

Draft Minutes for:

**The Adaptation for Climate-Sensitive Ecosystems and Resources
Advisory Committee Meeting**

**January 15, 2008
2:00-4:00 pm Eastern Time**

Participation by Teleconference Only

Prepared for:

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NOTICE

This document was prepared by Versar, Inc., an EPA contractor (Contract No. EP-C-07-025, Task Order No. 07), as a summary of the discussion held via conference call by the *Adaptation for Climate-Sensitive Ecosystems and Resources Advisory Committee* on January 15, 2008. This report captures the main points and highlights of the meeting. It is not a complete record of all detailed discussion, nor does it embellish, interpret, or enlarge upon matters that were incomplete or unclear. Statements represent the individual views of each participant.

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PREFACE

The U. S. Environmental Protection Agency's (EPA) Global Change Research Program (GCRP) is an assessment-oriented program within the Office of Research and Development that focuses on analyzing how potential climate change and other global environmental changes may affect water quality, air quality, aquatic ecosystems, and human health in the United States.

The GCRP is a member of the U.S. Climate Change Science Program (CCSP) and is therefore responsible for helping to implement their *Strategic Plan* and to fulfill the requirements of the Global Change Research Act of 1990 to conduct periodic assessments of climate change and variability. Hence, the GCRP is conducting an assessment for the CCSP draft report entitled *Synthesis and Assessment Product (SAP) 4.4: Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources*. A Federal Advisory Committee, Adaptation for Climate Sensitive Ecosystems and Resources Advisory Committee (ACSERAC), was established to conduct an external peer review of the draft SAP 4.4.

1. INTRODUCTION

A public teleconference was held by the *Adaptation for Climate-Sensitive Ecosystems and Resources Advisory Committee (ACSERAC)* on January 15, 2008. The teleconference was held to address EPA's response to the post panel meeting comments from the ACSERAC meeting that was held on October 23-24, 2007 at the Hyatt Regency Hotel, Bethesda, MD. The minutes of the teleconference are captured below. The Appendices to are as follows: Appendix A - List of Attendees; Appendix B - Draft Meeting Agenda; Appendix C - Draft Summary Comments by the Advisory Committee Following the October 22-23 Meeting; and Appendix D - Response to Committee Recommendations by the Report Authors.

2. WELCOME AND ADMINISTRATIVE PROCEDURES

Dr. Paul Risser, the committee Co-Chair, began by welcoming the committee and thanking them for their work. The committee concluded their panel meeting with a written response to the Synthesis and Assessment Product 4.4 report. The EPA has responded to those comments; today the committee will be walking through the EPA responses.

Dr. Reed Noss, committee Co-Chair, proposed that the group walk through EPA's response to the committee recommendations charge-by-charge and then chapter-by-chapter. He asked that the committee members raise any concerns they have regarding the responses, and stated that he personally does not have any significant concerns with the response that was taken.

Dr. Risser asked that the EPA representatives especially highlight any cases where the committee's recommendations were not incorporated into the new version of the document.

Janet Foellmer, the Designated Federal Official (DFO), officially opened the meeting by reading the Federal Advisory Committee Act (FACA) statement. She also welcomed the panel and stated that the purpose of the teleconference was for EPA to inform the committee of their disposition of the committee's advice. She then announced public comments would be taken at 3 pm. She thanked the committee members for their participation and turned the meeting over to Dr. Risser.

3. DISSCUSSION OF THE DRAFT REPORT

3.1 EPA Response to Charge Question Recommendations

Susan Julius thanked the committee for their comments, which she believes have improved the report substantially. With regards to the first charge question on how to organize the Synthesis and where it should appear in the report - EPA did not fully implement the recommendation of the committee, but did try to respect the spirit of what was being recommended. Changes were made to the Executive Summary in order to make it more appropriate for an executive audience, leaving the Synthesis Chapter to be tailored to a more general reader and serve to summarize the themes of the report as a concluding chapter. The revised Executive Summary now delivers the key messages and insights from the report in a shortened version that will be more easily digested by executive readers. The individual summaries making up the new Executive

Summary were also placed in the beginning of each chapter, giving the readers the key message up front.

Additionally, the authors attempted to make it clear in the Introductory Chapter and in the individual chapters why these particular systems were selected for analysis. Where appropriate, the authors highlighted that a system had adjacent land – such as the national parks – that would provide additional adaptive capacity if the managers were to partner with their neighboring agency.

The committee did not have any further remarks with regards to handling these recommendations.

Dr. Jordan West addressed the committee's recommendation of shortened or modified case studies that would be more explicit in their message. She explained that EPA's response to this recommendation was to develop a box version of each case study (none longer than a little over one page) that contained five headings used to condense its message. These include why the study was chosen, the management context, key climatic change impacts, adaptation options and a short conclusion section. The authors also took care to modify their adaptation options in order to make them more specific to the particular case. The full version of each case study has been moved to the Appendix, thus shortening the report and allowing the chapters to read more smoothly.

The committee was very satisfied with the response to this recommendation.

Ms. Julius addressed the committee's recommendation of ensuring precise terminology across chapters. She explained that the authors went back through the report to ensure that glossary terms were being used correctly. The authors indicated any areas where exceptions or caveats to normal glossary usage occurred, and specifically addressed these in the text. One particular term addressed was 'ecosystem management.'

There were no comments from the committee.

Ms. Julius and *Dr. West* reiterated the new placement and structure of the Synthesis Chapter, focusing on how the authors now had more explicit links in their individual chapters. They also added that the Synthesis Chapter now places greater emphasis on decision-making under uncertainty, and contains more information on the usefulness of current best management practices. More of an emphasis was also placed on adaptive management and monitoring, and the latter was now brought from its original position to the forefront of the chapter.

Dr. Risser applauded the authors for taking the committee's advice so seriously. The committee members had struggled a bit with what to recommend in this case, and overall this was a very pleasing outcome.

Dr. Joseph Arvai took this opportunity to ask if the committee members would be able to review this newest version of the report.

Ms. Julius responded that the committee would be able to suggest modification to these latest report revisions if they had serious issues with the steps that had been taken. However, they would not get a chance to read the full report and comment.

Dr. Michael Slimak added that the final report is scheduled to be completed by January 31, 2008 and at that time all committee members would receive a copy.

Having now covered the key points contained in Charge Questions #1-4, *Ms. Julius* moved on to addresses Charge Questions #5 - that the authors make more clear the main conclusions, key concepts, and recommendations across management systems and ecosystem types. This was addressed by changing the structure of the Executive Summary to focus on key themes in the report (not individual chapter conclusions) and to include these key themes in the beginning of each chapter. Also, the authors tried to bring out more clearly the themes of the Synthesis Chapter in their own chapters, as well as unify the language used across chapters.

There were no comments from the committee.

Ms. Julius moved on to address Charge Questions #6 - the characterization of confidence levels. She explained that the authors went to the Intergovernmental Panel on Climate Change (IPCC) 4th Report as precedence, stepping back from their current work and taking a look from a more qualitative perspective. The new method employed, involves first providing a verbal description of whether or not there was a large amount (high), or small amount (low) of evidence to support the rating, and then making an assessment of agreement or disagreement with the evidence (high or low). The authors took what they thought were the most relevant approaches in the report – the adaptation approaches – and asked if there was high or low agreement, with a resulting narrative for each approach. This was an extensive exercise, and a written explanation in support of it will appear in the report appendix.

Dr. Risser was pleased with this strong response to the committee's recommendation.

Dr. Elizabeth Malone believes that this outstanding work by the authors will serve as a real contribution to the literature, and will assist subsequent researchers performing similar analyses.

Dr. Noss concurred.

Ms. Julius went on to address the charge dealing with stake holder involvement, stating that in their response to the committee's recommendation, the authors attempted to clarify within the report that the stakeholder workshops were targeted at experts, and as a means to provide input comments and review of the chapter comments only. Engagement of the larger definition of stake holders would need to be done at the point of public review. The type of people that were recruited to the stakeholder workshops is clearly stated now in the introduction of the report.

Dr. David Patton suggested that the committee indicate both who they invited to these workshops and who did in fact attend. *Ms. Julius* agreed, informing the committee that a list of who were invited will appear in the Appendix, and a separate list of who actually attended will appear in the Acknowledgements. *Dr. Malone* agreed that this was a reasonable approach to

clarify the report and move away from any indication that this was a broad base of stakeholders. *Ms. Julius* agreed that issue was misleading in the previous draft.

3.2 EPA Response to Individual Chapter Recommendations

Ms. Julius informed the committee that the higher-level comments on the authors' response to the committee's chapter recommendations could be handled on this call. Many authors were on the line to take questions.

Dr. Patton began by suggesting deficiencies in the National Forest Chapter. Specifically, that BLN – the largest landholder in the country – is not addressed, nor are the other 100+ National Forests (only three were considered in this report). He suggested that the authors be prepared to answer questions from the public on these deficiencies.

Dr. Brad Griffith, author of the National Wildlife Refuge Chapter, asked if *Dr. Patton* saw the same deficiencies in his chapter.

Dr. Patton replied that yes, and added that because each refuge has a specific charge, the authors will next expect a variety of questions from the public. Specifically, questions might point to why one type of refuge was included and not another. *Dr. Griffith* defended such questions by stating that the chapter was set at the system level. *Dr. Patton* agreed that *Dr. Griffith* would be able to explain his choices well at the system level.

Ms. Julius added that because it is a preliminary review, comments from outsiders are exactly what they want and 'Preliminary' remains in the title of this report, because it can not be comprehensive. *Dr. Patton* again stressed that a lot of comments will come in, although he does not believe that they will all be negative.

Dr. Charles Peterson spoke for the U.S. Forest Service, noting that the Agency is really in its infancy in responding to climate change. He stressed that the goal of this report was to offer ways that the Agency can get started thinking about climate change and encourage managers to do similar assessments of their own units. He sees it as a starting point for any real management that will get done.

Dr. Patton agreed that what will come out of this report is policy statements, and also hopes that this report will inspire managers to do something.

Dr. J. Michael Scott stated that the authors of the Refuge Chapter were asked by the combined Directors of the US Geological Survey (USGS) and the Fish and Wildlife Service (FWS) to present the results of this Chapter, and that they also just received two invitations from the Director of the National Wildlife Systems to do the same. Therefore, he believes that the formalization of 'the handshake' between science and policy in report form is something worth thinking about.

Dr. Risser asked for any comments by the committee on the state of the National Parks Chapter. No concerns were raised.

Dr. Risser asked for comments from the committee on the Wild and Scenic Rivers and the Estuaries Chapters.

Dr. Carl Herschner stated that his only previous concern was the author's rationale for not prioritizing their adaptation recommendations. He accepts their logic presented in the written response to the committee's recommendations.

Ms. Julius replied that the summary in the beginning of the Estuaries Chapter does serve to highlight the important recommendation for this system.

Dr. Robert Van Woelik stated that he was pleased with the way the authors addressed the committee's comments across the board, and is looking forward to seeing the final product.

The committee agreed that there was nothing more that they needed to discuss with regards to the Synthesis Chapter.

Ms. Julius added that a crosswalk exercise could be done between the author's response to the committee's comments and the final document once the document was completed at the end of January.

