Second U.S. Geological Survey Wildland Fire Workshop

Los Alamos, New Mexico
October 31–November 3, 2000

By J.L. Coffelt and R.K. Livingston

U.S. GEOLOGICAL SURVEY

Open-File Report 02–11

Denver, Colorado
2002

U.S. DEPARTMENT OF THE INTERIOR
GALE A. NORTON, Secretary

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

The use of firm, trade, and brand names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

For additional information write to:

Regional Director, Central Region
U.S. Geological Survey
Box 25046, Mail Stop 150
Denver Federal Center
Denver, CO 80225–0046

Copies of this report can be purchased from:

U.S. Geological Survey
Information Services
Box 25286
Denver Federal Center
Denver, CO 80225

Participants in the Second U.S. Geological Survey Wildland Fire Workshop, October 31–November 3, 2000, Los Alamos, New Mexico.

Second U.S. Geological Survey Wildland Fire Workshop Los Alamos, New Mexico October 31–November 3, 2000

Preface

Historical Perspective

Prior to European settlement, Native Americans actively used fire for altering vegetation patterns and for other environmental purposes. This human influence on the environment shifted after European settlement in North Ameria, when it was believed that fire, unlike other natural disturbance phenomena, could and should be controlled. This belief was reinforced by several severe fires that occurred in the early 1900's, particularly the "Big Blowup" in Idaho in August 1910. The Big Blowup consumed 3 million acres in northern Idaho and western Montana and killed 85 people. Within a year of this fire, the U.S. Forest Service firefighting program was born, and all wildfires were extinguished as soon as possible. Wildfires in the lower 48 States decreased from about 40 to 50 million acres a year in the early 1930's to about 5 million acres in the 1970's. While the potentially deadly aspect of fire was obvious and immediate, the ecological changes and long-term risks resulting from fire suppression and exclusion mounted slowly and inconspicuously over many decades.

The effects of fire-suppression policies became most apparent in the aftermath of the Yellowstone National Park fires in 1988 and the 1994 Storm King Mountain fire in Colorado that, in total, claimed the lives of 34 firefighters. Scientists studying these and other recent fires concluded that century old fire-suppression policies were greatly increasing the risks of catastrophic wildland fires.

Year 2000 Fire Season

In the winter and spring of 2000, a weather phenomenon known as "La Niña" created unusually dry conditions along the southern portion of the United States, from California to Florida. La Niña created a pattern of dry, hot weather that contributed to record-low fuel moisture and dry vegetation. These dry conditions, coupled with the previous "El Niño" that created increased fire fuels and the cumulative effects of many decades of fire-suppression policies, made the potential for wildland fires extreme. As the summer developed, drought conditions persisted in several States, and very high to extreme fire-danger indices were reported throughout the West. Thunderstorm-caused wildland fires developed in a dozen States. By November 15, 2000, the country had experienced 90,674 fires that burned over 7 million acres. The National Interagency Fire Center reported that 861 structures had been lost, 30,000 firefighters and support personnel (including firefighters from Canada, New Zealand, and Australia) had been activated, and 1.6 billion dollars had been expended in firefighting activities. The 2000 fire season was the worst in 90 years.

Current Perspective

In the past decade, fire-management policies have shifted to embrace the reduction of long-term building of excessive fuel levels in the Nation's forests and rangelands. In 1995, the Departments of Agriculture and the Interior issued the Federal Wildland-Fire Policy Statement (Appendix A) identifying the critical role that fire can play in the management of forests and rangelands. As a result of revised policy, Federal agencies have increased the acres treated to reduce fire risk through "prescribed" fires and thinning techniques from 500,000 acres in 1995 to more than 2.4 million acres in 2001.

- A recommendation that a USGS Fire Initiative for fiscal year 2002 be developed and presented as an integrated component of the fire-management programs of the five principal fire-science agencies;
- A recommendation that more USGS personnel obtain fire-safety training and "red cards" in order to be available to provide scientific expertise at fire sites; and
- Recognition that the USGS must demonstrate a high level of commitment to fire science by establishing liaison positions, increasing funding for fire-related activities, and designating emergency-response teams.

As a result of the workshop and other fire-related activities, the USGS is moving forward on several fronts to more clearly define and integrate a fire-science program. The following principal efforts have been made since the conclusion of the workshop:

1. A draft MOU (Appendix F) with the five principal fire-science agencies has been prepared.
2. The USGS has responded positively to the establishment of an Interagency Research Coordination Committee that would better define the role of each agency with regard to fire-research needs. The USGS would be a member of this committee.
3. The USGS has developed a Fire Initiative for fiscal year 2002.
4. The USGS has established a group of regional wildland-fire coordinators.

Second U.S. Geological Survey Wildland Fire Workshop Los Alamos, New Mexico October 31–November 3, 2000

Preface

Historical Perspective

Prior to European settlement, Native Americans actively used fire for altering vegetation patterns and for other environmental purposes. This human influence on the environment shifted after European settlement in North Ameria, when it was believed that fire, unlike other natural disturbance phenomena, could and should be controlled. This belief was reinforced by several severe fires that occurred in the early 1900's, particularly the "Big Blowup" in Idaho in August 1910. The Big Blowup consumed 3 million acres in northern Idaho and western Montana and killed 85 people. Within a year of this fire, the U.S. Forest Service firefighting program was born, and all wildfires were extinguished as soon as possible. Wildfires in the lower 48 States decreased from about 40 to 50 million acres a year in the early 1930's to about 5 million acres in the 1970's. While the potentially deadly aspect of fire was obvious and immediate, the ecological changes and long-term risks resulting from fire suppression and exclusion mounted slowly and inconspicuously over many decades.

The effects of fire-suppression policies became most apparent in the aftermath of the Yellowstone National Park fires in 1988 and the 1994 Storm King Mountain fire in Colorado that, in total, claimed the lives of 34 firefighters. Scientists studying these and other recent fires concluded that century old fire-suppression policies were greatly increasing the risks of catastrophic wildland fires.

Year 2000 Fire Season

In the winter and spring of 2000, a weather phenomenon known as "La Niña" created unusually dry conditions along the southern portion of the United States, from California to Florida. La Niña created a pattern of dry, hot weather that contributed to record-low fuel moisture and dry vegetation. These dry conditions, coupled with the previous "El Niño" that created increased fire fuels and the cumulative effects of many decades of fire-suppression policies, made the potential for wildland fires extreme. As the summer developed, drought conditions persisted in several States, and very high to extreme fire-danger indices were reported throughout the West. Thunderstorm-caused wildland fires developed in a dozen States. By November 15, 2000, the country had experienced 90,674 fires that burned over 7 million acres. The National Interagency Fire Center reported that 861 structures had been lost, 30,000 firefighters and support personnel (including firefighters from Canada, New Zealand, and Australia) had been activated, and 1.6 billion dollars had been expended in firefighting activities. The 2000 fire season was the worst in 90 years.

Current Perspective

In the past decade, fire-management policies have shifted to embrace the reduction of long-term building of excessive fuel levels in the Nation's forests and rangelands. In 1995, the Departments of Agriculture and the Interior issued the Federal Wildland-Fire Policy Statement (Appendix A) identifying the critical role that fire can play in the management of forests and rangelands. As a result of revised policy, Federal agencies have increased the acres treated to reduce fire risk through "prescribed" fires and thinning techniques from 500,000 acres in 1995 to more than 2.4 million acres in 2001.

