Editorial Staff

U.S. Geological Survey/FRESC

Charles van Riper, III — Managing Editor
Maureen A. Stuart — Editor, Publications Coordinator and Desktop Publisher

Cover photo:
Buttes and mesas of Monument Valley, Arizona typify the spectacular landforms of the Colorado Plateau.
(© Al Richmond)

This report may be cited as follows:

van Riper, C., III, and M. A. Stuart, editors. 1999. Proceedings of the Fourth Biennial Conference of Research on the Colorado Plateau. U.S. Geological Survey/FRESC Report Series USGSFRESC/COPL/1999/16.

Copies of this report are available from the Station Leader, Colorado Plateau Field Station, Northern Arizona University, P.O. Box 5614, Flagstaff, AZ 86011-5614.

Proceedings of the Fourth Biennial Conference of Research on the Colorado Plateau

Editors

Charles van Riper III
Maureen A. Stuart

Fourth Biennial Conference
of Research on the Colorado Plateau
Northern Arizona University
Flagstaff

Sponsored and organized by
U.S. Geological Survey
Biological Resources Division

Co-sponsored by
Northern Arizona University

Report Series USGSFRESC/COPL/1999/16

Contributors

W. Sylvester Allred
Department of Biological Sciences
Northern Arizona University
Box 5640
Flagstaff, AZ 86011

Janet Balsom
Grand Canyon National Park
P.O. Box 129
Grand Canyon, AZ 86023

Matthew J. Betenson
Zion National Park
Springdale, UT 84767

Susan R. Boe
Arizona Game and Fish Department
Research Branch
2221 W. Greenway Rd.
Phoenix, AZ 85023

David N. Cagle
Arizona Game and Fish Department
Region I
HC 62 Box 57201
Pinetop, AZ 85935

Timothy W. Canaday
Death Valley National Park
Death Valley, CA 92328

Kenneth L. Cole
USGS/FRESC
Colorado Plateau Field Station
Northern Arizona University
Box 5614
Flagstaff, AZ 86011

Timothy E. Crews
Environmental Studies Program
Prescott College
220 Grove Ave.
Prescott, AZ 86301

Anne DaVega
Prescott College
220 Grove Ave
Prescott, AZ 86301

Norris L. Dodd
Arizona Game and Fish Department
Research Branch
Box 2326
Pinetop, AZ 85935

Ryan T. Eisfeldt
Center for Environmental Sciences and Education
Northern Arizona University
Box 5694
Flagstaff, AZ 86011

William B. Fawcett, Jr.
Department of Sociology, Social Work, and Anthropology
UMC 0730
Utah State University
Logan, UT 84322

M. Lisa Floyd-Hanna
Prescott College
220 Grove Ave
Prescott, AZ 86301

L.D. Garrett
Grand Canyon Monitoring and Research Center
2255 N. Gemini Drive
Flagstaff, AZ 86011

William S. Gaud
Department of Biological Sciences
Northern Arizona University
Box 5640
Flagstaff, AZ 86011

John G. Goodwin, Jr.
Arizona Game and Fish Department
Region II
3500 S. Lake Mary Rd.
Flagstaff, AZ 86001

David Hanna
Prescott College
220 Grove Ave
Prescott, AZ 86301

Matthew King
Center for Environmental Sciences and Education
Northern Arizona University
Box 5694
Flagstaff, AZ 86011

William R. Latady
Anasazi State Park
P.O. Box 1429
Boulder, UT 84716

Melissa F. Lema
Department of Biological Sciences
Northern Arizona University
Box 5640
Flagstaff, AZ 86011

Lyndon K. Murray
University of Texas at Austin
Department of Geological Sciences
Austin, TX 78701

Laird P. Naylor II
Bureau of Land Management
Utah State Office
324 S. State Street, Suite 301
Salt Lake City, UT 84145

Martin A. Nie
University of Minnesota, Duluth
Department of Political Science
304 Cina Hall, 10 University Drive
Duluth, MN 55812-2496

Michael J. Rabe
Arizona Game and Fish Department
Non-Game Branch
2221 W. Greenway Rd.
Phoenix, AZ 85027

Timothy D. Rogers
Arizona Game and Fish Department
Research Branch
2221 W. Greenway Rd.
Phoenix, AZ 85023