4. NEXT STEPS AND ACTION ITEMS

Ms. Julius explained that final edits to the report are not yet finished for the Synthesis Chapter, but that they will be concluded by the end of the week. Then, the report will need to go through EPA clearance before it can be turned over to the Climate Change Science Office by January 31, 2008.

Dr. Silmak added that after the Climate Change Science Office sends it out to other agencies for review, and that these agencies are given a two-week turn around schedule. He has offered the agencies the opportunity to be briefed on the document – including its origins, how the authors reached out the experts, why they chose the six resource types that they did, and the improvements with regards to being less policy prescriptive than they were in the first draft. He extended an invitation to all authors and committee members to participate in such a briefing. At this time, no date has been set.

Ms. Foellmer asked if anyone would like to make a public comment at this time. None were received.

Dr. Risser asked for any parting words from the authors.

Dr. Jill Baron thanked the EPA on the strong lead that they took with this project, adding that she had never seen a process run more smoothly. Many others concurred. *Ms. Julius* thanked the committee members.

Dr. Slimak encouraged the authors to publish journal articles related to this work in order to stimulate others in the climate change field. Suggestions from the committee on appropriate journals to submit to included the *Journal of Forestry* and *Frontiers in Ecology and the Environment*.

Dr. Risser adjourned the meeting.

APPENDIX A
LIST OF ATTENDEES

**Adaptation for Climate-Sensitive Ecosystems and Resources Advisory Committee
(ACSERAC)**

Members in Attendance:

Dr. Paul Risser
Acting Director, National Museum of Natural History
Smithsonian Institution, MRC 106
P.O. Box 37012
Washington, DC 20013-7012

Dr. Reed Noss
University of Central Florida
Dept. of Biology
4000 Central Florida Blvd.
Orlando, FL 32816

Dr. Robert Van Woesik
Professor, Dept. of Biological Sciences
Florida Institute of Technology
150 West University Blvd.
Melbourne, Florida 32901-6988

Dr. Joseph Arvai
Department of CARRS and
Environmental Science and Policy Program
Michigan State University
305 Natural Resources Building
East Lansing, MI 48824

Dr. Eric Gilman
Marine Scientist
Global Marine Programme
IUCN (The World Conservation Union)
2718 Napuaa Place
Honolulu, Hawaii 96822

Dr. Carl Hershner
Center for Coastal Resources Management
Virginia Institute of Marine Science
Gloucester Point, VA 23062

Dr. Elizabeth Malone
Senior Research Scientist
Pacific Northwest National Laboratory
Joint Global Change Research Institute

University of Maryland
8400 Baltimore Avenue, Suite 201
College Park, MD 20740-2496

Dr. David Patton
Professor Emeritus
School of Forestry
Northern Arizona University
P.O. Box 15018
Flagstaff, Arizona 86011-5018

Members Not in Attendance:

Dr. George Hornberger
Department of Environ. Sciences
University of Virginia
Clark Hall
Charlottesville, VA 22903

Dr. Daniel Tufford
Department of Biological Sciences
University of South Carolina
Columbia, SC 29208

Other Attending:

Joanna Foellmer - EPA
Susan Julius - EPA
Dr. Jordan West - EPA
Dr. Michael Slimak - EPA
Dr. Geoffrey Blate - EPA
Dr. Charles 'Pete' Peterson - UNC
Dr. Brad Griffith - USGS
Dr. Jill Baron - USGS
Dr. Brian Keller - NOAA
Dr. J. Michael Scott - USGS
Dr. Dave Peterson

APPENDIX B
DRAFT MEETING AGENDA

A Federal Advisory Committee for the U.S. Environmental Protection Agency's Office of Research and Development

**ADAPTATION FOR CLIMATE SENSITIVE ECOSYSTEMS RESOURCES
ADVISORY COMMITTEE**

**DRAFT AGENDA
January 15, 2008
2:00 – 4:00 pm Eastern Time**

Participation by Teleconference Only

2:00 - 2:15 pm	Welcome - Roll Call - Overview of Agenda - Objectives of Call	Committee Chair
2:15 - 2:20 pm	Administrative Procedures	Joanna Foellmer DFO ACSERAC
2:20 - 3:00 pm	Draft Report Discussion	Committee Chair
3:00 - 3:15 pm	Public Comment	
3:15 - 3:45 pm	Draft Report Discussion Continued	Committee Chair
3:45 - 4:00 pm	Next Steps - Action Items	Committee Chair
4:00 pm	Adjourn	

APPENDIX C

**DRAFT SUMMARY COMMENTS BY THE ADVISORY COMMITTEE
FOLLOWING 22-23 OCTOBER 2007 MEETING**

**Adaptation for Climate Sensitive Ecosystems and Resources
Advisory Committee (ACSERAC)**

**Draft Summary Comments on
“Synthesis and Assessment Product 4.4: Preliminary Review of
Adaptation Options for Climate-Sensitive Ecosystems and Resources”**

**Adaptation for Climate Sensitive Ecosystems and Resources
Advisory Committee (ACSERAC)**

**Draft Summary Comments on
“Synthesis and Assessment Product 4.4: Preliminary Review of Adaptation Options
for Climate-Sensitive Ecosystems and Resources”**

1.0 INTRODUCTION

The U. S. Environmental Protection Agency requested that the Adaptation for Climate Sensitive Ecosystems and Resources Advisory Committee (ACSERAC) conduct an expert peer review of the draft report titled *Preliminary Review of Adaptation Options for Climate Sensitive Ecosystems and Resources*. The Advisory Committee reviewed the draft report and the public review comments on the report. Following a two-day meeting on 22-23 October 2007, at which authors of each chapter made presentations and answered questions, the Advisory Committee offers the following review of the draft report.

2.0 OVERALL ASSESSMENT

The draft report shows evidence of thoughtful structure and includes valuable information on the status and prospects for managing adaptation to climate change in six of the federal management systems. The Committee’s comments and suggestions should be understood as ways to improve a basically good report.

The report is very long and could benefit from trimming. However, as it is unlikely to be trimmed enough to invite thorough reading, the summary chapters—the Executive Summary and the Synthesis chapter—take on increasing importance as the material that will be read by non-technical audiences.

Recommendations for all management system chapters include the following: (1) Add opening summaries to all six of the management system chapters, perhaps the summaries that are now in the Executive Summary. The chapter summaries should be similar in scope and level of detail to each other. (2) Add short introductions to the case studies to clearly state the purpose of the specific studies and the lessons to be drawn. (3) Standardize the conclusions sections and ensure that they are informative rather than broad-brush statements.

3.0 COMMENTS BY CHAPTER

3.1 EXECUTIVE SUMMARY

The Executive Summary is extremely important for non-technical audiences; thus, it will benefit from a systematic clarification of the report's main conclusions, key concepts, and recommendations. Specifically, across management systems and ecosystem types, identify the state of knowledge for ecosystem responses to climate change and adaptation options. The text should describe the potential consequences of neglecting to adapt to predicted ecosystem responses to projected outcomes of climate change.

Key policy areas should be identified, not prescribing policy, but identifying priority policy areas relevant to climate change adaptation. Specifically, the report should consider the observation that (i) there is a need for improved inter-agency communication and collaboration, and (ii) existing authorities may be inadequate to implement adaptation methods. Categories include those listed in column one of Table 9.4 from the Synthesis chapter, including the "no-regrets" option of mitigating non-climate-related stressors in part to improve ecosystem resistance and resilience to climate change, as well as several other options not covered in this table, including but not limited to:

- standardized regional monitoring (establishing ecosystem baselines and monitoring gradual changes through regional networks using standardized techniques in order to enable the separation of site-based influences from global changes to provide a better understanding of ecosystem responses to climate change),
- responses to changes in species distributions resulting from climate change outcomes, and
- "managed retreat" including land-use planning mechanisms.

If the Executive Summary is directed at an audience of Congress and Executive-level managers, it should be shorter than at present and much more succinct in highlighting key findings. As a part of this increased brevity, the chapter summaries currently in the Executive Summary should be moved to the beginning of the relevant chapters. If the chapter summaries remain in the Executive Summary, they should be rewritten to improve standardization in their content and style.

As a context for the report, the authors should clarify that planning for adaptation is needed even if the U.S. and international communities comply with internationally accepted measures to reduce greenhouse gas and aerosol emissions. That is, the effects from human-induced climate change by the production of greenhouse gases and aerosols are projected to continue for hundreds of years even if emissions were immediately discontinued. Thus, the use of the phrase "uncontrollable climate stresses" may be incorrectly interpreted to infer that causes of climate change are not controllable. While the effects from human-induced climate change by the production of greenhouse gases and aerosols are projected to continue for hundreds of years even if greenhouse gas concentrations were stabilized at present concentration levels, ultimately the causes of ecosystem stresses from climate change are controllable and can be mitigated.

The basis for structuring the report to focus on the six federal management systems, and use of case studies (which do not provide information on lessons learned specifically related to climate change adaptation) should be explained.

The summary should acknowledge the inclusion of case studies in the six management system chapters, and state the purpose for their inclusion, clarifying that while there is a dearth of examples of efforts to operationalize climate change adaptation, there are benefits of documenting lessons learned from the case studies on approaches to address non-climate-related stressors. Also, the role of the workshops as bases for these case studies should be more fully explained.

The report should recognize that there are numerous stressors on these systems, some of which may be influenced by climate change. For example, on pp. 1-4, the statement that, “wildfires, nuisance species, extreme events, and air pollution are the most critical stressors within national forest (NF) boundaries, and climate change will amplify them further, “ ignores other major stressors in national forests, in particular, fire exclusion and suppression, logging, and road-building.

3.2 MANAGEMENT SYSTEMS CHAPTERS

Recommendations for all management system chapters include the following: (1) Add an opening summary, perhaps the summary that is now in the Executive Summary. The chapter summary should be similar in scope and level of detail to summaries in the other management system chapters. (2) Add a short introduction to the case studies to clearly state the purpose of the specific studies and the lessons to be drawn. (3) Standardize the conclusions sections and ensure that they are informative rather than broad-brush statements.

The cases studies could be shortened and highlighted in an explanatory format, perhaps as discrete statements set off in the report format. In addition, some examples of anticipatory options for extreme events such as fire or hurricanes would be useful information for managers, for example: what could be done as a best management practice after an event? In this case, the Forest Service has not emphasized what the agency has done and is doing to adapt to change such as tree, shrub and grass plantings to prevent surface and gully erosion. Alternatively, the report would benefit from descriptions of management activities that have not been successful accompanied by an explanation of their failure.

The Review Committee and public responses discussed several topics that cut across all chapters; the following items somehow need to be considered:

- A working or broader definition of *adaptive management* is needed. The concern is that each agency has its definition that may not conform with the definition of adaptive management used by other agencies. In addition, the committee was concerned that the term was invoked as an answer without really defining what was meant by the description or how the technique was intended to address the issue.
- Several other terms and their definitions were used casually without clear definition, use or understanding of the credibility of their application, for

- example, ecosystem management, biodiversity, and resilience.
- Two areas of interest that were not fully discussed are: moving from local issues to landscape-level management, and involving stakeholders/cooperators from adjoining state and federal agencies in understanding how to use adaptive management to respond to change.
 - Given the number of personnel and level of funding needed to respond to change, there is a need to set priorities for resource use based on some level of triage.
 - The authors of the report should recognize that there are at least two target groups for which the information will be particularly valuable, namely for managers at the on-the-ground decision level and for administrators and planners. Those in the Congress and higher administrative positions will require yet another presentation and the information presentation and format should be directed toward the needs of these users.