The fire events during the summer and fall of 2000 emphasized the need for cooperative efforts among all Federal agencies in planning for, and managing, wildland fires. The number and size of fires throughout the Western United States provided evidence that past land-use practices and vigorous fire suppression and exclusion policies need to be revised to decrease the potentially devastating effects of high fuel loads in drought-affected areas.

Federal Wildland-Fire Policy

On August 8, 2000, President Clinton asked the Secretaries of Agriculture and the Interior to prepare a report that recommended how best to respond to the year's severe fires, reduce the impacts of these wildland fires on rural communities, and ensure sufficient firefighting resources in the future. The Secretaries' response to the President (Appendix A) was published on September 8, 2000, and contained five key recommendations:

1. Continue to make all necessary firefighting resources available;
2. Restore damaged landscapes and rebuild communities;
3. Invest in projects to reduce fire risk;
4. Work directly with local communities; and
5. Be accountable and establish oversight, coordination, program development, and monitoring to ensure objectives are met.

In response to these recommendations, Congress appropriated 1.8 billion dollars to the Departments of Agriculture and the Interior for support of fire-prevention efforts in the United States.

CONTENTS

FIGURES

U.S. Geological Survey Wildland Fire Workshop Los Alamos, New Mexico October 31–November 3, 2000

INTRODUCTION

This report summarizes the program and outcomes of the Second U.S. Geological Survey (USGS) Wildland Fire Workshop held on October 31–November 3, 2000, at Los Alamos, New Mexico.

This workshop was planned to build on the accomplishments and recommendations of the first USGS Wildland Fire Workshop held at the EROS Data Center in Sioux Falls, South Dakota, July 9–10, 1997. Activities within the USGS in the area of fire science have increased substantially since that first workshop. The second workshop and this report represent additional steps toward enhancing the visibility and effectiveness of USGS fire-related activities. A Web site also is being developed.

The primary objective of this second workshop was to provide an opportunity for exchange of information on current fire-science activities and research needs as the basis for future research and for USGS support to other Federal agencies. To achieve that objective, the workshop had the following additional purposes:

- Review current U.S. Forest Service wildland-fire-science activities, issues, and policies among USGS and other Department of the Interior (DOI) agencies;
- Increase understanding of the science, technology, and research needs of the fire-management community;
- Enhance communications among USGS researchers working on wildland fires; and
- Increase dialog between the USGS and other Federal agencies involved in fire science and management.

Workshop attendees (Appendix B) included scientists and program managers from the USGS who have been involved in fire-related research, as well as operational and research representatives of the Federal fire-management agencies.

SUMMARY OF THE SECOND WILDLAND FIRE WORKSHOP

The Central Region, Office of the Regional Director, hosted the Second Wildland Fire Workshop, which was held at Los Alamos, New Mexico, October 31 through November 3, 2000 (Appendix C). In addition to over 70 USGS scientists engaged in fire-related research and managers of organizational units involved in some aspect of wildland-fire activities, the workshop was attended by about 20 representatives of the following Federal agencies:

- Bureau of Land Management
- U.S. Environmental Protection Agency
- U.S. Department of Agriculture (USDA)—Forest Service
- National Park Service
- Bureau of Indian Affairs
- U.S. Fish and Wildlife Service
- Federal Emergency Management Agency
- USDA—Natural Resource Conservation Service

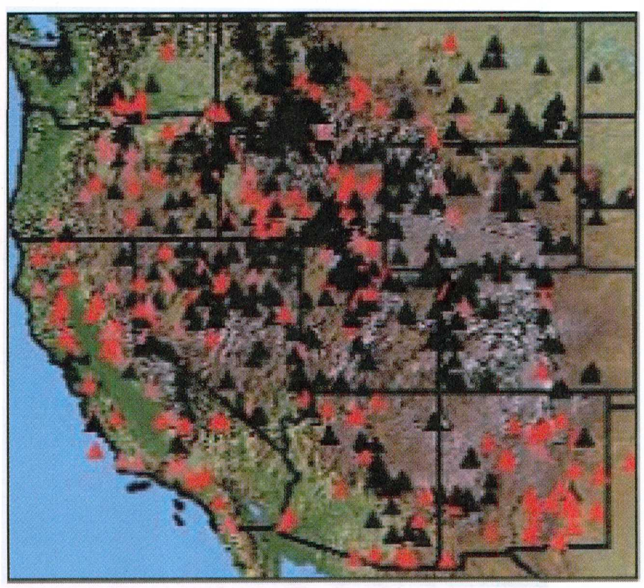

Figure 1. Locations of principal wildland fires during January–October 2000 in the western portion of the United States (source: http://www.nifc.gov/fireinfo/firemap.html).

The 4-day meeting began with presentations by most of these Federal agencies regarding their needs for fire-science support. Following these presentations, 25 poster and 17 presentations (Appendixes D and E) were presented in which past, ongoing, and future activities were described. Two field trips to recently burned areas associated with the Cerro Grande Fire near Los Alamos also were conducted (figs. 2 and 3). The field trips were followed by four "breakout" discussions in which participants discussed the future needs for wildland-fire-science research and technical support. The complete final agenda for the workshop is given in Appendix C.

Federal Agency Needs

The workshop began with two panel discussions on information needs of the participating, non-USGS agencies. The following briefly summarizes the major fire-science needs expressed during the panel discussions, which were moderated by John Moody, Research Hydrologist with USGS.

Bureau of Land Management

Presented by Dr. John Haugh, Senior Scientist:

- Historical knowledge (fire history)
- Vegetation maps—fuels reduction, pre-positioning of suppression resources, data standards
- Relation of fire to post-fire management to subsequent fire activity
- Questions on post-fire treatments/restoration techniques (soils, precipitation, plant competition, seed/plant assemblages, evaluation of rehabilitation effectiveness, and so forth)
- Relation of prescribed fires to fuels reduction (mechanical control, chemical control, and so forth)
- Use of fire to control invasive species (pinyon juniper, tamarisk, annual grasses, and so forth)
- Resistance/resilience of native species to fire (responses of sagebrush, endangered plants, effects on animals, and so forth)
- Effects of fire on watersheds in arid environments (infiltration characteristics, water-quality effects, threatened and endangered species, fire severity, and so forth)

Figure 2. Cerro Grande fire, Los Alamos, New Mexico, as seen by Landsat 7, May 15, 2000.

Figure 3. Field trip to an area burned during the Cerro Grande fire.

