

# Status of the Sierra Nevada

---

---

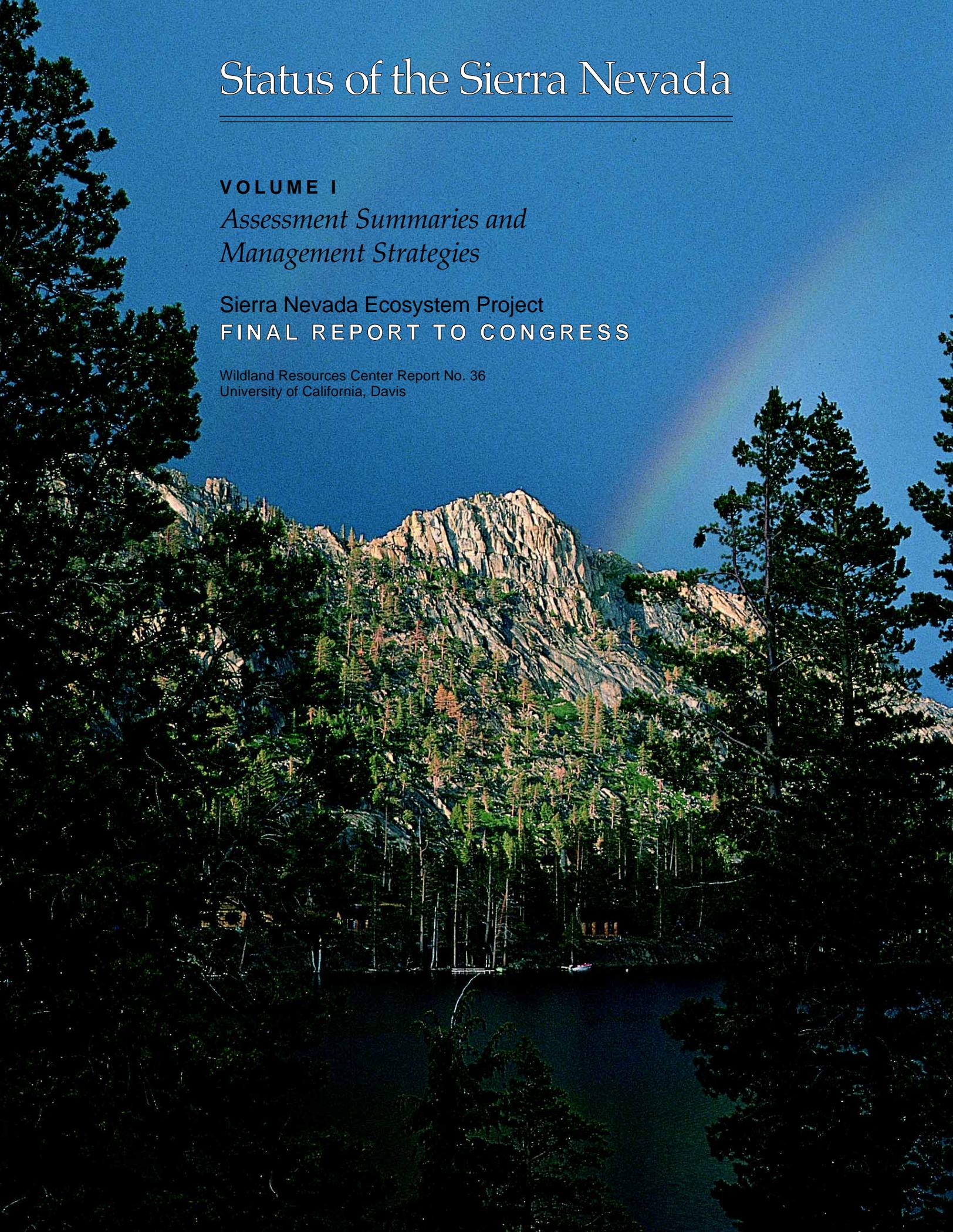
## **VOLUME I**

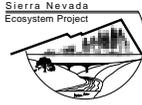
### *Assessment Summaries and Management Strategies*

Sierra Nevada Ecosystem Project

**FINAL REPORT TO CONGRESS**

Wildland Resources Center Report No. 36  
University of California, Davis





Sierra Nevada Ecosystem Project

## FINAL REPORT TO CONGRESS

# *Status of the Sierra Nevada*

---

---

VOLUME I

*Assessment Summaries and  
Management Strategies*



*Written and Edited by the SNEP Science Team and Special Consultants*

Wildland Resources Center Report No. 36

CENTERS FOR WATER AND WILDLAND RESOURCES  
UNIVERSITY OF CALIFORNIA, DAVIS

June 1996



*Sierra Nevada Ecosystem Project: Final Report to Congress*  
Volume I: *Assessment Summaries and Management Strategies*  
Wildland Resources Center Report No. 36  
ISBN 1-887673-00-8

Support for this research was provided by cooperative research agreement with the United States Forest Service Pacific Southwest Research Station and the University of California.