3.3 NATIONAL FOREST CHAPTER

To the credit of the author, Linda Joyce, and the eight co-authors, the document contains detailed information concerning climate change and sensitive environments. Topics were presented with detailed descriptions that reflect information available in the scientific literature. Cumulatively the literature for the complete document would, in an annotated bibliography, serve as a valuable working tool for both planners and managers for all government and state agencies that manage natural resources.

The Chapter reviews the legislation that governs the mission and goals of the Forest Service and is a constructive introduction to the complexity and difficulty that faces the agency in adapting to climate change and climate related disturbances. It is evident from the number of meetings with National Forest personnel that administrators in the Washington Office, Regional Offices and Leadership Teams were involved early in the process of collecting information and ideas about how climate change and catastrophic events might affect natural resource management. The agency apparently does not have a policy on adapting to climate change, or if there is such a policy, it is not clearly articulated in the six management goals and four ecosystem services.

The authors and the committee noted a number of missing concepts on sensitive environments that need to be addressed in the final report, including genetics in silvicultural treatments, recognizing timber harvesting as a stressor, the use of natural fire regimes, and the putative values of connecting landscapes. A discussion of the interacting consequences and complexity of mitigation techniques should be included. The committee noted that the Chapter focused entirely on forestland. The National Forest System includes large acreages of grassland and shrubland, where other stressors will merit consideration, for example, grazing and the ways it affects management of other resources.

The National Forest System was selected as a unit of focus for sensitive ecosystems but information from other agencies was not included. The Bureau of Land Management

(BLM), the Department of Defense (DOD), and Indian Reservations all contribute to the natural resource base of the United States. The BLM alone has more acreage than in National Forests, and their lands along with DOD and Indian Reservations influence how forests are managed. Statements of relevance of other land management agencies and the relevant stressor need to be included in the report. For example, grazing on BLM lands is a primary stressor and would have importance in managing the broad array of lands under the jurisdiction of the National Forests.

The committee raised the issue of using administrative, not ecological units such as Ecoregions, as a way to identify and collate information on stressors and climate change that overlay several administrative units (climate change and events are not restricted to administrative units). Using an administrative unit for case studies was acknowledged by the Review Committee as one way to give credit to agencies and stakeholders for the difficult task of integrating climate change into an adaptive process. However, this does not lessen the validity of ecosystems as an integrating unit.

3.4 NATIONAL PARKS CHAPTER

The focus on national parks as a management system allows this chapter to illuminate factors that are under the control of its managers. The chapter contains a wealth of information about various ecosystems in the national parks, sometimes focusing on one type (especially in “Stressors of Concern”), but several dimensions of adaptation require a richer analysis than an ecosystem-by-ecosystem organization provides. As the chapter itself says, “Preparing for and adapting to climate change is as much a cultural and intellectual challenge as it is an ecological one” (page 4-6, lines 32-33).

The organization of particular agencies and the multiple enabling legislative acts are important for consideration of how the particular types of systems are and can be managed. The history of the national parks is helpful in understanding how various management arrangements evolved, including planning documents and public input.

The focus on management systems allows the necessity for partnerships in adaptation approaches and activities to emerge. However, the Committee recommends an additional (short) section that refers to the situation of many national parks adjacent to or near other federally managed (BLM, DoD, National Forests, etc.) lands and Tribal lands. Coordination with other federal entities is a necessary component of effective management for adaptation to climate change.

The background discussion of climate change impacts is very general, as it is in many chapters; these discussions could be eliminated, since there is a section on global changes and impacts in the Introduction.

Including paleoecological data as a long-term perspective on climate variability and change would point managers to important insights.

This chapter, like the other chapters on management systems, provides very useful information about the state of knowledge, including the uncertainties that abound, and adaptation approaches, along with elements of implementation. Although it would be ideal to have a sort of “cookbook” of best practices, the chapter (and, overall, the report) makes clear this is impossible, that management actions should be aimed at limiting damages from climate change and experimenting to find ways of easing the ecological transitions to new climate regimes. Still, more site-specific examples of these types of actions would improve the chapter’s usefulness to managers.

To be more helpful to managers, the chapter should more clearly distinguish the following:

- What is under the control of park managers, and what actions would require partnerships with others, support from the public and Congress, and continuing monitoring and research. This delineation would also help to clarify what is possible in the short, medium, and long terms.
- The line drawn between “Nature” and people. Some of the stressors on the parks clearly come from human activities, and these should in principle be more controllable than, say, fires ignited by lightning strikes during drought conditions. However, it is also true that people are part of Nature—and are certainly included in park ecosystems. Showing human visitors how to align with the ecosystems around them, for instance, should be a part of what park managers can control and a pathway to reducing stress on the parks.
- Native and nonnative species. Nonnatives seem to be treated by definition as harmful, but climate change is almost sure to cause species movement; will species that move because of climate change be considered invasive and harmful in their new places? The chapter begins a good discussion of this issue on page 4-21 but does not take it far enough to be useful to managers.

Section 4.3.3, “Incorporating Climate Change Considerations into Natural Resource Management,” parallels but improves upon the mental model depiction in the synthesis chapter because this chapter’s section speaks in terms of resources “at risk”—that is, incorporating the uncertainty of the whole process.

Only one short case study is given in the chapter, Rocky Mountain National Park (RMNP). The case study’s usefulness would be improved if it were introduced by a paragraph or two that clearly state the purpose of the case study and the major points learned from it. For instance, the major point could be that laying foundations by establishing scientific information networks and other partnerships is very important. It is not clear why the chapter has only one case study or why this particular park was chosen. The text says RMNP “is a good example of the state at which most parks find themselves as they confront resource management in the face of climate change” (pages 4-31-32), but in fact it seems to have advantages over other parks: no danger of losing an iconic resource, like Glacier National Park; fewer visitors than other parks; “rich in information about its ecosystems and natural resources” (page 4-35, lines 2-3); and less pollution than

other parks. Nevertheless, the adaptation approaches being initiated and planned are given in enough detail to be helpful.

Better integration of this chapter, the other management system chapters, and the synthesis chapter is needed. In particular, the structure, level, and detail of the conclusions section should be similar across the chapters, perhaps reflecting Table 9.4 categories (selecting the most appropriate approaches and providing rationales). In addition, the importance of so-called no-regrets strategies, such as anticipatory responses (requirements regarding building in floodplains, restrictions on logging steep slopes, etc.) should be reiterated in the conclusion.

3.5 NATIONAL WILDLIFE REFUGES CHAPTER

The National Wildlife Refuge System (NWRS) is unique among those included in the synthesis report because of its origins specifically for species conservation and management. This continues as a primary dimension of its mission and has shaped decisions ranging from land acquisition to tract management. The refuge system is broadly dispersed and, although many tracts are fairly small, there are a large number of them, including some in locations that would not be considered suitable for other types of conservation areas due to prior anthropogenic alteration or proximity to human activities. In large part because of these aspects the NWRS managers have extensive background in acting for the purpose of adapting to conditions over which they have little control. The broad geographic coverage of the NWRS and location-specific attributes result in a wide variety of potential adaptations that can be applied to climate change.

The chapter is very effective at making the above points, thus placing climate change within the variable matrix of stresses with which the system must deal. Of central importance to this is their existing strategic orientation to systems-level rather than unit-only issues. This is a strength they need to build upon for successful adaptation in an uncertain future.

The chapter makes a recommendation for establishing two new entities: a national interagency climate change council and a national interagency climate change information network. Specific policy recommendations are beyond the scope of this report, and this one should be eliminated.

The following are some suggestions for things to consider that may improve the chapter.

- Include a chapter summary at the beginning. This could be what is currently in the executive summary.
- Ensure the chapter is conceptually consistent with the Synthesis
- Include greater consideration of anticipatory management and making optimal use of current best management practices. The NWRS is particularly well-suited to do this, thus implementing a “no regrets” policy.
- The chapter needs to be clear that the audience for needed policy changes is at the regional and national level. The level and extent of detail in the text should be

calibrated to what will be critical to those decision-makers.

- The case study was an interesting selection. Although there is only one it covers a very large footprint, yet there is concern that some critical insights for adaptation were missed. Some of this concern may be attenuated if the “lessons learned” from the case study are given greater emphasis. These results could be highlighted in a text box for greater emphasis.
- Be sure there is consistency between what refuge managers can do and how the approaches are summarized in Table 9.4.
- The chapter needs greater clarity in how the NWRS should address range shifts in the context of invasive species. How will non-native species be handled if they are in a refuge as a result of range shifts? The chapter talks about assisted dispersal in addressing range shifts but this leaves out natural dispersal.
- There is an inconsistency in the chapter that should be corrected. The second paragraph of Sect 5.1.4.5 (p. 5-10) discusses using historic conditions as a benchmark for success. The next paragraph states that the policy does not insist on a return to historical conditions but to use them as a frame of reference for understanding successional shift (p.5-11). Then the second take-away message (p. 5-63) is worded as if historical conditions are, in fact, the management target. These appear to be in conflict. The committee agrees with the frame-of-reference use for historical conditions, but suggests that this point be clearly described and that recommendations be consistent with current policy.

3.6 WILD AND SCENIC RIVERS CHAPTER

This is a nicely written chapter with a lot of good information. Improvements can be made by linking management options more clearly with potential climate change issues and by using the case studies to emphasize the linkage.

All of the material preceding the Case Studies is well written and conveys important information. The policy context section is very useful and should be used appropriately in the discussion of Adaptation Options. For example, the six steps for developing effective management strategies for WSRs are listed on page 6-16, lines 15-25. This could be a useful framework for carrying forward what is currently found feasible to the climate adaptation discussion.

Some parts of the Adaptation Section do not follow from the base information. For example, the paragraph on page 6-24, lines 6-10 suggests that managers need to develop reservoir operating plans, but this does not seem to be a reasonable suggestion because WSR managers do not have control over such plans. (How many of the options listed in Box 6.5 are reasonable under current structures?) More useful would be a discussion that includes a link back to the previous material, suggesting how the current options for management could be extended to address climate change issues. If there are deficiencies in the current options, these could be cited as barriers with suggestions on how they might be overcome. For example, how do the comments in the paragraph on 6-29, lines 12-20 apply to the options listed in Box 6-5?

Under the “proactive management” subsection, each of the management options should be linked directly to the adaptation options presented in the “Synthesis” chapter. This will provide a modicum of continuity for a reader and allow at least a high-level understanding of connections among chapters. Also, specific mention should be made of how the group assessed the level of confidence associated with each of these options to provide a tie to the uncertainty assessment of Table 1.1 in the Executive Summary.

The case studies are quite interesting, but the link to climate adaptation is missing. If this oversight is rectified, the case studies could assume a much more important role. For example, what is the main lesson for the Wekiva River? It seems that maintenance of flow is already a challenge and will continue to be a challenge. Are there lessons about what management strategies have been successful? What has failed? Given the lessons learned, are there useful speculations that can be made about how the six steps outlined on page 6-16 could be used for climate adaptation?

The Conclusions should be made stronger. The (implicit) recommendations are all very general – they do not apply specifically to WSRs and, as such, are not likely to be of great use to managers. In fact there is a disconnect between the chapter itself and the Conclusions. The authors should consider whether they have material from their own chapter that forms the basis for the conclusions.