- Prescribed-fire treatments and forest health on Bureau of Land Management lands—reduce stand density, restore biodiversity, control of weeds and exotics

U.S. Environmental Protection Agency

Presented by Dr. Dwight Atkinson, Director of Atmospheric-to-Water Modeling:

- Erosion as function of fire severity, soil characteristics, topography, and so forth
- Validation of erosion models
- Use of GIS to map fire risks
- Dynamic fire-risk modeling
- Water-quality issues in areas of high-erosion potential (abandoned mined lands and natural)
- Atmospheric contaminants resulting from wildfires

Joint Fire Science Program

Presented by Bob Clark, Manager of the Joint Fire Science Program:

- Applied research regarding fuels management
- Technology transfer (fuel-related information/tools)
- Fire behavior
- Fuels management
- Optimization of USGS' capabilities regarding invasives, threatened and endangered species, hydrology, mapping, and so forth
- Social aspects of wildland fires

USDA—Forest Service

Presented by Dave Cleaves, National Program Leader for Fire Systems Research:

- Technology transfer
- Evaluation of uncertainty associated with decision making
- Synthesis of data and research
- Monitoring and program design
- Access to discipline specialists, such as biologists and hydrologists
- Early warnings of increased risk of wildland fire
- Change in post-fire sediment yield—erosion, prediction, and downed trees impact
- Change in flood risk (models for streamflow increases)
- Effectiveness of post-fire channel treatments
- Monitoring post-fire treatments
- Water chemistry (changes, effects on aquatics, and so forth)
- Social sciences/community issues
- Rehabilitation/recovery
- Emergency response
- Pre-fire issues

National Park Service

Presented by Tom Zimmerman, Fire Science and Ecological Applications Program Leader:

- Technical assistance regarding development of fire-management plans
- Technology transfer
- Social-science aspects—fuels-management acceptability, fire-management plans
- Help in establishing priorities regarding protection of life and property
- Fire history
- Role of invasives
- Link between fire-management policy and land/resource management
- Ability to evaluate "risk" (safety, political, and so forth)
- Economic impacts of fire-management program
- Science-based decision making (fuels-management plans)—GIS, threatened and endangered species, technology transfer, and so forth
- Air-quality modeling
- Standardization of sampling and monitoring protocols
- Help on research component of fiscal year 2001 fires funding
- Information transfer (science level to management level)

Bureau of Indian Affairs

Presented by Hal Luedtke, Fuels Program Manager, Southwestern Region:

- Need participation on Burned Area Emergency Rehabilitation (BAER) teams for preparing BAER plans (USGS needs more experience in fires and fire behavior)
- Better GIS-based data (for example, soils)
- Baseline water-quality data
- Remotely sensed information as basis for rehabilitation planning
- Better hydrologic and biologic models to predict risks associated with management alternatives
- Cultural impacts as result of lands affected by wildfire
- Early warning systems (hydrologic and geologic hazards)
- Better stabilization treatments, especially at urban interface
- Reseeding (what is the value, specifically with native seeds?)
- Urban interface issues
- Use of pre-treatments (for example, use of herbicides and thinning)
- Noxious weed and soil responses
- Hazardous-fuels reduction
- Better pre-treatment
- Remote sensing (for example, smoke)
- Better vegetation/fuels maps

U.S. Fish and Wildlife Service

Presented by Bill Leenhouts, Fire Ecologist with the National Interagency Fire Center:

- Effectiveness of prescribed fire as a tool for habitat management
- USGS as partner to provide technical support (especially with regard to design of monitoring protocols and adaptive-management strategies)
- Long-term monitoring of post-fire effects
- Synthesis of science literature—field-management perspective
- Identification of effective post-fire rehabilitation techniques
- USGS as partner in post-fire decision making relative to rehabilitation (BAER teams)
- Broad (holistic) landscape-scale investigations of effectiveness of post-fire management

Office of the Secretary, Department of the Interior

Presented by Dr. Jim Douglas, Wildland Fire Program Coordinator:

- USGS needs to increase efforts to communicate its capabilities and interest
- Continue efforts to integrate across disciplines and geographic areas
- Expand social sciences aspects to enhance and round out approaches (controlled experiments, results/impacts of decisions, and so forth)
- Establish working relationships with other agencies in the fire-management community

Overviews of U.S. Geological Survey Activities

Following the presentations by the various Federal agencies regarding their programs and areas of technical support relative to fire science, a representative of each USGS discipline presented an overview of the fire-science activities and capabilities within their discipline. The presenters were:

- Biological/Ecologic Overview—Susan Grace, Research Ecologist
- Cartographic/Geographic Overview—John Kelmelis, Chief Scientist for Geography
- Hydrologic Overview—Julio Betancourt, Research Physical Scientist
- Geologic Overview—Susan Cannon, Research Geologist

These presentations highlighted USGS science activities and capabilities relative to wildland-fire issues, which provide a strong foundation for strengthening future fire-science programs.

Field Trips and Poster Session

Two half-day field trips were a part of the workshop and were used as an opportunity for participants to see firsthand the devastation that resulted from the Cerro Grande fire, which occurred about 6 months prior to the workshop. The first field trip, hosted by Craig Allen, Research Ecologist with USGS, focused on an overview of fire-science issues. Using the Los Alamos landscape as a backdrop, a region subjected to a number of recent wildfires including the La Mesa, Doere, and Cerro Grande fires, Dr. Allen's presentations covered topics ranging from historical changes in forest ecosystems to post-fire rehabilitation (fig. 4). The second field trip was hosted by Susan Cannon, Deborah Martin, and John Moody, researchers with USGS. This trip to Upper Rendija Canyon focused on watershed response to wildfires and included topics such as infiltration, runoff, erosion, sediment transport and deposition, and biological changes.

A poster session was held as part of the workshop. The session included 26 posters, the abstracts for which are presented in Appendix C.

Technical and Breakout Sessions

The next segment of the workshop was four technical sessions, each followed by a breakout session. The four sessions were:

- Session I—Tools and Techniques
- Session II—Post-Fire Watershed Response: Physical and Biological
- Session III—Post-Fire Watershed Response: Chemical
- Session IV—Large-Scale Integrated Approaches

Figure 4. Aftermath of Cerro Grande fire.

The abstracts for each of the 17 technical presentations given during the four sessions are shown in Appendix E.

The breakout sessions provided a forum for discussion and examination of the future role that USGS could provide regarding wildland-fire research and technical support. For each session, the objective was to identify the needs of the wildfire community to improve upon:

- Decision making relative to prescribed fires, forest thinning, and fire-hazard-reduction measures;
- Emergency response during wildland fires; and
- Mitigation efforts after forest fires, including hazard reduction, landscape stabilization, and watershed rehabilitation.

The following is a brief summary of each of these breakout sessions:

Breakout Session I—Tools and Techniques

Discussion topics for this session:

- What tools and techniques should USGS acquire, develop, or enhance in order to scientifically evaluate rehabilitation treatments?
- How can existing tools, techniques, and capabilities be integrated into a USGS science program?
- What are the important tools and techniques that can be used to facilitate USGS interaction with the BAER team on post-fire activities?

The team felt that in an environment of partnership with other Federal agencies involved in fire science, the USGS should explore the following:

- Protocols
- Mentorships
- Modeling capabilities
- Databases, including integration of non-USGS data
- "Red card" certification for some employees, which would allow participation on BAER teams
- Formation of a liaison group
- Development of increased capability for information dissemination (clearinghouse?)

Breakout Session II—Post-Fire Watershed Response: Physical and Biological

Discussion topics for this session:

- Should the USGS expand its programs on the ecological effects of wildfires?
- What is the appropriate scale to study this response, or should it be at different scales at the same time?
- Should the USGS develop a program to scientifically evaluate rehabilitation treatments?
- What is the appropriate scale to evaluate rehabilitation treatments—hillslope or watershed scale?
- If the USGS were to develop a program to assess post-fire hazards, what would the program consist of and at what scale would it be scoped?
- What are the important post-fire physical and biological components or processes that should be studied that are not being covered by other agencies?
- What processes could be studied best by collaborating with other agencies?