This publication is a continuation in the Wildland Resources Center Reports series. It is published and distributed by the Director's Office of the Centers for Water and Wildland Resources. The Centers sponsor projects in water and wildland resources and related research within the state of California with funds provided by various state and federal agencies and private industry. Copies of this and other reports published by the Centers may be obtained from:

**Centers for Water and Wildland Resources**  
**University of California**  
**1323 Academic Surge**  
**Davis, CA 95616-8750**  
**916-752-8070**

Copies of the Centers' publications may be examined at the Water Resources Center Archives at 410 O'Brien Hall, Berkeley Campus; 510-642-2666.

Please cite this volume as: *Sierra Nevada Ecosystem Project, Final Report to Congress*, vol. I, *Assessment Summaries and Management Strategies* (Davis: University of California, Centers for Water and Wildland Resources, 1996).

Photographs: Dwight M. Collins, cover, title page, chapters 1, 2, 5, 8, 9, 11, 12; Jerry F. Franklin, chapters 3, 6, 7, 10; B. Knight, chapter 4; Neil Michaels, appendixes.

The University of California, in compliance with Titles VI and VII of the Civil Rights Act of 1964, Title IX of the Education Amendments of 1972, Sections 503 and 504 of the Rehabilitation Act of 1973, and the Age Discrimination Act of 1975, does not discriminate on the basis of race, religion, color, national origin, sex, mental or physical handicap, or age in any of its programs or activities, or with respect to any of its employment policies, practices, or procedures. Nor does the University of California discriminate on the basis of ancestry, sexual orientation, marital status, citizenship, medical conditions (as defined in Section 12926 of the California Government Code) or because individuals are special disabled veterans of Vietnam era veterans (as defined by the Vietnam Era Veterans Readjustment Act of 1974 and Section 12940 of the California Government Code). Inquiries regarding this policy may be addressed to the Affirmative Action Director, University of California, Agriculture and Natural Resources, 300 Lakeside Drive, 6th Floor, Oakland, CA 94612-3560; 510-987-0097.

# Contents

---

---

	<i>The SNEP Science Team and Special Consultants</i>	v
	<i>Introduction</i>	1
CHAPTER 1	<i>Sierra Nevada Ecosystems</i>	5
CHAPTER 2	<i>People and Resource Use</i>	17
CHAPTER 3	<i>Institutions</i>	47
CHAPTER 4	<i>Fire and Fuels</i>	61
CHAPTER 5	<i>Plants and Terrestrial Wildlife</i>	73
CHAPTER 6	<i>Late Successional Old-Growth Forest Conditions</i>	91
CHAPTER 7	<i>Rangelands</i>	113
CHAPTER 8	<i>Watersheds and Aquatic Biodiversity</i>	123
CHAPTER 9	<i>Air Quality</i>	135
CHAPTER 10	<i>Case Studies in Ecosystem Management</i>	145
CHAPTER 11	<i>Institutional Integration</i>	167
CHAPTER 12	<i>The Future</i>	173
APPENDIX 1	<i>Contents of Volumes II and III</i>	177
APPENDIX 2	<i>SNEP Science Team, Contributors, and Staff</i>	183
APPENDIX 3	<i>Digital Geographic Data for the Sierra Nevada Region</i>	187
APPENDIX 4	<i>The SNEP Process in Detail</i>	197



# ***The SNEP Science Team and Special Consultants***

---

---

## ***Science Team***

Don C. Erman, Team Leader, University of California,  
Davis, CA  
Michael Barbour, University of California, Davis, CA  
Norman Christensen, Duke University, Durham, NC  
Frank W. Davis, University of California, Santa Barbara, CA  
Harrison Dunning, University of California, Davis, CA  
Deborah L. Elliott-Fisk, University of California, Davis, CA  
(former team leader)  
Jerry F. Franklin, University of Washington, Seattle, WA  
David Graber, National Biological Service, Three Rivers, CA  
K. Norman Johnson, Oregon State University, Corvallis, OR  
John W. Menke, University of California, Davis, CA  
Constance I. Millar, U.S. Forest Service, Pacific Southwest  
Research Station, Albany, CA  
Janet H. Momsen, University of California, Davis, CA  
Peter B. Moyle, University of California, Davis, CA  
David J. Parsons, U.S. Forest Service, Aldo Leopold  
Wilderness Research Institute, Missoula, MT  
Rowan A. Rowntree, U.S. Forest Service, Northeastern  
Forest Experiment Station, Albany, CA  
John Sessions, Oregon State University, Corvallis, OR  
John C. Tappeiner, National Biological Service,  
Corvallis, OR  
Susan L. Ustin, University of California, Davis, CA