For many, many systems, other stressors (water withdrawals, nutrient enrichment, etc.) will continue to have a deleterious effect unless proactive management options are undertaken. Most such actions would also be beneficial for climate change effects. The chapter and the report should recognize this inference explicitly and make appropriate recommendations.

Specific Editorial Comments on the Wild & Scenic River chapter

6-25, line 6. What does “outside the historical range of flow variability” mean? Natural flows are inherently variable, and historical records are always being broken (without any climate change needed). The sentence obviously intends something else, but it is hard to follow.

6-25, line 44. Biodiversity can not become extinct.

6-26, line 8. Again, what is meant by “exceeding historical bounds”? Considering things like flow and temperature to have strict bounds is problematic.

6-27, Reactive management section. The prose about reactive management is overly pejorative in tone. There will always be a need for reactive management; for example, rescuing stranded canoeists (one of the examples cited) can’t possibly be otherwise. And there will always be a need to repair damages caused by extreme events – this was true in the past and will be true in the future with or without climate change. Proactive management measures should be considered carefully under climate change scenarios,

but the utter dismissal of “reactive” approaches to bolster the claim that this should be done misses the mark.

6-29 and continuing. It would be useful to associate these topics with the “Adaptation Options” of the Synthesis and Executive Summary.

6-35, line 30. More runoff does not necessarily mean less recharge. If precipitation increases substantially in a region, for example, both runoff and recharge might increase.

3.7 NATIONAL ESTUARIES CHAPTER

This chapter is generally well written and is successful through the text on findings/conclusions. Thereafter, the text appears to lose steam and/or conviction, basically presenting a smorgasbord of options with little discrimination on the basis of priority concern or general utility.

The Background and Current Status of Management Systems sections are effective overviews. As noted in public comments and during the author presentation, there is a need to include the Coastal Zone Management Act in the legislation overview. The report prepared by the CSO is good, but should be edited down significantly for use in this document.

The section on adapting to climate change is comprehensive and strong, with the authors effectively identifying and explaining basic options and issues. Some caution or additional caveats should be considered for adaptive management (e.g., not simple, rarely effectively implemented), ecosystem based management (nice concept, not successfully implemented anywhere, may not be realistic), and maintaining resilience through sustaining biodiversity (a theoretical construct that is still subject to debate and is not clearly appropriate in estuarine systems undergoing climate change).

The Case Study is long and does not clearly make points related to the rest of the chapter. It could be improved by adding a section at the beginning that identifies and briefly explains each of the three points that the author, Pete Peterson, indicated as the basis for inclusion (existence of CHPP, multiple barriers to effective management, and difficulties associated with preservation of a barrier system).

The Conclusion section would benefit from an effort to prioritize the various items presented in each category. It would also be useful to utilize the framework of response options contained in Table 9.4 so that terminology throughout the report is more consistent.

An abstract for the chapter placed at the beginning would be a useful way to orient the reader and reinforce main messages.

3.8 MARINE PROTECTED AREAS CHAPTER

While the background, history and identification of the FKNMS Act, 1990, is fundamental to point out relevant management legislation, Chapter 8.1 does little to highlight adaptation options to protect and preserve the marine environment in general and the Florida Keys in particular. The authors should point out that the management plan for the Florida Keys was established to counteract local stressors and will not be effective at ameliorating or protecting local fauna and flora from climate change. The authors state that the science clearly suggests highly connected networks are the only option for climate change adaptive management. Yet, because policy recommendations are beyond the scope of the process, the authors can never explicitly make a recommendation that a network of no-take areas is needed in the Florida Keys, specifically designed around hydrodynamic connectivity models. Instead the text is loaded with prose that state the obvious, for example simply stating that National Marine Sanctuary sites are “the ones in need of management in response to climate change” (page 8-11) tells us little about options. Furthermore, we learn little from the following (8.2.1.2 Key species): “Under various climate change scenarios, management strategies employed to protect key species may differ”, and “In all sanctuaries protected for biological reasons, biodiversity may be affected by climate change and must be managed to meet sanctuary goals.”

The current status of management system (8.2) is really a brief review of some of the science issues rather than the status of the management and does little to blend the science with the management. In fact these issues are glaringly disparate. There is considerable emphasis on understanding the connectivity among ecosystems, which logically leads into arguments for MPA networks to facilitate larval exchange and inter-connection of meta-populations, which in turn may buffer these populations from climate-driven changes. Yet there is a disparity between the process in which the sanctuaries and MPAs were established and are now maintained and the message coming from the sciences indicating that networks should be established. The rhetoric is repeated throughout Chapter 8. Yet there are no networks (but a note that the National Marine Sanctuary Program Goal is to expand the nationwide system of MPAs). Therefore, the management options are 1) to protect intact systems (Papahānaumouākea, Hawaii) and prevent further degradation (Florida Keys) by reducing anthropogenic stressors inside (fishing) and outside (pollution) the protected areas, while there is no law that facilitates the latter. Several blanket statements throughout Chapter 8.2 tell us little about a reasonable strategy to approach obvious problems. For example, (page 8-15) “The addition of climate change may exacerbate effects of existing stressors and require new or modified management approaches.”

In discussing ocean warming, the reports states that “temperature changes may result in new species assemblages and biological interactions that affect ecological processes such as productivity, nutrient fluxes, energy flow, and trophic webs” (8.2.2.1.). It is first questionable that these four terms are really the most fundamental ecological processes of interest, and second, further expansion is necessary to explain how warming will affect the processes. In fact, this is not a semantic issue, but rather it is at the heart of the

problem because if fundamental processes are understood, then ‘state variables’ such as macroalgae or coral cover could easily be predicted.

The response of climate-sensitive corals reefs and bleaching is rightly discussed at length in the report. However, the authors suggest that thermal stress is the only facet that influences coral response. Yet, the literature stresses that both water temperature and irradiance interact to produce the bleaching effect (Iglesias-Prieto et al., 1992). This is important when discussions are held over adaptive management and refuges, later in the report. Indeed, there is a clear reciprocity between water temperature and irradiance, because corals perceive heat stress and intense irradiance, both, as photoinhibition (or as a further increase in excitation pressure over PS II) (Iglesias-Prieto et al., 2004). Therefore, low or reduced irradiance during times of temperature stress reduces photoinhibition, coral bleaching and coral mortality, as does the reciprocal involving moderate water temperature at high irradiance. The factors associated with a bleaching event therefore involve not only temperature but also irradiance and by association the particulate constituents in the water column that may reduce irradiance. Therefore, when examining the cause and effect of coral bleaching, temperature and irradiance should not be considered separately. This is particularly relevant to management strategy options most suitable under global warming (on page 8-27). The authors suggest that two types of coral reefs should be identified and given high priority protection status: 1) reefs that survived bleaching (one assumes that the reef corals bleached but recovered, although this is not explicitly stated), and 2) reefs that were not exposed to elevated water temperatures in most recent coral bleaching episodes. Again, many localities that did not bleach, for example in 2005, experienced low irradiance, because coral bleaching is a function of a) water temperature, b) irradiance and c) the historical nature of both temperature and irradiance. In other words, some locations may have experienced low irradiance while water temperatures were high, and therefore did not bleach, or other localities may constantly be subjected to high temperature fluctuations, therefore, a regional temperature anomaly would not stress local reefs that are constantly exposed to such variation. Clarifying issues involving temperature, irradiance and their histories is critical for any adaptive management in the face of climate change.

Section 8.3.2 is probably the most useful and relevant section of the report on marine protected areas and is particularly pertinent when considering the authors were charged to address adaptation options. The section on bleaching needs considerable expansion and elaboration because there are at least 20 years of research on this climate-sensitive phenomenon and the most visually obvious.

Ocean acidification (8-17). The literature states that higher latitudes will show the first signs and most intensive responses to climate change because of the greater solubility of CO₂ in cooler waters. It is fair that the authors say (8-31) that “management strategies have not yet been developed” (to combat local changes in pH one would presume). However, there is no mention of the disparity between statements of geographical expansion because of increasing water temperatures and adaptive management to higher latitudes, because the higher latitudes, it is argued, will become warmer and therefore less likely to more soluble.

Furthermore, and probably more importantly, the authors refer to range expansion as becoming “invasive” (8-21), because the species extend past boundaries beyond their known native range. Surely, if management is to become adaptive and protected area networks are established, then under climate change many species will simply expand geographically. But in the authors’ terms these species will be considered as “invasive” and given low management status, when in fact those very species are naturally adjusting to climate change and should be given priority status.

The concept of invasive species is considered further, but in light of increased seawater temperatures resulting from climate change. The authors discuss the most fundamental aspect of reproductive output, which is strictly speaking the definition of adaptation, or differential reproductive output of individuals of populations. Insufficient emphasis has been placed on discussions of population adaptation to climate change (only, page 8-16, “that adaptation and acclimatization to increasing temperature is largely unknown and remains a research topic of paramount importance”). Nevertheless, the authors mention that invasive species out-compete native species because “they will spawn earlier and for longer periods.” This assumption is based solely on the incorrect premise that all marine reproduction events are temperature driven. More recent evidence and critical inquiry suggests that marine reproductive cycles are not simply temperature driven, particularly made evident by examining low latitude environments, where temperature changes as little as 2-3 degrees centigrade, and simultaneous mass spawning events are still evident, for example on low latitude reef corals. Irradiance and day length also play critical roles in gametogenesis and the production of offspring.

The freshwater influx argument (8-19) is weak at best, most likely because it is based on one reference. The authors argue that increased runoff may cause greater stratification of water layers (Scavia et al., 2002), which will result in reduced productivity of estuaries. There is no systems approach here, nor is there any reference to the considerable literature on freshwater discharge, dating back over 100 years, discussing and documenting the detrimental influences of osmotic shocks and subsequent mortality of marine organisms, particularly on adjacent coral reefs. Changes in precipitation associated with climate change have been widely documented and need more careful consideration for a number of marine systems. Furthermore, there is mention of discharge from large river systems, particularly the Mississippi River on adjacent systems (8-20), yet these large rivers may also influence marine protected areas downstream by changing irradiance and water quality (nutrients, pesticides etc.), as has been clearly shown on the Great Barrier Reef. The authors acknowledge that pollution was previously managed “locally,” but now add that “climate change stressors ... present greater challenges,” without suggesting a solution to the challenges.