The team developed the following three themes to be considered for a USGS strategic plan:

1. Integrated study of post-fire landscape response

- Predictive models and tools for hazards assessment
- Plant community response, particularly invasive species
- Study of carbon and nutrient flux
- Threatened, endangered, and at-risk species
- Wildlife
- Stream channel
- Decision-making processes
- Economic and human benefits
- Modeling physical processes

2. Effectiveness and consequences of post-fire treatments and fire-management technologies

- Use of post-fire treatments as experimental study sites
- Focus on wildland-urban interface, including effects of land-use change
- Channel treatments
- Development of new techniques

3. Fire Ecology

- Baseline pre-fire information
- Fire history
- Landscape ecology relative to wildland fire
- Fire as a natural process
- Response of plant and animal populations

Breakout Session III—Post-Fire Watershed Response: Chemical

Discussion topics for this session:

- What are the important chemical constituents for a water-quality sampling program after wildfire?
- What factors determine which of these constituents are important and thus affect the decision process?
- Water-quality changes are probably transient after a wildfire; how can the USGS be prepared to act immediately after a wildfire?

The team developed the following four themes to be considered for a USGS strategic plan:

1. Data collection, both short and long term

- Protocols
- Pre- and post-fire
- Aquatic habitat
- Sediment
- Ash

2. Watershed characterization

- GIS coverages
- "Contaminated" areas, such as mined lands
- Baseline data

3. Basic research

- Soil properties
- Aquatic effects
- Persistence in the environment

4. Natural compared to "man-induced" ecosystem changes

- Response to fire-retardant chemicals
- Response of wildlife to prescribed burning

Breakout Session IV—Large-Scale Integrated Approaches

Discussion topics for this session:

- What current programs can the USGS build upon to provide the foundation for larger scale, integrated studies?
- What are the major components of an ecosystem response to a wildfire program if new money is available rather than reprogrammed money?
- In what fields should new hires be pursued to make an ecosystem response to a wildfire program in the USGS recognized as a leader in the fire-science community?
- What is the primary USGS role relative to addressing wildfire-science needs?

The team developed four themes to be considered for a USGS strategic plan:

1. Analysis of past-fire history

- Social-science component
- Long-, medium-, and short-term records
- Consistent record keeping
- Accessible information
- Inclusion of non-forested regimes
- Relationship between "natural" fire recurrence and climate change

2. Wildland/urban interface

- Assessment and evaluation of homeowner-initiated prevention measures
- Prioritization of fuels-management needs within interface
- Interagency and interorganizational cooperation
- "Community" involvement

3. "Threshold" phenomena in fire science

- Convergence of thresholds
- Initiation of larger scale studies to discover thresholds
- Possible use of modeling techniques

4. Integrated science

- Coordinate across USGS and across agencies
- Include social-science component
- Need to have interagency communication to acquire "buy in"
- Address both long- and short-term science needs
- Establish prototype project
- Include spatial and temporal variations
- Analyze cumulative effects
- Identify tools required by land-management agencies
- Evaluate current decision-making processes

SUMMARY AND CONCLUSIONS

The objective of this workshop was to provide an opportunity for exchange of information on current activities and perceived research needs as the basis for future research and USGS support to other Federal agencies. From a combination of keynote presentations, panel discussions, field trips, oral and poster technical presentations, and break-out discussions, the attendees came away from the workshop feeling that the workshop was successful in achieving these objectives.

Because of the growing interest in wildland fires and the need for easily accessible information about USGS fire-related activities, a Web site has been developed. Located at: http://firescience.cr.usgs.gov/index.html, the site provides links to Web sites of all Federal agencies involved in wildland fire; information concerning the USGS workshops held in 1997 and 2000; discussion of USGS capabilities, programs and products; and a directory of USGS offices and scientists.

POST-WORKSHOP DEVELOPMENTS

At the conclusion of the workshop, it was evident that the USGS needs to move forward on several fronts in order to have a clearly defined and well-integrated fire-science program. The following are the primary efforts that resulted from the workshop:

1. During his keynote address to the workshop attendees, Larry Hamilton, Director of the Bureau of Land Management's National Office of Fire and Aviation, discussed the desirability of the USGS signing a Memorandum of Understanding with the five principal fire-science agencies and offered to provide his assistance and support to make that endeavor a reality. Shortly after the workshop, the Budget Officer for Central Region, USGS, initiated the Memorandum of Understanding with the assistance of Mr. Hamilton's staff. This document is presented in Appendix F.
2. Considerable discussion at the workshop centered on the President's FY 2001 Fire Initiative (Appendix G), which provided about $1.8 billion to the principal fire-science agencies. It was clear from presentations by the other Federal agencies attending the workshop, and from subsequent discussions, that there was a need for science-related activities to be a part of the implementation of forest-management plans developed in response to this initiative. Dave Cleaves, Science Decision Specialist for the U.S. Forest Service, has called for an Interagency Research Coordination Committee, of which the USGS would be a member and whose purpose it would be to better define the role of each agency with regard to research needs.
3. At the conclusion of the workshop, attendees were asked to volunteer to become members of a team that would become the focus of the development of FY 2002 Fire Initiative for the USGS. This team consists of the following:
    - Sue Cannon, Geology
    - Tom DiNardo, Geography
    - Bob Eppinger, Geology
    - Susan Finger, Biology
    - Sue Grace, Biology
    - Jennifer Harden, Geology
    - Bob Jarrett, Water
    - Dick Jachowski, Biology
    - Jacqueline Klaver, Mapping
    - Ray Kokaly, Geology
    - Russ Livingston, Water
    - Deborah Martin, Water
    - John Moody, Water
    - Doug Posson, Biology
    - Wayne Rohde, Geography
    - Jonathan Taylor, Biology
4. Shortly after the workshop, an effort was initiated to update the bibliography of fire-related studies and research conducted by the U.S. Geological

Survey scientists that were previously compiled by Deborah Martin. That publication (Martin, in press) includes more than 300 references/citations and also is available online at http//:firescience.cr.usgs.gov/index.html.

For the USGS to participate effectively in fire-related activities, the agency must be able quickly to communicate the needs of the land-management agencies to appropriate entities within the USGS. In recognition of this requirement, the USGS has established a Fire Science Coordination Team. With the establishment of this team, a structure and mechanism for orderly information flow within the USGS regarding science and technical support for the National Fire Initiative has been created.

The objectives of the Fire Science Coordination Team are to:

1. Distribute information regarding planning and implementation of the National Fire Initiative to appropriate organizational units within the USGS.
2. Assure timely, effective, and coordinated response to science and technical-support requests from the fire community including Federal, State, and local governments.
3. Communicate proactively USGS fire-science capabilities to all levels of the land-management agencies.
4. Coordinate USGS fire-science and fire-related capabilities across Divisions and Regions.
5. Assist in the development of budget initiatives in collaboration with other Federal agencies and non-Federal interests.

REFERENCE CITED

Martin, D.A., in press, Bibliography of fire-science studies and research by the U.S. Geological Survey: U.S. Geological Survey Open-File Report 02–280.