William H. Romme
Biology Department
Fort Lewis College
Durango, CO 81301

Melissa S. Siders
North Kaibab Ranger District
Kaibab National Forest
Fredonia, AZ 86022

Thomas D. Sisk
Center for Environmental Sciences and Education
Northern Arizona University
Box 5694
Flagstaff, AZ 86011

Tim K. Snow
Arizona Game and Fish Department
Non-Game Branch
2221 W. Greenway Rd.
Phoenix, AZ 85027

Michael H. Soulen
Grand Canyon Monitoring and Research Center
2255 N. Gemini Drive
Flagstaff, AZ 86011

Elaine Stanley
Center for Environmental Sciences and Education
Northern Arizona University
Box 5694
Flagstaff, AZ 86011

Maureen A. Stuart
USGS/FRESC
Colorado Plateau Field Station
Northern Arizona University
Box 5614
Flagstaff, AZ 86011

Charles van Riper III
USGS/FRESC
Colorado Plateau Field Station
Northern Arizona University
Box 5614
Flagstaff, AZ 86011

Brian F. Wakeling
Arizona Game and Fish Department
Research Branch
2221 W. Greenway Rd.
Phoenix, AZ 85023

James H. Witham
Arizona Game and Fish Department
Region III
5325 N. Stockton Hill Rd.
Kingman, AZ 86401

Kei Yasuda
575 East 43rd Avenue
Eugene, OR 97405

Contents

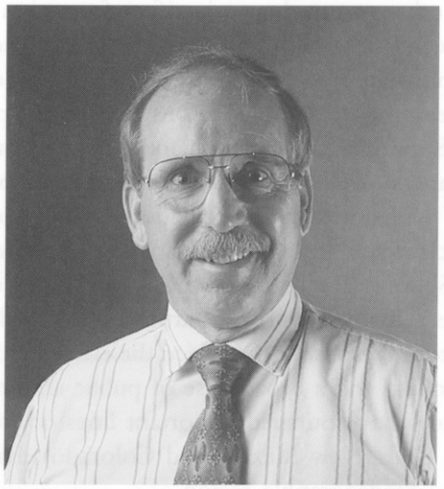
Preface

The 13 papers in this volume are contributions from federal, state, and private sector researchers, who come together at Northern Arizona University every other year to share scientific information with land managers on the Colorado Plateau. This is the fourth Proceedings for which I have had the pleasure of providing a Preface. This Colorado Plateau Biennial Conference series of publications focuses on providing information to USGS partners, particularly land managers on the Colorado Plateau. The papers of this fourth Proceedings contribute to the ever growing pool of scientific data that provides baseline scientific information pertaining to physical, cultural, and biological resources of the Colorado Plateau. Support for many of these studies have come from a spectrum of federal, state, and private partners concerned about the well-being of the Plateau's resources. I applaud the effort of the contributors. With modest funding and a broad base of public and institutional support, these authors have pursued important lines of work in the four states (Arizona, Utah, New Mexico and Colorado) that comprise the Colorado Plateau biogeographic region.

There remains much to be done. As a people, we face the prospect of extensive local and global environmental changes that continue to perturb the physical, cultural, and biological resources on lands of the Colorado Plateau. As the research branch for the Department of the Interior, we in the USGS are committed to identify, in a sound scientific manner, information that can be used by land managers to protect our resources from detrimental change due to modern human influences. We must develop the information necessary to alert our managers, leaders, and the public to the importance of their natural surroundings as elements of those basic resources that sustain us, inspire us, and represent our natural biological and environmental heritage. Our task has just begun.