## ***Special Consultants***

Philip S. Aune, U.S. Forest Service, Pacific Southwest  
Research Station, Redding, CA  
Joan Brenchley-Jackson, University of California, Davis, CA  
Tom Cahill, University of California, Davis, CA  
Gary Darling, State of California Resources Agency,  
Sacramento, CA  
Michael F. Diggles, U.S. Geological Survey, Menlo Park, CA  
Timothy P. Duane, University of California, Berkeley, CA  
Robert Ewing, Weyerhaeuser Corporation, Tacoma, WA  
Gregory Greenwood, California Department of Forestry  
and Fire Protection, Sacramento, CA  
Richard Kattelman, University of California, Santa  
Barbara, Mammoth Lakes, CA  
Jon Kennedy, U.S. Forest Service, Sacramento, CA  
Jonathan Kusel, Forest Community Research and University  
of California, Westwood, CA  
Douglas Leisz, Placerville, CA  
Dennis Machida, California Tahoe Conservancy, South Lake  
Tahoe, CA  
Kevin S. McKelvey, U.S. Forest Service, Pacific Southwest  
Research Station, Arcata, CA  
Larry Ruth, University of California, Berkeley, CA  
James R. Shevock, U.S. Forest Service, Regional Office, San  
Francisco, CA  
Carl N. Skinner, U.S. Forest Service, Pacific Southwest  
Research Station, Redding, CA  
William Stewart, Pacific Institute, Oakland, CA  
C. Phillip Weatherspoon, U.S. Forest Service, Pacific  
Southwest Research Station, Redding, CA



# Introduction

---

---

## Background

In a few lines contained in the Conference Report for Interior and Related Agencies 1993 Appropriation Act (HR 5503), Congress authorized funds for a

scientific review of the remaining old growth in the national forests of the Sierra Nevada in California, and for a study of the entire Sierra Nevada ecosystem by an independent panel of scientists, with expertise in diverse areas related to this issue.

This act created the Sierra Nevada Ecosystem Project (SNEP). The primary emphasis of the project was to assemble and assess the comprehensive data necessary to assist Congress and others in making important policy decisions for the future management of the Sierra Nevada. The other emphasis was to examine alternative management strategies that could help meet the broad goal for which the study was undertaken. That goal was to maintain the health and sustainability of the Sierra Nevada ecosystem while providing resources to meet human needs. Concern over conservation and use of the Sierra Nevada is not new. Some of the more recent issues connect to general concern over forest conditions in the Pacific Northwest and to specific concerns raised by a series of articles in the *Sacramento Bee* ("The Sierra in Peril") and subsequent conferences ("Sierra Summit," "Sierra Now").

More congressional direction on the scope of the SNEP study and the structure of the independent team was provided by a second bill. It was not passed before adjournment but was later read into the *Congressional Record* as a guide to the study. Letters from various members of the House of Representatives to the Chief of the U.S. Department of Agriculture, Forest Service, gave additional explanation of the intended legislation. The Forest Service supplemented the \$150,000 provided in HR 5503 to conduct the study by committing \$6.5 million over the three years of project work.

The first step in the study was formation of a Steering Com-

mittee (appendix 4) composed of a representative each from Forest Service Research, Washington Office; Forest Service Research, Pacific Southwest Station; U.S. Department of the Interior, National Park Service; University of California; and California Academy of Sciences, plus a "scientist of eminent standing" and member of the National Academy of Sciences. The Steering Committee selected a Science Team leader, worked with the team leader to select the team, developed the charge for the team in keeping with congressional intent, and provided overall guidance and advice throughout the study. The charge to the team and the congressional bills and letters were included in the *SNEP Progress Report*, May 1994.