APPENDIXES

Appendix A—Federal Wildland-Fire Policy

Managing the Impact of Wildfires on Communities and the Environment

(reprinted here verbatim from its source)

A Report to the President
In Response to the Wildfires of 2000
September 8, 2000

I. Executive Summary

On August 8, 2000, President Clinton asked Secretaries Babbitt and Glickman to prepare a report that recommends how best to respond to this year's severe fires, reduce the impacts of these wildland fires on rural communities, and ensure sufficient firefighting resources in the future.

The President also asked for short-term actions that Federal agencies, in cooperation with States, local communities and Tribes, can take to reduce immediate hazards to communities in the wildland-urban interface and to ensure that land managers and firefighter personnel are prepared for extreme fire conditions in the future.

This report recommends a Fiscal Year (FY) 2001 budget for the wildland fire programs of the Departments of Agriculture and the Interior of $2.8 billion. Included within this total is an increase of nearly $1.6 billion above the President's FY 2001 budget request in support of the report's recommendations. This includes additional funding of about $340 million for fire preparedness resources, new funding of $88 million to increase cooperative programs in support of local communities, and approximately $390 million for fuels treatment and burned area restoration. The increase also includes about $770 million to replenish and enhance the Departments' fire suppression accounts, which have been depleted by this year's extraordinary costs, and to repay FY 2000 emergency transfers from other appropriations accounts.

A summary of the key points discussed in the body of the report:

1. **Continue to Make All Necessary Firefighting Resources Available.** The wildfires of the summer of 2000 continue to burn. As conditions change, new fires will start as others are controlled or die out. As a first priority, the Departments will continue to provide all necessary resources to ensure that firefighting efforts protect life and property. The Nation's wildland firefighting organization is the finest in the world and deserves our strong support.

2. **Restore Landscapes and Rebuild Communities.** The Departments will invest in restoration of communities and landscapes impacted by the 2000 fires. Some communities already have suffered considerable economic losses as a result of the fires. These losses will likely grow unless immediate, emergency action is taken to reduce further resource damage to soils, watersheds, and burned over landscapes. Key actions include:

    - **Rebuilding communities and assessing economic needs**. Assess the economic needs of communities and, consistent with current authorities, commit the financial resources necessary to assist individuals and communities in rebuilding their homes, businesses, and neighborhoods. Existing loan and grant programs administered by the Federal Emergency Management Agency (FEMA), the Small Business Administration (SBA), and USDA's Forest Service and rural development programs should provide this assistance.

- **Restoring damaged landscapes.** Invest in landscape restoration efforts such as tree planting, watershed restoration, and soil stabilization and revegetation. In so doing, priority should focus on efforts to protect:
  - Public health and safety (e.g. municipal watersheds);
  - Unique natural and cultural resources (e.g. salmon and bulltrout habitat) and burned-over lands that are susceptible to the introduction of non-native invasive species; and
  - Other environmentally sensitive areas where economic hardship may result from a lack of re-investment in restoring damaged landscapes (e.g. water quality impacts on recreation and tourism).

3. **Invest in Projects to Reduce Fire Risk.** Addressing the brush, small trees, and downed material that have accumulated in many forests because of past management activities, especially a century of suppressing wildland fires, will require significant investments to treat landscapes through thinning and prescribed fire. Since 1994, the Forest Service and the Bureau of Land Management have increased the number of acres treated to reduce fuel build-up from fewer than 500,000 acres in 1994 to more than 2.4 million acres this year. Building on the forest policies of the past eight years, the wildland fire policy, and the concepts of ecosystem management, the Departments should establish a collaborative effort to expedite and expand landscape-level fuel treatments. Important dimensions of this effort include:
   - **Developing a locally led, coordinated effort between the Departments of Agriculture, the Interior, and Commerce, and other appropriate agencies through the establishment of integrated fuels treatment teams at the regional and field levels.** The role of each team would be to identify and prioritize projects targeted at communities most at risk, coordinate environmental reviews and consultations, facilitate and encourage public participation, and monitor and evaluate project implementation. Each team will work closely with local communities to identify the best fit for each community.
   - **Utilizing small diameter material and other biomass.** Develop and expand markets for traditionally underutilized small diameter wood and other biomass as a value added outlet for excessive fuels that have been removed.
   - **Allocating necessary project funds.** Commit resources to support planning, assessments, and project reviews to ensure that hazardous fuels management is accomplished expeditiously and in an environmentally sound manner.
4. **Work Directly with Communities.** Working with local communities is a critical element in restoring damaged landscapes and reducing fire hazards near homes and communities. To accomplish this, the Departments recommend:
   - **Expanding community participation.** Expand the participation of local communities in efforts to reduce fire hazards and the use of local labor for fuels treatment and restoration work.
   - **Increasing local capacity.** Improve local fire protection capabilities through financial and technical assistance to State, local, and volunteer firefighting efforts.
   - **Learning from the public.** Encourage grass roots ideas and solutions best suited to local communities for reducing wildfire risk. Expand outreach and education to homeowners and communities about fire prevention through use of programs such as Firewise.
5. **Be Accountable.** Establish a Cabinet-level coordinating team to ensure that the actions recommended by the Departments receive the highest priority. The Secretaries of Agriculture and the Interior should co-chair this team. Integrated management teams in the region should take primary responsibility for implementing the fuels treatment, restoration, and preparedness program. The Secretaries should assess the progress made in implementing these action items and provide periodic reports to the President.

II. Background

The 2000 fire season is undoubtedly one of the most challenging on record. Wildfires are on pace to break decades-old records. As of early September, more than 6.5 million acres—more than two times the ten-year national average—have burned. The intensity of this year's fires is the result of two primary factors: a severe drought, accompanied by a series of storms that produced millions of lightning strikes and windy conditions, and the long-term effects of more than a century of aggressively suppressing all wildfires, which has led to an unnatural buildup of brush and small trees in our forests and rangelands.

This season has stretched the capabilities of the wildland firefighting system—stretched, but not broken. Such a season tests our firefighters' training and the fire management infrastructure, and we have found that both are sound. This is a credit to the Nation's firefighters, support personnel, military and international partners, managers, and local communities who provide crucial help and resources.

More than 29,000 people have been involved in firefighting efforts, including about 2,500 Army soldiers and Marines and fire managers from Canada, Australia, Mexico and New Zealand. Our partners, both military and international, are assisting under pre-existing agreements with the National Interagency Fire Center in Boise, Idaho. In addition, 1,200 fire engines, 240 helicopters, and 50 airtankers are in use this season.

As challenging as this fire season has been, our firefighters have been successful in extinguishing more than 95 percent of wildfires before they become large fires (i.e., 100 acres or more). In all, they have extinguished more than 75,000 wildfire starts this season.

Weather

The weather phenomenon known as La Niña, characterized by unusually cold Pacific Ocean temperatures, changed normal weather patterns when it formed two years ago. It caused severe, long-lasting drought across much of the country, drying out our forests and rangelands. The situation was exacerbated by the fact that the drought followed several seasons of higher-than-normal rain, which fueled the growth of grasses and other plants that quickly dried when the rains stopped. This left millions of acres susceptible to fires. To make matters worse, this weather pattern also spawned a series of mostly dry thunderstorms with heavy lightning across the West. Because of the drought conditions, lightning strikes have ignited more new fires than would normally be associated with such storms.

The current season corresponds to a historical pattern of extensive wildfires during similar unusual weather conditions. The result has been an extended, severe fire season, with wildfires burning simultaneously across the western United States.