Dennis B. Fenn
Chief Biologist
U.S. Geological Survey

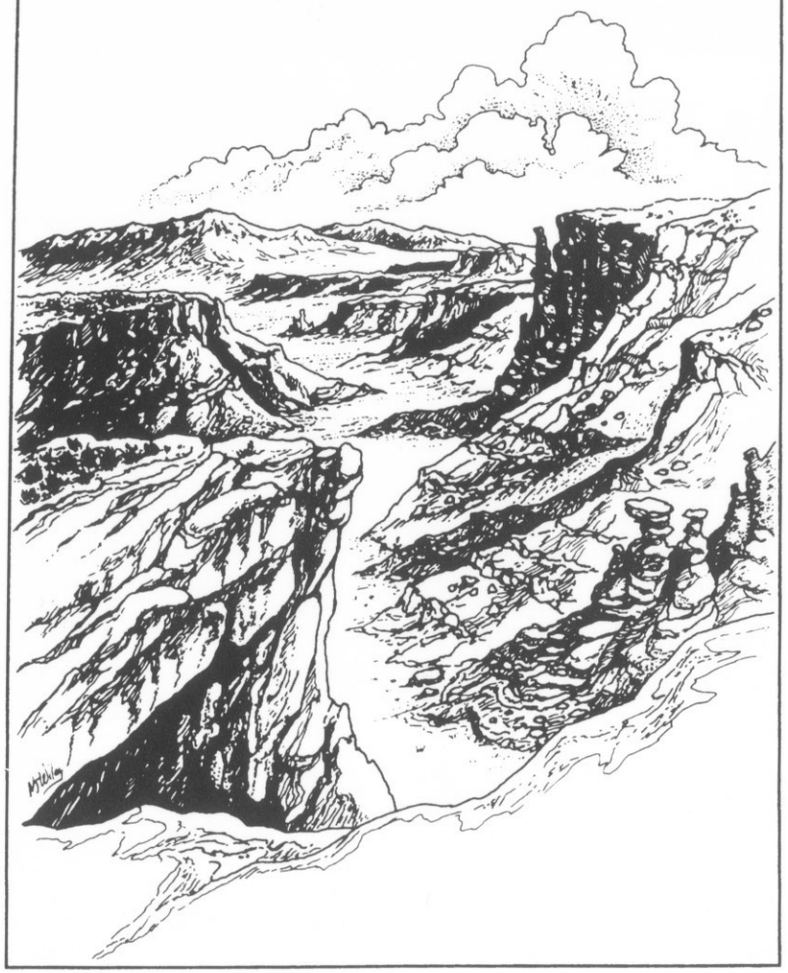
Dedication
to
Dr. Henry O. Hooper



This Proceedings of the Fourth Biennial Conference of Research on the Colorado Plateau is dedicated to Dr. Henry O. Hooper. Dr. Hooper has been an integral part of the growth and success of USGS Colorado Plateau Field Station (CPFS) and other federal partnerships on the Northern Arizona University (NAU) campus. After an illustrious career as a professor of Physics at Wayne State University and then the University of Maine, Dr. Hooper came to Arizona in 1981 as Associate Vice President for Academic Affairs and Graduate Dean. In 1989, Dr. Dennis Fenn of the National Park Service approached NAU regarding the possibility of placing a National Park Service Cooperative Park Studies Unit (CPSU) on campus. Dr. Hooper took an immediate interest in this matter, and continued to support, both financially and in concept, the CPSU at Northern Arizona University. For his efforts, in 1993 Dr. Hooper was awarded the NPS Regional Director's Natural Resources Award for his involvement with the CPSU.

In the fall of 1993 the CPSU was transferred to the newly created National Biological Service, and then in 1997 to the U.S. Geological Survey. Dr. Hooper met each change with the same enthusiasm that he directed to the former CPSU. Throughout this 1993-1998 transition period, Dr. Hooper devoted additional time and energy to assure that the Colorado Plateau Biennial Conference was continued on the NAU campus. His energies also contributed to the quality of the Biennial Conference Proceedings Series. Without the continued support of Dr. Hooper, the Colorado Plateau Biennial Conference Proceedings would not have been a continuous reality. As Dr. Hooper moves into retirement, following the 1999 academic year, it is important that we remember and recognize the contributions that he has made to science and research at NAU, to the USGS Colorado Plateau Field Station, and to federal, state and private land managers throughout the Colorado Plateau.

Introduction



Introduction to the Proceedings of the Fourth Biennial Conference of Research on the Colorado Plateau

The 13 chapters in this book were selected from the 75 research papers presented at the Fourth Biennial Conference of Research on the Colorado Plateau. The theme of this meeting centered around research, inventory, and monitoring on lands over the Colorado Plateau, with a focus on the newly created BLM Grand Staircase-Escalante National Monument. The conference, held on 15-18 September 1997 in Flagstaff, Arizona, was hosted by the USGS Forest and Rangeland Ecosystem Science Center Colorado Plateau Field Station (CPFS) and Northern Arizona University.