The Science Team, eventually composed of eighteen members, was augmented by nineteen special consultants (both groups are listed after the table of contents). In addition, many other scientists worked closely with team members (one hun-

*Team leader Don C. Erman (right) discussing SNEP with Ken Roby of the U.S. Forest Service, Donna Lindquist of Pacific Gas and Electric Company, and other participants at a public meeting to report progress. (Photo by Neil Michaels.)*



dred seven as authors or coauthors of chapters and reports), some throughout the project; their contributions appear in volume II or III or are acknowledged elsewhere (appendix 4). Overall management of the project was the responsibility of the University of California Centers for Water and Wildland Resources, through a research agreement with the Forest Service, Pacific Southwest Research Station.

### Approach

In broad outline, the Science Team divided its energy into (1) a period of data gathering and evaluation of data quality, (2) a period of assessment of the past and current status of the ecosystem, and (3) a final period of projecting and evaluating future trends under different possible strategies. The project devoted most of its effort to analyzing existing information rather than conducting new studies or experiments. The integration of this accumulated information became a primary objective, as the team sought a range of options for future directions of management. The study used geographic information systems (GISs) extensively as a primary means of synthesizing data, displaying information, and considering options for further analysis.

The Science Team identified the primary questions to examine by involving a wider group of scientists to assist in data gathering and evaluation and by discussing the findings and implications of all the assessments. This process quickly showed the integral role of people, including their communities and institutions, as important ecosystem components equal to the flora, fauna, and other natural features. The team also recognized that dialogue with the public was necessary. A group of seventy people with diverse interests and responsibilities in the Sierra was assembled as “key contacts.” This group met with the team to review progress, ask questions, help in framing scenarios, assist in review of assessments, and plan larger public involvement. The team held

smaller work sessions and reported on progress several times at announced public meetings called by the Steering Committee. Throughout the study, many team members met with individuals and local and regional groups, presented reports at professional and technical meetings, briefed county, state, and federal agency personnel, and held local workshops. These interactions between scientists and the public helped refine our process, content, approach, and scope.

The charge of this study was not confined by the jurisdictions of ownership and management but rather followed the realities of the landscape. Data from both public and private lands were examined to the limit of time and resources; however, the 60% of the range in federal lands is highlighted because of availability of information.

The team found that much has been studied in the Sierra Nevada, although, in many areas vital to understanding the future, essential knowledge was unavailable or tests of ideas have yet to be done. Science Team members were asked to draw reasonable inferences from their assessment of existing information, including their own observations. They have been explicit about the basis of this knowledge and these data and about where they are making assumptions or giving personal judgments.

### Assessments

Assessment of the individual components of the system involved teams of various sizes, contacts with other scientists, requests for commissioned reports, review of published and unpublished literature, workshops, individual knowledge and observation, and in some cases original analysis of data or field evaluations. Assessment projects were guided by five questions:

1. What were historic ecological, social, and economic conditions, trends, and variability?
2. What are current ecological, social, and economic conditions?
3. What are trends and risks under current policies and management?
4. What policy choices will achieve ecological sustainability consistent with social well-being?
5. What are the implications of these choices?

In many places our assessments have used historical data as a guide to understanding natural ecological processes and conditions. These data have been as varied as ice cores from the poles, tree rings from thousand-year-old trees, diaries of early explorers, and photographs taken at the turn of the century. The past is always imperfectly known and understood, partly because the data are imperfect and because alternative explanations of processes and conditions may fit the same data. Supporting information from experimental research and from observations of conditions at select locations (such as parks)

*Team member William Stewart (center) listens to input from Mono County Supervisor Andrea Lawrence (left), Mike Albrecht of TUCARE (right), and others at a public meeting. (Photo by Neil Michaels.)*



have been used to strengthen inferences from the past. But these approaches aim at understanding the present, not setting a fixed benchmark of what the future should be. The assessment summaries focus on those aspects of the ecosystem in which either existing conditions or present trends are in need of remedial action. Possible actions are given as alternative management strategies for improving conditions.

What volume I presents is a brief summary of only some of the more important findings from these assessments. Practical limits of summarizing the substantial body of knowledge assembled by the study required us to omit much of the depth and richness. We have worked to avoid oversimplification or generalization without presenting the detailed methods and literature common to science reports. Thus, the full context, citation to sources, justification, and supporting data must be examined in the complete assessment reports. We have further summarized the assessments in a series of critical findings that are presented at the beginning of each chapter in this volume. These represent *new* findings, findings that *confirm* what has been generally believed about the Sierra, and *emergent* or *synthesizing* ideas that arose from SNEP's integrated analysis of individual reports.