Historic Wildfires

This year's fires also reflect a longer-term disruption in the natural fire cycle that has increased the risk of catastrophic fires in our forests and rangelands.

Natural fire patterns were first disrupted on a large scale with settlement activity during the second half of the 19th century when millions of acres of forests and wildlands were cleared to make way for farm crops and livestock pastures. During this time, timber companies, responding to a growing country's need for lumber and fuel, often took the biggest trees, leaving behind slash, undergrowth and smaller trees. These activities set the stage for disastrous fires.

One of the most significant examples of this phenomenon occurred in 1871 in Peshtigo, Wisconsin, near the Great Lakes. The area around Peshtigo, mostly private land, had been extensively logged. Merchantable timber was removed; slash and dense undergrowth were left behind. On October 8, 1871, a brush fire quickly erupted into an inferno, consuming Peshtigo in an hour and damaging 16 other towns and more than 1.2 million acres. The human toll—more than 1,200 people killed—stands as the worst wildfire disaster in U.S. history.

The Peshtigo tragedy served as a deadly warning about what can happen when forest health is badly compromised—in this case, by logging activities. In fact, Peshtigo represented the beginning of new fire cycle throughout the Great Lakes region that would not be broken for more than 50 years.

In the West, a similar pattern erupted in August 1910 with the "Big Blowup"—the Great Idaho fire. As in the 2000 fire season, a severe drought plagued the region when dry storms, accompanied by hurricane-force wind, produced thousands of lightning strikes and ignited hundreds of small fires. These fires converged to create a monster fire that was virtually unstoppable given the limited firefighting capability of the times. It consumed 3 million acres in northern Idaho and western Montana, killed 85 people, and destroyed the property and livelihoods of many others.

Speaking about the Big Blowup, Stephen Pyne, a professor at Arizona State University and a leading authority on the history of fire, said, "August of 1910 was the single most important moment in American fire history" because it radically changed the way the country viewed wildfires.

The ferocity of the Big Blowup, which came on the heels of other devastating fires on both private and government land, triggered a call for a systemic policy change. Less than a year later, the national Forest Service firefighting program was born. A war on all wildfires was declared. From that point on, all wildfires were extinguished as soon as possible.

Results of Suppression Policy

As a result of the all-out effort to suppress fires, the annual acreage consumed by wildfires in the lower 48 states dropped from 40 to 50 million acres a year in the early 1930s to about 5 million acres in the 1970s. During this time, firefighting budgets rose dramatically and firefighting tactics and equipment became increasingly more sophisticated and effective.

While the policy of aggressive fire suppression appeared to be successful, it set the stage for the intense fires that we see today. Full suppression of all wildfires initially gave our forests and wildlands a chance to heal, creating a false sense of security. However, after many years of suppressing fires, thus disrupting normal ecological cycles, changes in the structure and make-up of forests began to occur. Species of trees that ordinarily would have been eliminated from forests by periodic, low-intensity fires began to become a dominant part of the forest canopy. Over time, these trees became susceptible to insects and disease. Standing dead and dying trees in conjunction with other brush and downed material began to fill the forest floor. The resulting accumulation of these materials, when dried by extended periods of drought, created the fuels that promote the type of wildfires that we have seen this year.

The problems of unnaturally heavy undergrowth have been exacerbated by the introduction in the 1800s of non-native invasive weeds and grasses. These plants corrupt a region's ecological processes, robbing the soil and native plants of vital nutrients and water. Invasive species such as cheatgrass, which is pervasive on today's Western landscape, is one of the first plants to establish after a fire. It grows earlier, quicker, and higher than native grasses. Then it dies, dries, and becomes fuel.

In short, decades of aggressive fire suppression have drastically changed the look and fire behavior of Western forests and rangelands. Forests a century ago were less dense and had larger, more fire-resistant trees. For example, in northern Arizona, some lower elevation stands of ponderosa pine that once held 50 trees per acre, now contain 200 or more trees per acre. In addition, the composition of our forests have changed from more fire-resistant tree species to non-fire resistant species such as grand fir, Douglas-fir, and subalpine fir. As a result, studies show that today's wildfires typically burn hotter, faster, and higher than those of the past.

The Changing West

In addition to the unnatural fuel buildup developing in our forests and rangelands, wildland firefighting has become more complex in the last two decades due to dramatic increases in the West's population.

Of the 10 fastest-growing states in the U.S., eight are in the interior West. While the national average annual population growth is about one percent, the West has growth rates ranging from 2.5 to 13 percent.

As a result, new development is occurring in fire-prone areas, often adjacent to Federal land, creating a "wildland-urban interface"—an area where structures and other human development meet or intermingle with undeveloped wildland. This relatively new phenomenon means that more communities and structures are threatened by fire. Wildland firefighters today often spend a great deal more time and effort protecting structures than in earlier years. Consequently, firefighting has become more complicated, expensive, and dangerous.

Current Fire Management Policy

This Administration has sought to increase efforts to reduce risks associated with the buildup of fuels in forests and rangelands through a variety of approaches, including controlled burns, the physical removal of undergrowth and other unnatural concentrations of fuel, and the prevention and eradication of invasive plants. Implicit in the Administration's policy is the understanding that reversing the effects of a century of aggressive fire suppression will be an evolutionary process, and not one that can be completed in a few short years.

As the composition and structure of our Nation's forests have changed over time, conditions that increase the likelihood of catastrophic fire have grown. Periodic, severe wildfires have occurred when weather conditions have produced drought, dry lightning, and high winds. This was illustrated in 1988, the year of the Yellowstone fires, and in 1994, when fires claimed the lives of 34 firefighters, including 14 of our country's most elite firefighters in one inferno on Storm King Mountain in Colorado. This pattern has repeated itself in the year 2000.

After evaluating the 1988 and 1994 fires, foresters, fire ecologists, biologists, and others cautioned that the century-old policy of excluding all fires from the forests rangelands had brought about ecological changes that were increasing the likelihood of catastrophic wildfire. This was confirmed by the 1999 General Accounting Office Report, *Federal Wildfire Activities*, which noted "[F]ederal acreage is susceptible to catastrophic wildfires, particularly where the natural vegetation has been altered by past uses of the land and a century of fire suppression."

Given the experiences of the 1988 and 1994 fire seasons and the recommendations of scientific experts, the Clinton/Gore Administration initiated the first-ever, comprehensive interagency review of wildland fire policy. Based on this review, which was summarized in the 1995 Federal Wildland Fire Policy Statement, the Departments of Agriculture and the Interior predicted serious and potentially permanent environmental destruction and loss of private and public resource values from large wildfires. The policy statement recognized the important function that fire plays in many ecosystems and identified the critical role fire can play in the management of forests and watersheds. The policy noted that, "[C]onditions on millions of acres of wildlands increase the probability of large, intense fires beyond any scale yet witnessed. These severe fires will in turn increase the risk to humans, to property and to the land upon which our social and economic well-being is so intimately intertwined."

As three of the country's leading wildland fire ecologists recently said, "Fires will inevitably occur when we have ignitions in hot, dry, windy conditions. . . . It is one of the great paradoxes of fire suppression that the more effective we are at fire suppression, the more fuels accumulate and the more intense the next fire will be."