This is the fourth volume in a planned series of Colorado Plateau Proceedings, highlighting research and resource management efforts related to physical, cultural and natural resources within the biogeographic province of the Colorado Plateau. Many of the protocols and management techniques presently being utilized in land management units over the Colorado Plateau are a result of collaborative work between CPFS staff, university and agency scientists, and land managers. The scientific work published in this Proceedings Series contributes significantly to those collaborative efforts. It has been clearly demonstrated that, because of similarities across the Colorado Plateau, techniques that work in one management unit are applicable to other units throughout the province, and possibly to other areas of the country that have similar habitat and climatological parameters.

Each paper selected for publication in this Proceedings represents original research and has been peer reviewed by scientists of that particular research discipline. The papers are divided into two major sections: I. those that deal with **Biological Resources**; and, II. those addressing **Cultural Resources**. The Biological Resources section comprises the first 9 chapters of this book, with the first three chapters dealing with vegetation and the next six with studies of animal ecology. The final four chapters fall under Cultural Resources, evenly divided between archeology and policy chapters pertaining to human perceptions of managing cultural resources.

I. Biological Resources

It is fitting to begin this section, and in particular the book, with a chapter dealing with a unique aspect of the Colorado Plateau. The paper by Cole and Murray describes Holocene vegetation of Capital Reef National Park from packrat midden analyses. Fossil packrat middens are valuable sources of paleoecological information in arid regions of the southwest. On the Colorado Plateau, information on pre-settlement vegetation is often lacking, and analyses of packrat middens allow researchers to reconstruct these earlier vegetation communities. Such was the objective of this first paper, in that Capitol Reef National Park needed a baseline of vegetation community information from which to construct restoration guidelines. Information from packrat middens allowed Cole and Murray to demonstrate that the present vegetation community is apparently an artifact of overgrazing. The chapter clearly documents that vegetation species lost since pre-settlement were those that were more palatable to large herbivores. In fact, the authors argue that in their reconstruction of vegetation communities, some species reached their lowest levels in the past 5,400 years. Conversely, species typical of present-day over grazed ranges on the Colorado Plateau, were not present in the earlier packrat midden record. The authors also feel that the increase in Utah juniper (*Juniperus osteosperma*) pollen in their middens records over that past 200 years, has probably been a result of fire suppression at Capitol Reef National Park.

The second chapter of the Biological Resources section also examines vegetation changes, but in this instance switches time-frames, examining only historical forest structure. Garrett and Soulen provide an analysis of the changing over-story density of the Apache/Sitgreaves National Forest in eastern Arizona. They examine tree-density data from surveys in 1911, 1967, 1988 and 1994, concluding that the density of trees per acre has increased dramatically in all size classes up to 20" dbh. Computer simulated treatments utilizing analyses with a Geographic Information System, revealed that agencies would realize enhanced positive values if tree densities in the forests were brought into line with pre-settlement conditions.

The final vegetation chapter by Floyd-Hanna et al. deals with vegetation response to fire at Mesa Verde National Park. The authors document their efforts at monitoring vegetation response and mitigation to the lightning-initiated 'Chapin 5' fire in August 1996. The 4,781 burned

acres were divided into 7 pre-fire vegetation communities and 2 principal geological substrates for monitoring purposes. Subsets of these 9 areas were monitored, and either aerially seeded or had mechanical removal of alien plant species. The authors demonstrated multiple pathways of native vegetation recovery from the 1996 fire, but also feel that in certain areas alien plants now dominate the landscape and are preventing the recovery of native vegetation communities. This will certainly present a challenge to the 'noxious weed' initiative of Mesa Verde National Park.

