for Ecological Applications.

Linda Joyce, USDA Forest Service and Colorado State University
Dr. Joyce is Research Project Leader with the USDA Forest Service Rocky Mountain Research Station. She supervises a team of scientists who conduct research on the impact of terrestrial and atmospheric disturbances on alpine and forest ecosystems. She is also an affiliate faculty member in the Graduate Degree Program in Ecology and in the Rangeland Ecosystem Sciences Department, both programs at Colorado State University. Her research interests include modeling vegetation and ecosystem dynamics to assess the impact of climate change on ecosystem structure and function, quantifying the impacts of management on natural resources, linking ecological and economic analyses, and spatially optimizing natural resource production. Dr. Joyce serves as the Climate Change Specialist for the USDA Forest Service. She has contributed to the forestry and rangeland sections of the Intergovernmental Panel on Climate Change assessments. She received a bachelor's degree in mathematics from Grand Valley State University, a Master's in Environmental Science from Miami University of Ohio, and a Ph.D. in range ecology from Colorado State University.

Peter Kareiva, The Nature Conservancy
Dr. Kareiva received his Ph.D. from Cornell University in 1981. He has been on the faculty at Brown University, University of Virginia, University of Washington, Santa Clara University, and University of California at Santa Barbara. He has also taught and done research in Asia, Latin America, and Europe. Peter's interests span agriculture, conservation, ecology, and the interface of science and policy. In addition to a long academic career, he worked for NOAA Fisheries for three years, and was Director of the Northwest Fisheries Science Center Conservation Biology Division. Scientifically Peter is best known for contributions to insect ecology, landscape ecology, risk analysis, mathematical biology, and conservation. But what he is most proud of is the fact students from his lab have faculty positions at over twenty different universities, as well as leadership positions in governmental agencies and international organizations throughout the world. His current projects emphasize the interplay of human land-use and biodiversity, resilience in the face of global change, and marine conservation.

Brian Keller, NOAA
Brian Keller is the Science Coordinator of the Florida Keys National Marine Sanctuary, where he is responsible for the Sanctuary's research and monitoring program. He has a B.S. in

biochemistry from Michigan State University (1970) and a Ph.D. in ecology and evolution from the Johns Hopkins University (1976). He was a postdoctoral associate at the Scripps Institution of Oceanography (1976-1979) and Yale University (1980-1984). His research has included sea urchin population ecology in Jamaican seagrass communities (advisor: Jeremy B.C. Jackson); kelp forest dynamics in central California (with Paul Dayton and David Ven Tresca); snapping shrimp behavior, larval dispersal, and taxonomy (with Nancy Knowlton); and the collapse of staghorn coral populations along the north coast of Jamaica (with Nancy Knowlton and Judy Lang). He served as Acting Head and Research Fellow at the Discovery Bay Marine Laboratory, University of the West Indies, Jamaica (1984-1986), and was the Project Manager of an oil spill study at the Smithsonian Tropical Research Institute in Panama (1987-1994). He has authored or edited more than 30 papers, chapters, and technical reports. Brian was the first Executive Director of the Ecological Society of America (1994-1997) and then moved to the Florida Keys as a marine ecologist for The Nature Conservancy prior to being hired by the Florida Keys National Marine Sanctuary in 2000. He also is serving as the Regional Science Coordinator for the Southeast, Gulf of Mexico, and Caribbean Region of the National Marine Sanctuary Program.

Margaret Palmer, University of Maryland
Dr. Palmer is Laboratory Director of the Chesapeake Biological Laboratory in the University of Maryland Center for Environmental Sciences. She is also a Professor of Biology and Entomology at the University of Maryland, College Park. She received her Ph.D. in oceanography, but in the last 20 years has turned her attention to freshwater systems. The broad objective of Palmer's research is to understand what controls stream ecosystem structure and function. She specifically focuses on how land use and urbanization influence stream ecosystems and on producing the best science to guide ecologically effective restoration of rivers and streams. Palmer has more than 90 peer reviewed publications with numerous awards from the National Science Foundation, the Environmental Protection Agency, the C.S. Mott Foundation, and the David and Lucile Packard Foundation. She currently is leading the National River Restoration Science Synthesis project (www.nrrss.umd.edu), has an active research lab of 12 graduate students, postdocs, and research technicians working on various aspects of stream ecosystem science (www.palmerlab.umd.edu). Palmer has served on numerous advisory boards and scientific panels and led the Ecological Society of America’s committee to develop an action plan for the ecological sciences for the 21st century. Palmer was Director of Biological Sciences at the University of Maryland from 1997-1999 and Program Director of Ecology at the National Science Foundation from 1999-2000.

Charles (Pete) Peterson, University of North Carolina
Dr. Peterson is an expert on the organization of soft-sediment benthic communities in estuaries and lagoons. His interests include predation and intra-and inter-specific competition, the influence of hydrodynamics on ecological processes, and the role of resource limitation in suspension-feeding bivalve populations. Though best known for his experimental approach to testing hypotheses concerning benthic systems, he also conducts research in paleoecology, invertebrate fisheries management, estuarine habitat evaluation, and barrier island ecology. Dr. Peterson has also contributed to environmental science as chair of the Global Ocean Ecosystems Dynamics program, which addressed how global change may be expected to affect marine ecosystems. He was the recipient of a Pew Fellowship, which he used to develop environmental

regulations for coastal water quality and estuarine fisheries management in North Carolina. Dr. Peterson employed an active adaptive management approach and developed management schemes for the preservation of seagrass habitat and dependent biodiversity, and to restore oyster habitat and production.

Coordinating Author Nominee

Bill Dennison, University of Maryland
Dr. Dennison is a Professor of Marine Science and Vice President for Science Applications at the University of Maryland Center for Environmental Science (UMCES). Dr. Dennison coordinates the Integration and Application Network. The focus of this program is on integrating science with its potential uses by seeking input from a variety of disciplines and engaging stakeholders to develop direct applications for resource management. Bill Dennison is a marine ecologist, with a specialty in ecophysiology of marine plants, who has conducted coastal marine research in all of the world's oceans. He has published papers on a diversity of topics: seagrasses, corals, macroalgae, microalgae, bacteria and viruses, effects of toxicants, nutrients and sediments on marine ecosystems, harmful algal blooms, water quality and ecosystem health. He has also produced a variety of science communication products: books, newsletters, posters, video/DVDs, web sites. He has organized national and international scientific conferences in the U.S. and Australia. His research focus has been on the ecophysiology of marine plants and the development of tools and techniques to solve environmental problems associated with the land-sea interface.