After the policy was put in place, the Departments dramatically increased the number of acres treated to reduce fire risks. In 1995, Federal agencies treated fewer than 500,000 acres. This year, the Departments will remove brush, small trees, and downed material from more than 2.4 million acres using small, intentionally set, "prescribed" fires and mechanical thinning techniques.

Across the country, the Departments have been working to assess the important roles that fire plays in different ecosystems and to integrate this knowledge into management practices. They also began the Joint Fire Science Project to provide a scientific basis for helping the Departments prioritize their fire prevention activities on the ground. In 1999, this project developed maps, with state-level resolution, that identify forests most at risk from large, catastrophic fires. Work continues to improve the resolution of the maps so that they can be used to help assist with strategic planning, prioritizing resources and identifying specific projects on the ground.

The Departments have been moving quickly to incorporate this new information in their budget requests and other policy documents, but the severity of this year's fire season has added extra impetus to move these recommendations forward.

III. Key Elements of the Administration's Wildland Fire Management Policy

The new wildland fire policy that the Administration has developed in recent years acknowledges the dangers posed by the long-term building of excessive fuel levels in our forests and rangelands. It seeks to reduce those risks through a variety of approaches, including controlled burns, the physical removal of undergrowth and other unnatural concentration of fuel, and attacks on invasive plants. Implicit in the Administration's policy is the understanding that reversing the effects a century of aggressive fire suppression has had on our nation's public lands will be an evolutionary process, not one that can be completed in a few short years.

The key elements of the Administration's wildland fire management policy are set forth below. They include: (1) integrated firefighting management and preparedness; (2) reducing hazardous fuel accumulations; and (3) local community coordination and outreach.

Notably, the Administration's wildland fire policy does not rely on commercial logging or new road building to reduce fire risks and can be implemented under its current forest and land management polices. The removal of large, merchantable trees from forests does not reduce fire risk and may, in fact, increase such risk. Fire ecologists note that large trees are "insurance for the future—they are critical to ecosystem resilience." Targeting smaller trees and leaving both large trees and snags standing addresses the core of the fuels problem.

The Congressional Research Service (CRS) recently addressed the effect of logging on wildfires in an August 2000 report and found that the current wave of forest fires is not related to a decline in timber harvest on Federal lands. From a quantitative perspective, the CRS study indicates a very weak relationship between acres logged and the extent and severity of forest fires. To the contrary, in the most recent period (1980 through 1999) the data indicate that fewer acres burned in areas where logging activity was limited.

Since 1945, the fluctuation pattern of acres burned in the 11 Western States has shown a steady rise with some of the worst fire seasons in the late 1980's, when timber harvest peaked at 12 billion board feet. In fact, the 10-year average annual number of acres burned nationwide in the 1980's when logging activity was heaviest was higher (4.2 million acres) than in both the 1970's (3.2 million acres) and the 1990's (3.6 million acres).

Qualitative analysis by CRS supports the same conclusion. The CRS stated: "[T]imber harvesting removes the relatively large diameter wood that can be converted into wood products, but leaves behind the small material, especially twigs and needles. The concentration of these fine fuels on the forest floor increases the rate of spread of wildfires."

Similarly, the National Research Council found that logging and clearcutting can cause rapid regeneration of shrubs and trees that can create highly flammable fuel conditions within a few years of cutting. Without adequate treatment of small woody material, logging may exacerbate fire risk rather than lower it.

The President has proposed to protect more than 43 million acres of remaining National Forest roadless areas. These areas have tremendous ecological value and serve as important watersheds, areas for recreation, and important habitat for fish and wildlife.

Some critics have expressed concern that the Administration's proposed roadless area policy could increase wildfire risks. The facts do not support this conclusion. To the contrary, all available evidence suggests that fire starts may be fewer in unroaded than in previously roaded forests. Fires are almost twice as likely to occur in roaded areas as they are in roadless areas.

The proposed roadless area protection policy would not affect the Federal agencies' ability to control wildland fires. The agencies' success rate in extinguishing wildfires on initial attack is the same in roadless, wilderness, and roaded areas. Approximately 98 per cent of all fires are extinguished before the grow large and out of control. In addition, the proposed roadless policy would allow road construction if a wildland fire threatened public health and safety.

The Forest Service has identified 89 million acres of National Forest System land that have a moderate to high risk of catastrophic fire. Of these acres, less than 16 per cent are in inventoried roadless areas. Moreover, the Forest Service would prioritize efforts to reduce fuels in areas that have already been roaded because these areas tend to be much closer to communities and have higher fire risks. Indeed, given current funding levels and the scope of the fuels issue, the Forest Service would do fuels reduction work for 15 years in roaded areas.

A. Firefighting Management and Preparedness

The Administration's review of wildland fire policy validated the importance of maintaining an integrated firefighting management structure that can deliver first-class firefighting resources to the front lines of wildfires.

The Departments operate under a model interagency framework that has been developed over two decades. Program management and coordination takes place through a national-level group, the National Wildfire Coordination Group, which includes representatives from the States. It determines training, equipment, and other standards to ensure that all Federal, State, and local agencies can easily operate together.

The fire program operates under a command structure called Incident Command System to respond to and manage wildfires on an intergovernmental basis. The system includes local fire operations that are supported by a national network of coordination centers and supply bases. The National Interagency Fire Center in Boise, Idaho, oversees national wildfire operations.

The Administration has provided full support to the interagency firefighting effort (see attachment A) and has implemented a series of budget and management improvements.

Based on lessons of recent fire seasons, especially 1999 and 2000, the Departments have reassessed the assumptions and variables used in planning models to determine the resources needed to fight fires. They recommend funding 100 percent of this revised estimate of full preparedness.

In addition, the Departments have devoted special attention to firefighting training and coordination. As part of this emphasis, the Departments have added training courses, modified current classes, and, in some cases, raised the qualifications for certain positions. In 1999, the Departments issued a revised qualifications system for firefighting and prescribed fire positions in order to ensure that the U.S. continues to field the finest firefighting and prescribed fire force in the world.

B. Reducing Hazardous Fuel Accumulations

Implicit in the Administration's efforts to reduce wildfire risk through the elimination of brush, small diameter trees, and other fuels and the reintroduction of fire to forest and rangeland ecosystems is the understanding that reversing the effects a century of aggressive fire suppression will be an evolutionary process, not one that can be completed in a few short years.

The Administration's forest policies have emphasized the importance of reducing hazardous fuel accumulations in our forests and rangelands and restoring the health and natural processes of forest and rangeland ecosystems. Reduction of fuels can be achieved in a variety of ways—by mechanical, chemical, biological and manual methods. The prudent use of fire, either alone or in combination with other means, can be one of the most effective means of reducing such hazardous fuel. In addition, early research has demonstrated that the selective removal of undergrowth and non-native plant species, can significantly reduce fire risks. The Administration is testing the effectiveness of these strategies' pilot projects.

By way of example, in a report published in *Proceedings from the Joint Fire Science Conference and Workshop, 1991*, researchers studied four large wildfires in Montana, Washington, California, and Arizona to determine if previous fuel treatment and thinning activities had any impact on fire severity. The sites selected for study underwent treatment within ten years prior to being burned in wildland fires. The findings indicated that fuel treatments mitigate fire severity. "Although topography and weather may play a more important role in fuels in governing fire behavior, topography and weather cannot be realistically manipulated to reduce fire severity. Fuels are the leg of the fire environment triangle that land managers can change to achieve desired post-fire condition."