### Strategies

Ecosystem assessment findings provide a basis for evaluating where conditions may be heading and how much the Sierra Nevada has changed. The congressional language and background for this study emphasized that the report was to advise Congress on existing and possible future conditions of the old-growth and late successional forests and the ecosystems of the Sierra Nevada. Thus, the team was not asked to prepare a single plan, a range of options for implementation, or preferred alternatives, as in an environmental impact statement process required under the National Environmental Policy Act.

Improvements in conditions through remedial actions usually imply a definition of the goals of alternative strategies. SNEP was not charged with selecting the goals for society or the Sierra Nevada ecosystem. However, to devise strategies one must have goals. The team selected goals within the overall charge to the project, to be explicit and to suggest how conditions and trends revealed by the assessments could be changed. Many of our goals were chosen through input from public interaction. Discussions with the public, which continued over the course of the project, became a mutual search for strategies for improved management—not to find a finite set of the best alternatives but rather to understand better the connections among so many complex parts of the Sierra Nevada ecosystem.

Such an exercise may quickly overwhelm easy summary or comprehension because of the infinite combinations or variations of factors that make up the ecosystem. Thus, we chose a small sample of strategies to demonstrate broad choices and implications for meeting the stated goals. The strategies should also educate us on the ways in which parts of the sys-



*Science team member Constance I. Millar (left) discusses assessment findings with Joan Reiss, environmental consultant. (Photo by Neil Michaels.)*

tem interact and should lead to a better understanding of unexpected ramifications brought about by human action. No single model of the Sierra that encompasses all interacting parts is possible. We have deliberately chosen several models—mathematical and nonmathematical, quantitative and qualitative—to illustrate our strategies. Models are only one way to organize and display a thought process. Their utility is to aid in understanding the implications of choices, in suggesting other choices, and in opening up the territory for informed decision making. Some of the strategies required development of new methods or interpretations of scientific knowledge (e.g., areas of late successional emphasis, fuels management). The details and background for these strategies are given in full in the other volumes.

### The SNEP Reports

The complete report of SNEP is contained in four volumes: Volume I contains critical findings, the context for the study, summaries of the major points from the assessments and case studies in the other volumes, and a presentation of alternative strategies and their implications for the future health and sustainability of the ecosystem.

Volume II contains the technical assessments of historical, physical, biological, ecological, social, and institutional conditions in the Sierra Nevada, selected case studies, details on the scientific basis and methods used in strategies, and references



*At a September 1995 public workshop in Sacramento, SNEP team member John Sessions (standing) fields questions about simulation models. (Photo by Neil Michaels.)*

to the literature and data sources. All chapters in volume II were reviewed extensively, including anonymous peer review secured by the Steering Committee.

Volume III includes late submissions of peer-reviewed papers from volume II, additional commissioned reports, and summary listings of workshops and participants. A list of the contents of volumes II and III is included in volume I (appendix 1).

Volume IV is a computer-based catalogue of all public databases, maps, and other digitally stored information used in the project. A major goal of the project was to leave an accessible and usable database containing information, approaches to analysis, and a framework for future study and decision making. These materials are listed under the SNEP name and available on the Internet from the Alexandria Project at the University of California at Santa Barbara and the California

Environmental Resource Evaluation System (CERES) project of the Resources Agency of the State of California. A directory of the GIS portion and available data is in appendix 3.

The project was conceived as a scientific study by independent scientists. Thus, the reports presented in volumes II and III (and summarized in volume I) are attributable to the authors and follow the usual standards for citation, accuracy, and statement of opinion. Throughout the study, the team fostered debate and welcomed diversity of ideas. At the end, some issues remained in contention among team members and are so noted in the report. Assessment chapters, as in the journals of science, are not intended or written as consensus documents. Understanding complex ideas and recognizing areas of uncertainty come about as much by seeing different views as by studying a single, dominant perspective. But we have made every effort to document the basis in facts, assumptions, knowledge, and inferences that we used in reaching our conclusions. Readers of our reports, by their own analyses of our information, may reach new conclusions. We have intended that the bases for our conclusions and the process of our reasoning be open and available to alternative analyses.

No single strategy that we explore is considered comprehensive for all components of the ecosystem or the entire range, and all need specific information on local conditions to be fully useful. If our understanding of the scientific relationships within the ecosystem is correct, then the same understanding may be employed to develop other strategies and even reach other ends. This study has shown us that options are available that could lead to better management. Before a different management policy for the Sierra Nevada ecosystem proceeds, society must define the future vision, the charter for the future Sierra Nevada.

Having before us a summing up of this knowledge should help us all make informed choices in the give-and-take of the democratic process.