Finally, on page 8-23, four arguments and justifications are made to implement MPA networks. The authors argue that a network of MPAs would allow adaptation of marine management for climate change. The four justifications are given and discussed: 1) MPA networks are more effective than a single MPA at protecting the full range of habitat and community types because they spread the risk of loss from disturbances such as climate-

change impact across a larger area; yet, there are no MPA networks; 2) networks protect short- and long-distance dispersers; 3) networks provide enhanced larval recruitment among adjacent MPAs; 4) networks allow for protection at an appropriate scale, without the need to establish one extremely large reserve. The recent implementation of the Papahānaumokuākea Marine National Monument comes to mind, as it is downstream of the main Hawaiian Islands and it is one large reserve. Again, the arguments and the “reality” are disjunct; there are no marine protected networks while all evidence points to a need. The authors again point to this issue on page 8-23: “In the long term, the most effective configuration would be a network of highly protected areas nested within a broader management framework.” Such a framework should consider upstream activities to control and maintain high water quality (mentioned on page 8-26, regarding linking the MPAs into adjacent governance systems and reduce land-based pollution). Furthermore, on page 8-27, a network of MPAs reaches high prominence again, because of ‘representation, replication, sustainability and connectivity’. Again, entire sections are dedicated to connectivity (8.3.1.1 and 8.3.3.2), source-and-sink concepts, larval transport, adult movement, and the theoretical effectiveness of networks. The most useful study by Airame et al. (2003), suggested that no-take zones comprising 30-50% of a Sanctuary will sustain the system. Clearly, the Florida Keys National Marine Sanctuary, with only about 6% no-take zones, is not an effective strategy. Numerous authors have shown that marine reserves 10-20 km apart will facilitate larvae exchange and sustain most marine populations. The authors suggest that a management strategy should include a representative range of habitat types, and replication of those habitats will reduce the risk of loss (page 8-31). Clearly, the sooner the current goal to protect 30% of habitats as no-take zones is reached, the greater the chance of survival of coral reefs, which are particularly sensitive to global climate change.

The authors (on page 8-24) suggest that the most effective management strategy to preserve marine ecosystems is to include stakeholders in decision making, by engaging sanctuary advisory councils and holding public scoping meetings. While involving stakeholders is a necessary strategy, it will not necessarily lead to some emergent adaptive management strategies and will simply shift the onus onto others. Performance measures are discussed, to more effectively assess the success of specific programs. However, the metrics do not include climate change; climate change metrics should be included. The authors further suggest that Condition Reports will provide summaries on the state of the resources and management responses that threaten the resources. The reports are meant to provide management with information to respond on “a site-by-site basis”. Such a process conflicts with earlier arguments made on MPA networks and further statements on ‘managing for resilience’ at the system level. Suggesting that “managers should strive to maintain the maximum number of species in the absence of detailed data on ecological and species interactions,” and managers should continue to develop and implement strategies to reduce land-based pollution (page 8-26), are relatively obvious statements, but there is no mention of how this should be done. Furthermore the dichotomy is introduced, without much consideration, that regional guidelines should encourage herbivory at low latitudes, to reduce macroalgae, but reduce herbivory at high latitudes to maintain kelp forests. It is often inferred that locally enhancing parrotfish and surgeonfish on coral reefs will lead to positive cascading effects

that will increase coral cover, because recruitment will be increased. However, there is an urgent need to address the relevance of this assumption and in which context, before false hopes and incorrect trajectories are predicted, when in fact the problem occurs on multiple scales and increasing the biomass of these herbivores may have little influence on resilience. Besides, managing for high levels of herbivory at low latitudes compared with managing for low biomass of herbivores at high latitudes needs further consideration, especially in the face of global climate change when geographic boundary shifts are commonplace; and, if this dichotomy is correct, then, where is the latitudinal boundary where we shift strategies? And why is it there?

Other management solutions discussed include: 1) more monitoring in MPAs (8-32) and 2) the use of satellites to forecast bleaching events. The later is even less convincing than the former. Remote tools are said to “help managers prepare for bleaching events so that when the event occurs, managers can have the necessary capacity in place to respond.” These two solutions do not facilitate management for climate change unless the monitoring is hypothesis driven and specific to assessing an adaptive management strategy.

Case studies (8.4). The case studies mostly reiterate the discussion and give few options of active forms of adaptive management except on the Great Barrier Reef, which is an exemplary example, but managed under entirely different laws (Australia).

See Appendix A for literature citations.

3.9 SYNTHESIS CHAPTER

3.9.1 STRUCTURE OF THIS CHAPTER

The committee’s discussion about the structure of the Synthesis chapter was framed by two issues: (1) the committee’s review of the Executive Summary, specifically as it relates to the goal of this section in the report; and (2) the intended audience of the Synthesis chapter.

Regarding the Executive Summary, the committee asked if it would provide a brief overview of the entire report—including the Synthesis chapter. If so, the committee suggested that the Synthesis chapter might not need to devote space/text to additional expository material that would orient readers with respect to the preceding chapters in SAP 4.4.

However, the committee members noted (based on the committee’s opinion that the Synthesis chapter may be the one that is most widely read) that the Synthesis chapter should include a short expository introduction with the suggestion that sections 2.1, 2.2, 2.3, and 2.6 in the current iteration of the report form a new introduction to the Synthesis chapter (which may be renamed Introduction and Synthesis). The goal of this recommendation from the committee is to better orient readers who may not read the

report in its entirety. The result of such a change would be the creation of a new Chapter 2, which would deal with the scientific background of the report (currently, Sections 2.4 through 2.5).

Based on its discussion with the EPA editors of the report, the committee understood that upper level managers/directors within federal agencies, members of Congress, and perhaps supervisory resource managers would be the primary audience for the Synthesis chapter. If so, the committee advises EPA to adopt the recommendation outlined in the previous paragraph (regarding the provision of expository material for readers in the Synthesis chapter). The committee also advises the editors/authors to be much clearer about the goal of the synthesis chapter. Specifically, the committee was concerned that the Synthesis chapter does not adequately pull together, and then explain in necessary detail, the common themes from the other sections of the report. Some of the themes that the committee felt deserved more detailed attention are outlined in section 4 below.

3.9.2 PLACEMENT OF THIS CHAPTER

The committee recommends that consideration be given to moving the Synthesis chapter to the beginning of SAP 4.4 (and labeled Chapter 1: Introduction and Synthesis; see above), following a very brief Executive Summary (which would not have a chapter designation). The rationale is to give this important section more prominent placement in the report to capture the attention of readers. Some committee members suggested that the Synthesis also be provided as a separate document, in addition to being part of the report. Once again, the goal of this suggestion was to give this important chapter prominence. If the Synthesis is indeed moved to the front of SAP 4.4, an argument could be made for providing a new, brief concluding chapter for the report.

3.9.3 SYNTHESIS CHAPTER AS A GUIDE FOR SUBSEQUENT REVISIONS OF EACH CHAPTER

Many committee members believe the Synthesis chapter should be (1) revised first; and then (2) used as a guide for the authors when they revise the individual chapters in SAP 4.4. This comment stems from the perception that the main themes in the Synthesis do not appear within the individual chapters. Taking this approach would help the editors to (a) provide consistency across the chapters; and (b) ensure that the synthetic themes in Chapter 9 are indeed the themes that should be elevated to agency managers/directors and members of Congress. This approach may also assuage committee concerns regarding the “softness” of some of the report’s synthetic themes and big-picture recommendations. Specifically, there is significant concern that the gravity of some problems, challenges, and recommendations raised in the individual chapters were not treated with the same emphasis in the Synthesis chapter.

3.9.4 CONTENT OF THIS CHAPTER

The committee strongly believes that many key themes in Chapter 9 were not given the in-depth treatment that they deserve; the result is that readers (including this committee)

cannot assess with confidence their appropriateness with respect to their applicability and/or utility in evaluating adaptation options in a climate change context. Six such themes are outlined briefly below.

- a) *State of knowledge regarding decision making for ecosystem management*
The committee felt that the Synthesis chapter, and indeed the report as a whole, does not reflect a clear understanding of the state-of-the-art and science as it relates to decision making under uncertainty (which, in turn, is applicable to adaptation decision making under climatic change). The committee strongly advises the authors/editors to provide a section in the synthesis chapter that deals with (1) common biases and traps in decision making and (2) approaches for structuring complex decisions of the type that are the focus of SAP 4.4.

Specifically, the committee felt that the some of the common problems common to decision making under uncertainty—such as a lack of specificity regarding adaptation problems, incomplete specification of adaptation objectives, poorly constructed attributes and measures used to characterize objectives, unimaginative adaptation alternatives, and—importantly—tradeoff avoidance—did not receive adequate attention. The authors/editors may wish to consult the authors/sources listed in Appendix C for guidance on this subject.

- b) *“Buzzword” paradigms*
The committee was concerned that SAP 4.4 relies too heavily on certain management options/paradigms (e.g., the precautionary principle, ecosystem-based management, adaptive management, etc.) without imparting to the reader a clear understanding of what these options/paradigms mean—both in terms of their technical merits or methodology and their applicability to adaptation decisions under climatic change. The “biggest offender” in this regard is the report’s heavy reliance on the concept of adaptive management. The committee was concerned by what appears to be, at best, an overly simplistic view of adaptive management (including Figure 9.1). This is a shame for two reasons: First, much of what is positive (and negative) about adaptive management is lost on readers. Second, the superficial treatment of adaptive management further contributes to the general level of misunderstanding that surrounds the concept. In the end, the committee believes that drawing attention to the adaptive management framework in the context of climate management is appropriate but recommends that the discussion of it in this report be clarified, appropriately defined, and bolstered. The committee points to the citations in Appendix D, which may be helpful.
- c) *Monitoring as a synthetic theme*
The importance of monitoring of climate change and the response of systems to adaptation options as a synthetic theme in this chapter cannot be stressed enough.
- d) *Acknowledging the need for greater complexity in modeling*
Species-by-species or even ecosystem-by-ecosystem planning will often not be adequate for characterizing the suitability of adaptation options. Climate change

adaptation scenarios must become more complex, accounting for the relative sensitivities of various species (e.g., some animals will die out or shift their ranges faster than others) resulting in sometimes drastic changes to food webs. The committee also discussed the concept of “nativeness” among species and agreed that, as ecosystems continue evolve in response to a wide variety of external stressors such as climate change, the concept may need to be rethought when used as a criterion for assessing adaptation options.

e) No-regrets options

While not wishing to make specific policy recommendations, the committee felt that SAP 4.4 should pay greater attention to so-called “no-regrets” alternatives, which primarily address non-climate objectives but also respond to climate change via a secondary pathway, when considering the suite of adaptation options.

f) Treating this report as one step in a series

The committee felt strongly that the importance of couching SAP 4.4 as one step in an ongoing series of analyses regarding adaptation to climatic change cannot be stressed enough. Failing to do so—and sending the signal to EPA and others that this subject will require continued attention—would be an opportunity lost.

Section 1.9/Table 1.1

The committee is under the impression that some sections of the current Executive Summary might find their way into the Synthesis chapter. One such section is the one that deals with uncertainty and confidence (Section 1.9 and the accompanying table, Table 1.1). The committee thinks that this section needs to be more detailed with respect to a justification for authors’/editors’ judgments about confidence.

4.0 SPECIFIC CHARGE QUESTIONS

Focus on Six Management Systems From Across Federally Owned and Managed Lands and Waters as an Effective Way to Review Adaptation Options for Climate-Sensitive Ecosystems and Resources [Charge Question Number 1]

The committee expressed mixed sentiments on this charge question. The report did not make clear why these six management systems were selected, but not others. In particular, the Bureau of Land Management (BLM), Department of Defense (DoD), and Indian tribes all manage substantial areas of land and water and have biodiversity conservation as part of their mandate. In the western U.S., BLM lands cover more area than any other jurisdiction and often constitute the matrix in which other land ownerships are embedded. The committee believes that, at a minimum, the omission of these land management systems should be acknowledged and explained in the report. Cross-cutting ecosystem issues that will require coordination with these and other land managing

agencies (including state lands), as well as with private landowners, can then be addressed in the Synthesis chapter and Executive Summary.