Chapter #4 of the Biological Resources section provides a transition into wildlife management, where Wakeling et al. examine the performance of aerial forward-looking infrared (FLIR) surveys on cattle, elk, and turkeys in the forests of northern Arizona. Wildlife managers are often challenged by techniques needed to determine total numbers of animals, whether it be for carrying capacity or in order to set hunting season bag limits. Aerial FLIR surveys became popular because they seemed to standardize and objectively survey large wildlife species without bias. Wakeling et al. conducted FLIR tests on known number of cattle, known turkey roosts, and known locations of elk herds using replications with fixed wing aircraft and then helicopters. Their findings demonstrate that FLIR is not yet suitable for small animals such as turkeys, and that not all large animals are observed. The authors recommend against the use of FLIR as a sole estimate of large-bodied wildlife species in Arizona, until correction factors for target species, timing, and habitat can be developed.

In the next chapter, Sisk et al. provide a unique insight into how they have developed a 'management team' approach to shape an experimental research program that examines the livestock grazing debate on the Colorado Plateau. The authors base their chapter on the assumption that domestic livestock grazing is the most pervasive human impact on lands of the Colorado Plateau. In fact, ranching versus environmental interests have made livestock grazing the most contentious issue in the southwestern United States. The authors feel that this polarization of interests has come about because there is a lack of scientifically sound, defensible information to support either side of the issue. Sisk et al. provide a plan of action where they take the claims of each interest group, reformulate these claims into testable hypotheses, and then provide research designs for each of the hypotheses. This chapter exemplifies a modern-day ap-

proach on how science must deal with volatile social issues, if there is ever to be any hope of bringing disparate groups together so that a solution can be reached which is acceptable to all parties.

Chapters #6 and #7 move into more wildlife specific information, both being radio telemetry studies that examine behavior of mammals. Lema et al. examine the social behavior of Abert's Squirrels (*Sciurus aberti*) in Chapter #6, presenting the results of a 12 month study on radio-collared squirrels near Flagstaff, Arizona. They demonstrate, for the first time, that this species exhibits extensive social behavior. According to the authors, it was previously believed that Abert's squirrels were solitary animals. Lema et al. found pairs and trios of squirrels occupying communal nests that included male/female and male/male combinations of varying age classes. They also found, in over half their observations, that more than one Abert's squirrel occupied a tree. The authors conclude this chapter suggesting that communal nesting behavior among Abert's squirrels may facilitate thermoregulation, and that this type of nesting and tree sharing may reinforce social bonding and resource sharing. In Chapter #7, Siders et al. examine foraging distances of two uncommon bat species on the Kaibab Plateau in northern Arizona. This radio telemetry study determined the foraging areas of seven lactating female spotted bats (*Euderma maculatum*), documenting daily movements of up to 42 km. It appears that although the bats forage in locations at 2500 m elevation, they prefer to day roost at lower elevations (e.g., approximately 1000 m elevation). The authors also provide information on maternity roosts and relative numbers of 18 bat species captured from between 1994 and 1998.

The final two biological chapters deal with studies of Merriam's turkeys. In Chapter #8 Wakeling and Goodwin examine over-winter survival of turkeys in the North Kaibab region of Arizona. During 1996, several severe fires occurred on the Kaibab Plateau, and the authors wanted to examine, with radio-collared birds, the potential influence of these fires on over- winter survival. They found significantly higher mortality in this area of Arizona in 1996 when compared to other regions of the state. First-year birds were more greatly affected, with a mortality rate of 90% versus 34% in adult females. All cohorts of turkeys experienced the greatest mortality between January and March, and the authors attribute the increased mortality to deep snow and limited food availability. This study supports the contention that winter food availability is closely

tied with turkey over-winter mortality. In the last chapter of the Biological Resources section, Rogers et al. examine the impact of U.S. Forest Service transportation corridors on male turkey distributions. The authors found that turkeys avoided locations less than 200 m from roads, for all resightings and for all roost sites. However, improved high-traffic roads had a much greater negative influence than did unimproved, low-traffic roads. They were not able to ascertain what level of road use that turkeys found unacceptable.

II. Cultural Resources

Chapter #10 begins the Cultural Resources section of this book, with a study by Fawcett and Latady on an archeological survey of Black Ledge, a mesa immediately adjacent to Coombs site, the largest ancestral pueblo village in south-central Utah. The authors use archeological data from Black Ledge (principally lithic artifacts and site settings) to examine potential reasons for a prehistoric shift from formal (bifacial) technology to expedient (core) technology. In other words, they examined the question of why nomadic people of the Colorado Plateau settled into a more sedentary style of living. The theme of this chapter is the comparison of Late Archaic sites of mobile hunter-gathers with the equally ephemeral sites created largely by women, as they harvested, processed and transported wild resources for use during the Late Formative period. Fawcett and Latady conclude that their survey data support the same shift in organization of prehistoric lithic technology (from bifaces to cores) on the Colorado Plateau, that has been observed in many other places throughout the southwestern United States and around the world.