The committee acknowledges an advantage of organizing the report by management system: specific institutional issues can be addressed by individual management agencies and changes in management direction and actions can be implemented relatively easily. Among the disadvantages of this approach are that the chapters contain considerable redundancy in the background material, come to somewhat different and occasionally conflicting conclusions and recommendations, and are not well coordinated. The report does not adequately synthesize the various approaches offered in the chapters.

Some of the committee members felt that a superior approach would be to organize the report by major ecosystem type, since many or most ecosystems occur in more than one management system, whereas some ecosystem types are poorly represented (especially in the East) across all of the six management systems selected. A manager needing information or advice on how to manage riparian forest or sagebrush steppe, for example, might receive clearer guidance from a report with an ecosystem-based organization. Nevertheless, the committee recognizes that such a drastic reorganization of the report is not feasible at this late date in the production schedule.

CCSP Guidance on Characterizing Confidence Levels for Proposed Adaptation Approaches [Charge Question Number 6]

The guidelines instruct authors “to express the level of confidence in the current understanding of an issue by being transparent about the amount of evidence available and the degree of consensus in the scientific community surrounding that issue.” Although the element of uncertainty is mentioned and discussed in the chapters, the report does not adopt a consistent expression of uncertainty throughout the document. For example, Table 1.1 does not express confidence as described by CCSP, which makes it difficult for readers to interpret the entries in this prominently featured table. In other chapters, distinctions are made about confidence levels without providing the rationale—and therefore the necessary transparency. The report will benefit from a systematic review of the rationale used in making statements about certainty and levels of confidence, and by attaching the rationale to the instances in which the characteristics are presented the text and tabular material.

Stakeholder Involvement [Charge Question Number 7]

The committee agrees with EPA about the importance of meaningfully including stakeholder input in adaptation planning and decision making. Meaningful involvement by a diverse array of stakeholders serves two important functions. First, such involvement undoubtedly increases the comprehensiveness and rigor of the report because stakeholders bring to the planning process a will represent a wide range of objectives and concerns, along with and a history of interests and previous engagement with the problems at hand. Secondly, meaningful input will increase the defensibility of the report—and the resulting adaptation plans and decisions—in the eyes of those who

could not directly participate in consultations. As a result, the committee believes that issues. Thus, the stakeholder workshops that were held to during the writing of the report were an important and a useful part of the process.

However, the committee feels that the stakeholder involvement process that was used to inform the preparation of SAP 4.4 was not as rigorous as it might otherwise have been. Specifically, the committee felt that the value of the stakeholder involvement in the process, however, was diminished because stakeholder representation was apparently limited to a relatively narrow range of professionals. It seems that there were many good reasons for this: The committee was told that many stakeholders did not respond to invitations to participate. Nevertheless, the committee believes that a wider array of stakeholder participants—including managers, policy-makers, users and visitors—should have been identified and included in deliberations. So as not to alienate potential readers of SAP 4.4, the committee suggests that EPA be clear about (1) why their stakeholder involvement was limited and (2) the implications of a relatively narrow stakeholder involvement process. Related, it may be more appropriate to call the consultations that took place around SAP 4.4 something other than a “stakeholder involvement” process. The committee also suggests that *who* was involved in this stakeholder involvement process, representation was not always clearly identified; i.e., (it would have been useful to know who was invited as well as who attended each workshop.) and in some cases the representation was apparently limited to a narrow range of professionals. The stakeholder participants should be systematically designed to include managers, policy-makers, users and visitors—with the perspectives easily identified.

The committee also points out that simply involving stakeholders in planning and decision making does not represent a solution to a planning or decision the problem. Nor does it supplant the need for managers to not necessarily represent other groups who should take responsibility for a decision. Stakeholder involvement should be used as a means to identify objectives and concerns, elicit ideas about. Thus, stakeholder involvement assists in identifying issues, obtaining views on alternative management approaches, and broadens and deepens understanding about the acceptability of alternative management options. Ultimately, however, ultimately the agencies will need to take final responsibility for planning and management.

APPENDICES

APPENDIX A

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APPENDIX B

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APPENDIX C

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APPENDIX D
RESPONSE TO COMMITTEE RECOMMENDATIONS
BY THE REPORT AUTHORS

Response to ACSERAC Recommendations
on
***Synthesis and Assessment Product 4.4: Adaptation for Climate-Sensitive Ecosystems
and Resources***

Charge Q1. To improve the effectiveness of the review of adaptation options by the chosen six federally owned and managed lands and waters, the Committee recommendations were to: (1) make clear why these six management systems were selected, and why others were not (BLM and DoD lands, for example), (2) begin the report with a synthesis of the various adaptation approaches discussed in the underlying chapters, and (3) summarize information by major ecosystem type since many ecosystems occur in more than one management system.

We agree with the Committee that better clarification is needed for why these six management systems were selected and others were not. We have (1) added text to the Introduction and the Executive Summary to explain that this report is not meant to be exhaustive of all types of Federal lands, but is meant to cover enough types of management systems to provide useful insights to other federally and non-federally managed lands and waters. We believe that we have satisfied this goal with the choice of these six management systems and that although other large federally managed systems are not included, insights gained from these six systems may be applied to them.

The Executive Summary has been rewritten to (2) summarize the themes brought out in the Synthesis Chapter, as drawn from across the management system chapters, rather than retaining the original organization of summarizing each management system chapter individually. In the current Summary, we include a synthesis of the various adaptation approaches discussed in each management system chapter, as the Committee recommended. However, we do not (3) provide a summary of information by major ecosystem type because the level of effort required to this in the timeframe available is not possible and because the current organization of this information is the most useful for managers. The current organization of this report by management system establishes the necessary context of desired ecosystem conditions and natural resource management goals to provide managers with an understanding of how climate change may affect those goals and the diverse adaptation options available to address potential impacts. An ecosystem cross-cut of this same information would be beneficial, though not necessary, since this current organization meets the goals of the report to provide managers with as useful as possible a review of the state of knowledge of adaptation options.

Charge Q2. To improve the usefulness (and clarity) of the information in the management system chapters, the Committee recommended the following: (1) add opening summaries to all six of the management system chapters, (2) add short introductions to the case studies to clearly state the purpose of the specific studies and the lessons to be drawn, (3) standardize the conclusions sections and ensure that they are informative rather than broad-brush statements, (4) ensure precise use of terminology across chapters and avoid “buzzwords”, (5) give added attention to scaling from local issues to landscape-level management, and (6) ensure that the information is presented in an accessible form for multiple target audiences.

We agree with the Committee’s recommendations and have done the following: (1) We added opening summaries to each of the management system chapters, using a similar style across chapters. (2) We developed case study summary boxes for each chapter that use a common format and provide bulletized information on each case study, including why the case study was chosen, the management context, key climate change impacts, adaptation options that may be implemented, and conclusions/lessons learned. The full case studies have been moved to an appendix within SAP 4.4. (3) While we did not impose standardization of the conclusion sections on the author teams, some conclusions sections have been modified where necessary to make them as informative as possible (see Appendix A for individual Management System Chapter modifications and responses to Federal Advisory Committee recommendations).

In response to the Committee’s concern about (4) the use of “buzzwords” in SAP 4.4, we made sure that each chapter uses the same definitions for terms such as ecosystem management, biodiversity, resilience, and adaptive management. Where terms are critical to an understanding of how to respond to climate change, those terms are explained fully and used consistently across chapters, as defined in the glossary.

With respect to the Committee’s recommendation (5) about scales of management, each chapter discusses as fully as necessary both local- and landscape-level management. For some chapters, this required no changes, and for others, some modifications were made (see Appendix A for individual Management System Chapter modifications and responses to Federal Advisory Committee recommendations). The chapters also discuss the necessity of developing partnerships with others across state and federal agencies to adaptively manage at the landscape level, but the details of those working relationships will depend on specific circumstances and are not elaborated on in the chapters. Whether working at larger scales with other partners or working at smaller scales within single systems, methods to prioritize resources will be necessary. Each chapter recognizes this need, and where appropriate, mentions such a need to set priorities based on some method of triage, but the details of how this might be done are not within the scope of this report.

We agree with the Committee that (6) the two primary target groups for the information in this report are managers on the ground and administrators and planners. With that in mind, we re-wrote the Executive Summary to target the second audience – policy makers – and provide them with key, policy-relevant insights and lessons learned. More technical

information for the manager target audience that was previously in the Executive Summary is now provided in chapter summaries at the front of each chapter.

See Appendix A for individual Management System Chapter responses to Federal Advisory Committee recommendations.

Charge Q3. With respect to the case studies, the Committee recommended that they be shortened considerably and include a greater emphasis on the reason the case study was chosen and the lessons learned about adaptation in that location.

As mentioned above, we developed case study summary boxes (of 1.5 pages or less) for each chapter that use a common format to document the approach and the lessons learned from each one. Those boxes include brief, bulletized information on the following: why the case study was chosen, the purpose of each case study, the management context, key climate change impacts, adaptation options that may be implemented, and conclusions/lessons learned. The full case studies have been moved to an appendix in SAP 4.4.

Charge Q4. The Committee recommends that the structure of the Synthesis chapter be altered to include an introduction and clear articulation of the chapter's goal and common themes drawn from the rest of the report.

The Committee was concerned about the need to orient the reader to the purpose and information presented in the Synthesis chapter because of the likelihood that it may be the only chapter read by certain audiences. With this concern in mind, the Synthesis chapter now includes a Summary similar to each of the Management System chapters. In addition to the summary, it also (1) provides more information on decision making under uncertainty with respect to ecosystem management, and (2) a more complete explanation of the technical merits of current management approaches and options, and their usefulness with respect to adapting to climate change. Monitoring was given even greater emphasis as a synthetic theme, as were options that address non-climate objectives and climate change impacts simultaneously. It was also emphasized in this chapter as well as the Executive Summary that this report is anticipated to be only the beginning of an ongoing effort to further our knowledge about how to adapt effectively to the consequences of climate change.

Because the Executive Summary was greatly shortened and now summarizes the Synthesis chapter, the Synthesis chapter was kept as the final chapter to the report. The underlying chapters provide the data that inform the Synthesis chapter, and therefore conceptually the Synthesis chapter belongs most appropriately at the end. While the Management System chapters did not explicitly use the Synthesis chapter as a guide for revising their chapters, themes that appear in the Synthesis were brought out more clearly in the chapters, and terminology common to the Synthesis was used in the chapters to

make the link clear between the underlying material in the chapters and their appearance as specific themes in the Synthesis.

Charge Q5. The Committee recommended that the Authors make more clear the main conclusions, key concepts, and recommendations across management systems and ecosystem types.

We agree that the main conclusions and key concepts across management systems need to be clearer. Therefore, the Executive Summary was rewritten to provide the most important conclusions and concepts up front and as quickly and succinctly as possible. We did not provide a summary of the state of knowledge for ecosystem responses to climate change and the potential consequences of neglecting to adapt to predicted ecosystem responses to climate change. The addition of this information would be impractical and unnecessary for three reasons: (1) it would cause SAP 4.4 to almost double in length, (2) it is already the focus of SAP 4.2 (observed and projected changes to land and water resources and biodiversity) and SAP 4.3 (threshold changes in ecosystems), and (3) it goes beyond the scope of SAP 4.4 that is intended to cover management options as a response to climate change impacts.