An archeological survey of Cedar Breaks National Monument in southern Utah, is the theme of Chapter #11. Canaday et al. subdivide their survey work at Cedar Breaks into two discrete locations of the Markagunt Plateau: those areas below 9,200 feet and those above 10,000 feet elevation. They found little prehistoric use in the lower site, but demonstrated extensive use of the higher elevations over the past 4,000 years. Procurement of chert from the Brian Head Formation for hunting purposes appears to have been the primary activity. The authors have also initiated a number of ancillary studies, such as trace mineral analyses and palynological (pollen) studies from a peat bog, to provide a better understanding of prehistoric use of Cedar Breaks and the Markagunt Plateau.

Chapter #12 provides a transition from purely archeological studies to human policy surrounding cultural resources. Balsom summarizes the benefits and drawbacks of the Spring 1996 'Experimental Habitat Building Flow' in Grand and Glen Canyons. In particular the potential loss/preservation of cultural resources from higher water volume releases of Glen Canyon Dam is examined. From 45 previously recorded sites, four were chosen to measure potential impacts on archeological resources. The author's overall conclusion was, with a few cautions, that habitat building flows were beneficial to the cultural resources along the Colorado River in Grand and Glen Canyon National Parks.

The final chapter of the Fourth Biennial Conference Proceedings is that of Nie, who examines the debate over establishment of wilderness in Utah, and particularly the Grand Staircase-Escalante National Monument. Through a number of personal interviews and a compilation of newspaper articles and federal legislation, the author weaves a complex picture surrounding the debate over Southern Utah Wilderness and how this fits into the framework of the 'true' West. It is apparent from this treatise that issues on the southern Colorado Plateau, and in particular Utah, transcends solely environmental protection, to a plethora of regional-specific themes and concerns. Nie argues that placing the debate only in terms of wilderness acreage is overly simplistic, and that one has to examine more closely the values of the local residents and focus on culture and place. It is only once these dimensions of cultural values are included in the equation, can the wilderness debate on the Colorado Plateau be understood and the conflict diminished.

Acknowledgments

Any Proceedings is never a single effort, but a direct result of work by many individuals. This Fourth Proceedings is no exception. The dedicated Colorado Plateau Field Station staff (T. Arundel, K. Cole, M. Debold, E. & P. Deshler, C. Drost, K. Estes, J. Grahame, J. Hart, S. Jacobs, M. Johnson, E. Nowak, E. Paxton, A., A., & M. Rasmussen, M. Sogge, K. Thomas, V. Tondini, and D. Willey) provided much needed assistance during the conference. I would especially like to thank Maureen Stuart, who spent many hours of editorial assistance with the final drafts of each chapter and coordinated with GPO during the publication phase. Thanks are also extended to the many reviewers who unselfishly devoted their time and efforts to improving each chapter. The financial support that Drs. Michael Collopy and Henry Hooper provided for publication

of this Proceedings is greatly appreciated. Finally, I express deep appreciation to my wife Sandy, and our children Jacqueline, Kimberly, Carena and Charles IV for their support and understanding during the time that this Proceedings was in production.

This book, like the products of other symposia that are centered around a particular theme, should help to focus attention on some of the research presently being conducted on lands of the Colorado Plateau. In particular, it is hoped that the new BLM Grand Staircase-Escalante National Monument will be able to utilize some of the ideas and concepts presented within the Biennial Proceedings, to launch their efforts toward management and stewardship of their newly created lands on the Colorado Plateau. Finally, if the material in this volume, as that contained in previous Biennial Conference Proceedings, can act as a stimulus for future support of research and management of physical, cultural, and natural resources over the Colorado Plateau, it will make the organizational and editorial work of the past two years a worthwhile and productive effort.

Charles van Riper III

Station Leader, USGS/BRD
Forest and Rangeland Ecosystem Science Center
Colorado Plateau Field Station