Charge Q6. The CCSP guidelines on characterizing confidence levels for proposed adaptation approaches would benefit from providing a review of the rationale used in preparing certainty and levels of confidence statements.

We agree that the characterization of confidence levels needs to be done in a more systematic manner, with greater explication by the authors as to how they determined their characterizations. To that end, the method for characterizing levels of confidence was redesigned (see Appendix B for the directions and template used by the authors), and the characterization exercise was repeated following this new method. The Authors' explanations of how they made their determinations of confidence will be provided to the reader in an appendix to SAP 4.4. The sections on uncertainty in the Introduction, Executive Summary, and Synthesis chapters have been revised to clarify how the confidence levels were obtained and, in the Synthesis chapter, to discuss the new results. In this report, treatment of confidence follows the IPCC guidelines for the IPCC 5th Assessment Reports. For SAP 4.4, this involves characterization and communication of confidence through two separate but related elements. The first element is the amount of evidence available to support the determination that the effectiveness of a given adaptation approach is well-studied and understood (high or low). The second element is the level of agreement or consensus within the scientific community about the different lines of evidence on the effectiveness of that adaptation approach (high or low). Thus, each of the synthetic adaptation approaches drawn from across the chapters of this report is assessed and given a ranking of "high" or "low" for each element (amount of evidence and amount of agreement).

The Authors' explanation of how they determined their confidence for each adaptation approach includes what they considered related to: (1) peer-reviewed and gray literature; (2) data and observations; (3) model results; and (4) their experience, including their experience in the field, their analyses of data, and their knowledge of the performance of specific adaptation options under each type of adaptation approach. Each adaptation

approach was evaluated for its effectiveness at achieving increased resilience in the near term and any non-technical or non-ecological considerations were excluded.

Charge Q7. The Committee recommends that EPA be clear about (1) why their stakeholder involvement was limited and (2) the implications of a relatively narrow stakeholder involvement process so as not to alienate potential readers.

We agree that the discussion of stakeholder involvement in SAP 4.4 might lead the reader to believe that a comprehensive process was used to engage all interested and relevant parties to participate in the development of SAP 4.4. So as not to mislead the reader, we added text in the section on stakeholder engagement to make clear that the initial planning of SAP 4.4 involved engaging a narrowly-defined targeted group of expert stakeholders to review the substance of the report. Small groups of no more than 20 people from the fields of adaptation science and resource management were asked to provide comments to the authors of the report on its content through participation in the series of six workshops. We also included in the Acknowledgements section of each Management System chapter the list of those individuals that were invited to the initial workshops, as well as those that attended, along with the organizations they represented. At each workshop, chapter lead and contributing authors presented draft information on their chapters and case studies and incorporated the expert input into their revisions. We also made clear in the Introduction that beyond the narrowly defined group of expert “stakeholders” we engaged in the workshops, a broader array of relevant stakeholders were invited to contribute to the shaping of this document through a public review process. Feedback was received from non-governmental organizations, industry, academia, state organizations, and private citizens as well as federal government representatives. That feedback resulted in significant changes to this report.

Appendix A – Chapter-Specific Responses to ACSERAC Comments

National Forest Chapter

The chapter revision has included text addressing missing concepts on the genetics in silvicultural treatments, recognizing timber harvesting as a stressor, the use of natural fire regimes, and the putative values of connecting landscapes. The interacting consequences and complexity of mitigation techniques has been addressed in several sections. The committee noted that the Chapter focused entirely on forestland and the revision has broadened the ecosystems mentioned in the text as well as expanded the management options beyond those specific for forests.

The Committee pointed out that although the National Forest System was selected as a unit of focus for sensitive ecosystems, information from other agencies (BLM, DOD, tribal lands) was not included. The objective of selecting NFS as well as the other federally managed lands described in this report was to give a sense of how particular land management goals might be affected by climate change where those goals were clearly articulated, as they are for federal lands. Other federal lands such as those managed by BLM, DOD, etc. and tribal lands may or may not have climate change objectives that are similar to the NFS. We have revised the text to acknowledge the need for the USFS to interact with these other agencies where NFS lands are adjacent or intermingled with lands that they manage or, for example, where the USFS needs to coordinate with the BLM on mining. Although the discussion of adaptation approaches or particular management recommendations in the chapter (e.g., fire) likely has relevance for other federal lands (e.g., those managed by BLM) we have not specifically highlighted the relevance.

Using an administrative unit for case studies was acknowledged by the Federal Advisory Committee as one way to give credit to agencies and stakeholders for the difficult task of integrating climate change into an adaptive process. Given that the objective of this report was to explore how the agency might adapt to climate change, highlighting the administrative structure in which adaptation will likely take place provided a context for some of the adaptation challenges. We agree that this approach does not lessen the validity of ecosystems as an integrating unit.

The case study sections have been revised to have a common format across all chapters and shortened to highlight lessons learned. The Committee suggested that the case studies would benefit by some examples of anticipatory options for extreme events such as fire or hurricanes as well as descriptions of management activities that have not been successful accompanied by an explanation of their failure. We had recognized the need for anticipatory options in the public comment version and have revised the text to add some anticipatory options for fire. At this point, adaptation actions on the ground are limited; however, we agree that sharing the success or failure of adaptation options would be critical to facilitate a learning environment and have included that point in the revision of the chapter.

The Federal Advisory Committee and public comments discussed several topics that cut across all chapters. The first suggestion was to develop a working or broader definition of *adaptive management* and to carefully review the use of this term. Within the NF chapter, the revision has included the definition as is currently used within NFS and more importantly highlighted areas where adaptive management approaches have been used (Northwest Plan) and are currently being used (Sierra Nevada Forest Plan). Additionally, the challenges of using adaptive management were also included.

The Committee expressed concern about the use and definition of terms such as biodiversity and resilience. In the NF chapter, the revision added a clearer statement of how biodiversity was to be treated and a longer discussion of resilience.

The Committee highlighted the need to add more discussion to two areas: moving from local issues to landscape-level management, and involving stakeholders/cooperators from adjoining state and federal agencies in understanding how to use adaptive management to respond to change. With respect to both concerns, the NF chapter now has more discussion about adaptive capacity and the need to understand the adaptive capacity across the environmental, social, and economic sectors. An understanding of adaptive capacity and a partnership across the public-private spectrum would hopefully lead from local issues to landscape-level (or higher) management.

The Committee also highlighted the challenge that given the number of personnel and level of funding needed to respond to change, there is a need to set priorities for resource use based on some level of triage. The NF chapter had already identified the need to set priorities, and identified the triage approach from the medical environment as one possible priority setting process.

The Committee also noted that there are at least two target groups for which the information will be particularly valuable, namely for managers at the on-the-ground decision level and for administrators and planners. Those in the Congress and higher administrative positions will require yet another presentation and the information presentation and format should be directed toward the needs of these users. This concern has been addressed by the lead authors for the report in restructuring the entire report.

National Parks Chapter

An executive summary was put at the beginning of the Parks chapter to give the key findings from the chapter. Text was added or edited to note the importance of collaboration in adaptation approaches and activities referring to those national parks adjacent to or near other federally managed (BLM, DoD, National Forests, etc.) lands and Tribal lands (see sections of the summary and intro on pages 4-4, 4-25, 4-29, 4-32).

The background discussion of climate change impacts was deleted as recommended because of the general discussion already covered in the Introduction to SAP 4.4.

Reference was made to paleoecological data (see page 4-30), as a long-term perspective on climate variability and change to point managers to important insights.

Many more site-specific examples were added throughout the chapter of the types of actions that could be taken to limit damages from climate change and the types of experiments that could be conducted to find ways of easing the ecological transition to new climate regimes to improve the chapter's usefulness to managers. Also, a paragraph was added that explicitly states the folly of reliance on manuals to determine adaptation options (see p 4-28).

Text was added in the chapter and its summary to make clear those actions that are near, medium, and long term that are either under the control of park managers or that require partnerships with others, support from the public and Congress, and continuing monitoring and research.

Because stressors that come from visitors are more controllable than those that are directly related to changes in climatic conditions, those human-induced stressors have been addressed with added text (see text on p. 4-20 and in the Executive Summary). Text relating to visitor education was also added (see p 4-28).

The discussion of nonnative species and their treatment under changing climatic conditions was expanded to provide a definition of the term (see page 4-14) and to provide much more guidance on when they should be considered invasive and harmful and how to treat them (see p. 4-22).

A short summary of the case study on the Rocky Mountain National Park (RMNP) was written for the chapter and the full case study was moved to an Appendix. In this summary, it now clearly states the purpose of the case study and the major points learned from it. The adaptation approaches mentioned in the full case study that are initiated or planned are provided in the summary to retain the most useful information from the full case study.

Throughout this chapter, references are made to concepts mentioned in the Synthesis chapter using the specific terms developed for the Synthesis chapter to better integrate information within this chapter with other management system chapters and the synthesis.

National Wildlife Refuges Chapter

The chapter makes a recommendation for establishing two new entities: a national interagency climate change council and a national interagency climate change information network. In response to a concern that specific policy recommendations are beyond the scope of this report, we have toned down the "recommendation" to a "suggestion" and eliminated the use of explicit body names.

It was suggested that a chapter summary would be useful at the beginning of the chapter. This has been done, using information originally presented in the Executive Summary and modifying it for consistency with other chapter summaries.

The FACA recommended that all chapters be made conceptually consistent with the Synthesis. It is already consistent where it should be. No more consistency was imposed (as a command decision) since the Synthesis chapter conceptually draws from and synthesizes information from the underlying chapters, not the other way around. The themes in the Synthesis chapter emerged from a reading of all the Management Systems chapters.

Another recommendation was to include greater consideration of anticipatory management and making optimal use of current best management practices. The NWRS is particularly well-suited to do this, thus implementing a “no regrets” policy. Anticipatory management and optimal use of current best management practices is stressed in this chapter already. No change is necessary.

Another concern was that the chapter needs to be clear that the audience for needed policy changes is at the regional and national level. The level and extent of detail in the text should be calibrated to what will be critical to those decision-makers. We added an explicit target audience phrase on p. 5-6 and edited the paragraph there for internal consistency.

It was also noted by the FACA that the case study was an interesting selection. Although there was only one selected, it covers a very large footprint. However, there was concern that some critical insights for adaptation were missed. It was suggested that some of the concern could be attenuated if the “lessons learned” from the case study were given greater emphasis through use of a text box for greater emphasis. We have worked to highlight the lessons learned in the “box” that replaces the case study section in the report.

To ensure consistency between what refuge managers can do and how the approaches are summarized in Table 9.4, the table was edited.

It was stated that the chapter needs greater clarity about how the NWRS should address range shifts in the context of invasive species, i.e., how non-native species should be handled if they are in a refuge as a result of range shifts. The chapter talks about assisted dispersal in addressing range shifts but this leaves out natural dispersal. We clarified the native/non-native issue and expanded the text in the sections related to this concept.

Finally, the FACA stated that there is an inconsistency in the chapter that should be corrected. The second paragraph of Sect 5.1.4.5 (p. 5-10) discusses using historic conditions as a benchmark for success. The next paragraph states that the policy does not insist on a return to historical conditions but to use them as a frame of reference for understanding successional shifts (p.5-11). Then the second take-away message (p. 5-63)

is worded as if historical conditions are, in fact, the management target. These appear to be in conflict. The committee agrees with the frame-of-reference use for historical conditions, but suggests that this point be clearly described and that recommendations be consistent with current policy. In response to these concerns, we edited the first and third paragraphs to ensure internal consistency.

Wild and Scenic Rivers Chapter

For the most part the FACA comments were quite complementary and brief for the WSR chapter. There was some need expressed to both expand on the management options and to better link those to the text. Thus a new table was developed that replaced the old Box 6.5 (which was criticized by the panel). This new Box summarizes the types of adaptation options and directly ties to sections in the text.

There was a little concern that some of the suggestions for options could not be accomplished by WSR managers. This is fully recognized by the authors but it is clearly stated that these actions should be considered by working with those (e.g., dam managers, local land owners) who do have the appropriate power. Many or most WSRs will *never* be protected from climate change impacts if actions outside of federally-owned lands are not taken. This is in part because many WSR designations are in watersheds that are somewhat developed.

The Conclusions have been re-written as requested and the language concerning very clear statements about the need for proactive management has been added.

National Estuaries Chapter

We responded to specific issues raised about the National Estuaries Chapter and to relevant generic issues raised about the entire 4.4 product and its Executive Summary.

- (1) We appreciate the compliments on our writing and then, armed with good will and pride, considered the suggestion made to prioritize our Conclusions. We decided that our Conclusions section has several attributes that make prioritization inappropriate. First, the Conclusions are prepared in its beginning as an organized series of points, each leading logically and stepwise to the next. Thus, this portion has its own organizational structure for which prioritization simply does not make sense. Second, we break our Conclusions up subsequent to this logical series into several categories (Management Response vs. Research Priorities, which we organize into separate sections (Conceptual Gaps in Understanding; Data Gaps; Governance Issues; Tool Needs; and Education)). Each of these sections speaks to largely separate audiences, and in that sense the relevant conclusions do not lend themselves well to prioritization because different agencies must respond. In other words, although some issues may be more urgent than others, it is not unreasonable to expect progress on all fronts because in general different groups are responding. Prioritization could actually be counter-productive if it was used to allow one agency of group to avoid doing their part. However, to be true to the spirit of this suggestion, and to respond to another recommendation of the FACA panel, we did prepare an Abstract (Summary) of about 3 pages, in which the most important conclusions are identified and stressed.
- (2) We were pleased to make the addition of extensive comments about the importance of state programs under CZMA, including especially local land-use planning, to implementation of management adaptations to climate change. We added an entirely

new section (7.3.3.4) in which to present this program and its role. In addition, we made mention later in the text in presenting management adaptations where the CZMA plays a useful role. In so doing we cited and incorporated conclusions of the CSO report provided in one public review.

- (3) We agree with and entered all caveats as requested about the use of “adaptive management”, “ecosystem-based management”, and the reliability of biodiversity as a means of providing resilience to climate change. On this last point, we also reflected the uncertainty over effects of biodiversity in our new Confidence Table.
- (4) We added to the Albemarle-Pamlico Estuary case study the explanation for how selection and inclusion of this example highlights important issues developed in our chapter (as presented verbally by Pete Peterson at the review meeting). This case study is also now presented separately from the main text, so its length is no longer an issue.
- (5) We made small modifications in the text where appropriate to utilize the terms describing options for achieving resilience in Table 9.4.
- (6) Finally, we prepared an Abstract, as requested, although it is now termed a “Summary”.

Marine Protected Areas Chapter

For section 8.1 we have modified text, added an example, and deleted text. Section 8.2 develops a series of interrelated topics (ecosystem characteristics/management goals, stressors, management/sensitivity of goals to climate change) that lead to the topic of management options in section 8.3; we modified the text on page 8-15 noted in the comments. We agree that the ecological processes listed in section 8.2.2.1 are not necessarily the most fundamental and modified this list. Further expansion of how range shifts (not warming) may affect the processes is provided in the references cited. Regarding effects of light on bleaching we have modified text, added citations, and added an adaptation option in Box 8.5. Considerable expansion and elaboration of the section on bleaching is not feasible at this stage of completing this "preliminary review;" there are numerous literature citations. There appears to be some confusion about invasive and native species changes/effects and we modified text on this topic. Regarding freshwater influxes and pollution we modified text and suggested a possible solution. We agree that increasing the size of no-take zones is clearly called for. We disagree that engaging stakeholders simply shifts "the onus onto others;" our experience is that MPA managers are held accountable. We agree with other comments about this section and modified text. We added a section on management adaptations to the FKNMS and PMNM case studies.

Synthesis Chapter – Response to Federal Advisory Committee Comments

The synthesis chapter was changed in six substantial ways in response to the review committee’s remarks:

- 1.) The context, role and general intent of the synthesis chapter was laid out in the beginning of the chapter.
- 2.) In several sections greater detail was added—this request for greater detail mirrored some of the comments from the FACA review comments.
- 3.) The papers of Gregory and Arvai were consulted, and used to add greater depth to the discussion of adaptive management and decision-making under uncertainty.
- 4.) The no-regrets option was given greater emphasis.
- 5.) Prose was added to make clear that the subject of adaptation will require continued attention, and that in no way is this report the “final word”.
- 6.) The importance of monitoring was given even more emphasis.

There were, of course, numerous other revisions as well. But the above six modifications represent criticisms raised by the advisory committee that were felt to be especially trenchant and on-target, and hence warranting substantial revisions.

Appendix B – Directions to Authors and Template for Characterizing Confidence in Response to AC SERAC Recommendations for Charge Question 6

Directions to Authors for Estimating Confidence

In your judgments of confidence, please consider the following:

- Peer-reviewed and gray literature (journal articles, reports, working papers, management plans, workshop reports, other management literature, other gray literature)
- Data and observations
- Model results
- Your own experience, including your experience in the field, your analyses of data, and your knowledge of the performance of specific adaptation options under each type of adaptation approach.

Peer reviewed literature should serve as the primary source considered in your judgments, with minimal reliance on the gray literature, except where no peer reviewed literature are available. Data, observations, model results, and your own experience may be used as secondary lines of evidence. Because promoting resilience may be a management strategy that is useful only on shorter time scales of a few decades, please evaluate each adaptation approach for its effectiveness at achieving increased resilience in the near term. Also, please exclude from your consideration any non-technical or non-ecological considerations, such as how difficult adaptation approaches may be to implement, since these issues are dealt with elsewhere in SAP 4.4.

For each adaptation approach, you are asked to consider two separate but related elements of confidence. The first element is the amount of evidence that is available (indicating that the topic is well-studied and understood) to assess the effectiveness of a given adaptation approach. The second is the level of agreement or consensus across the different lines of evidence regarding the effectiveness of the adaptation approach. This method for estimating confidence is one of several provided by the IPCC to its authors for the IPCC WG IV reports¹. *We are asking you to evaluate only those adaptation approaches for which you have adaptation options listed from your chapter (see separate attachment, “Adapt_Approach.doc”, for this listing).* Please consult the tables provided in Adapt_Approach.doc and then use the template pages below to rank the amount of evidence and level of agreement for each approach as “high” or “low”; this will result in each adaptation approach falling into one of the four quadrants shown below:

		Qualitatively defined levels of understanding	
Level of agreement or consensus	↑	High agreement Low evidence	High agreement High evidence
		Low agreement Low evidence	Low Agreement High evidence

¹ Guidance Notes for Lead Authors of the IPCC Fourth Assessment Report on Addressing Uncertainties, July 2005

Amount of evidence (theory, observations, models) →

Confidence Template for Completion by Authors

1. Protecting key ecosystem features

Description: focusing management protections on structural characteristics, organisms, or areas that represent important “underpinnings” or “keystones” of the overall system

Confidence: is strategic protection of key ecosystem features an effective way to preserve or enhance resilience to climate change?

High/low amount of evidence

Is this adaptation approach well-studied and understood, or instead is it mostly experimental or theoretical and not well-studied? Does your experience in the field, your analyses of data, and your understanding of the literature and performance of specific adaptation options under this type of adaptation approach indicate that there is a high/low amount of information on the effectiveness of this approach?

High or low evidence?	
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Please convey the amount and type of evidence available that provides support for high/low amount of evidence:

High/low amount of agreement

Do the studies, reports, and your experience in the field, analyzing data, or implementing the types of adaptation strategies that comprise this approach reflect a high degree of agreement on the effectiveness of this approach, or does it lead to competing interpretations?

High or low agreement?	
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Please convey the information from the different lines of evidence that provides support for the high/low amount of agreement:

2. Reducing anthropogenic stresses

Description: minimizing localized human stressors (e.g., pollution) that hinder the ability of species or ecosystems to withstand climatic events

Confidence: is reduction of anthropogenic stresses effective at increasing resilience to climate change?

High/low amount of evidence

Is this adaptation approach well-studied and understood, or instead is it mostly experimental or theoretical and not well-studied? Does your experience in the field, your analyses of data, and your understanding of the literature and performance of specific adaptation options under this type of adaptation approach indicate that there is a high/low amount of information on the effectiveness of this approach?

High or low evidence?	
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High or low agreement?	
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Please convey the information from the different lines of evidence that provides support for the high/low amount of agreement:

3. Representation

Description: protecting a portfolio of variant forms of a species or ecosystem so that, regardless of what climatic changes occur, there will be areas that survive and provide a source for recovery

Confidence: is representation effective in supporting resilience through preservation of overall biodiversity?

High/low amount of evidence

Is this adaptation approach well-studied and understood, or instead is it mostly experimental or theoretical and not well-studied? Does your experience in the field, your analyses of data, and your understanding of the literature and performance of specific adaptation options under this type of adaptation approach indicate that there is a high/low amount of information on the effectiveness of this approach?

High or low evidence?	
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High or low agreement?	
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Please convey the information from the different lines of evidence that provides support for the high/low amount of agreement:

4. Replication

Description: maintaining more than one example of each ecosystem or population within a reserve system such that if one area is affected by a disturbance, replicates in another area provide insurance against extinction and a source for recovery of affected areas

Confidence: is replication effective in supporting resilience by spreading the risks posed by climate change?

High/low amount of evidence

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High or low agreement?	
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Please convey the information from the different lines of evidence that provides support for the high/low amount of agreement:

5. Restoration

Description: rebuilding ecosystems that have been lost or compromised

Confidence: is restoration of desired ecological states or ecological processes effective in supporting resilience to climate change?

High/low amount of evidence

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High or low agreement?	
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Please convey the information from the different lines of evidence that provides support for the high/low amount of agreement:

6. Refugia

Description: using areas relatively less affected by climate change as sources of “seed” for recovery or as destinations for climate-sensitive migrants

Confidence: are refugia an effective way to preserve or enhance resilience to climate change at the scale of species, communities or regional networks?

High/low amount of evidence

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High or low evidence?	
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High/low amount of agreement

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High or low agreement?	
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Please convey the information from the different lines of evidence that provides support for the high/low amount of agreement:

7. Relocation

Description: human-facilitated transplanting of organisms from one location to another in order to bypass a barrier (e.g., urban area)

Confidence: is relocation an effective way to promote system-wide (regional) resilience by moving species that would not otherwise be able to emigrate in response to climate change?

High/low amount of evidence

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High or low evidence?	
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