The General Accounting Office (GAO Report GAO/RCED–99–65) also has emphasized the need for fuels management, concluding that "the most extensive and serious problem related to the health of forests in the interior West is the over-accumulation of vegetation, which has caused an increasing number of large, intense, uncontrollable, and catastrophically destructive wildfires."

The Departments have moved forward with an aggressive program to thin forest stands to reduce small diameter trees, underbrush and accumulated fuels

Between 1994 and this year, the Departments increased their efforts to reduce fire risks through prescribed fire and thinning by close to 500 percent (see attachment B). In 1999, the Departments treated 2.2 million acres. At the same time, the Departments have increased the use of prescribed fires to begin steering our forests and rangelands back toward more healthy conditions.

Presently, both Departments are developing strategies to address aggressive fuel management. These call for a targeted approach to removing excessive fuel through mechanical treatments and prescribed fire in order to protect communities at risk, help prevent insect and disease damage, and generally improve overall ecosystem health and sustainability. Obviously, large-scale improvements will take several years to occur against the backdrop of a century-long suppression policy. Nonetheless, this year's fire season is providing some evidence that the controlled reintroduction of fire is beginning to bear fruit.

An example involves a wildfire in South Dakota's Black Hills. The Jasper fire, more than 82,000 acres, is the largest fire in the history of the Black Hills. It has displayed the most severe fire behavior in the history of the area, burning 50,000 acres in only a few hours. During the course of a fierce crown-fire run—where flames roar through the forest through the tops of the trees—the fire burned into a section of the Jewel Cave National Park where a prescribed fire had been conducted near the Park's visitor center and housing area. When it hit the prescribed burn area, the fire changed from a crown-fire to a ground-based fire where it could be effectively fought. Fire crews were able to remain in the area only because of the defensible space and barriers created. As a result, none of the Park's major structures burned.

As dramatic as this example is, an equally dramatic example illustrates the risks that are inherent in prescribed fires if they are not implemented in a careful and well-managed manner.

Specifically, the Cerro Grande fire near New Mexico's Los Alamos National Laboratory, which began as a prescribed fire in Bandelier National Park in New Mexico in May, is a terrible reminder of the costs if prescribed fires are not well-planned and executed. Nearly 300 homes were damaged or destroyed, 18,000 people were evacuated, and 48,000 acres were burned. The Administration fully supported a compensation program enacted by Congress for the victims of the fire. The Administration is also fully committed to implementing changes in prescribed fire policy and procedures as a result of investigations and reviews of the Cerro Grande fire.

C. Local Community Coordination and Outreach

The Administration's wildland fire policy recognizes that effective fire management requires close coordination with local communities, particularly those communities that are in the wildland-urban interface. As the management of private lands has become a key factor in the fire-risk equation, the Departments have recognized the importance of providing outreach, education, and support for local communities who must play a primary role in reducing fire hazards in and near their communities.

As discussed above, the changing demographics are expanding the wildland-urban interface and creating new challenges for fighting wildland fires. Increasingly, many homes on private land in and around new communities are at risk. Indeed, the National Fire Protection Association (NFPA) estimates that wildfires destroyed more than 9,000 homes between 1985 and 1995. Officials further believe that the number of homes damaged by wildfires in the 1990s is six times that of the previous decade. More than 1,000 homes have been destroyed during this summer alone.

Safe and effective protection in these areas demands close coordination between local, State, Federal and Tribal firefighting resources. Typically, the primary burden for wildland-urban interface fire protection falls to property owners and State and local governments. Rural and volunteer fire departments provide the front line of defense, or initial attack, on up to 90 percent of these high-risk and costly fires. While they have a good record in rapidly suppressing traditional wildland fires, these local resources often struggle to effectively address the complex demands of fighting fire in the wildland-urban interface.

The Departments also have taken steps to assist communities in developing their own firefighting capabilities. The Forest Service's State and Volunteer Fire Assistance Programs, for example, provide technical and financial assistance to local firefighting resources to help promote effective and coordinated integrated fire management response. Through the Volunteer Fire Assistance Program, the Forest Service has been successful in providing firefighting equipment to rural fire departments and in training their firefighters to meet Federal interagency standards.

The Departments have made available the training facilities at the National Interagency Training Center in Boise, Idaho, to community-based firefighters. By way of example, the BLM Boise District in Idaho has trained more than 1,500 firefighters from 57 different fire departments from both urban (e.g. Boise) and rural areas within the last five years. Training opportunities recently have been extended to ranchers who are interested in fire proofing their properties and understanding basic fire suppression tactics. The Boise District also has formalized an agreement with Ada County, Idaho, to train and integrate county employees into certain firefighting operations and promote an effective and coordinated integrated fire management response.

The problem of fires in the wildland-urban interface is multifaceted and will not be solved overnight. Nevertheless, there are a number of short-term actions that the Federal government, in cooperation with State, tribal and local governments, can take to reduce the future risk to communities and resources.

A top priority for reducing risk is to reduce fuels in forests and rangelands adjacent to, and within communities. Particular emphasis should be placed on projects where fuel treatment can also be accomplished on adjoining State, private, or other nonfederal land so as to extend greater protection across the landscape. This provides protection from catastrophic fires that develop on public lands. This can be accomplished by making available adequate incentives and technical assistance to communities and private landowners to encourage the reduction of hazardous fuels around homeowner properties. These individual actions will not only provide greater personal protection but will also increase the safety and effectiveness of firefighting personnel. When done on a large scale, fuel reduction around individual homes can result in greater overall protection for an entire landscape or watershed.

The Departments have been implementing a number of programs to educate communities and homeowners in recently burned areas and high-risk urban-wildland interface areas about fire hazards. The Forest Service's Firewise program, for example, is a very successful program designed to educate rural homeowners about precautions they can take to make their homes more fire resistant and more easily defendable by local fire departments. Firewise specifically helps communities and homeowners recognize fire hazards, design Firewise homes and landscapes, and make wise planning, zoning, and building material choices. These efforts play an important role in reducing the loss of lives and property—as well as tremendous government expense—in the wildland-urban interface.

IV. Consequences of the 2000 Wildfire Season

Economic Impacts

Although the data needed for a thorough assessment of economic impacts on areas affected by this year's wildfires are not yet available, preliminary reports indicate that the losses from the 2000 wildfires will be substantial and widespread. Montana Governor Racicot estimated that businesses were losing about $3 million a day because of fire. Idaho Governor Kempthorne estimated losses in Idaho at $54.1 million overall, of which $15 million comes from about 500 small businesses. He estimated another $12.5 million in agricultural losses and $12 million in watershed restoration costs.

Economic impacts arise both directly from fire damage and indirectly from changes in local economic activity, such as a drop in tourism. Both direct and indirect effects of the wildfires have exacted a heavy economic toll on many local, often rural communities.

In Hamilton, Montana, the loss of more than 300,000 acres to fire prompted officials to close much of the public land essential to Montana's tourism economy. As a result, the Chamber of Commerce reports that seven chamber members alone had reported losses totaling $500,000. A local fishing guide who relies on tourists told reporters that he had lost 76 percent of his normal business in one month alone.

In Idaho, two ranchers lost more than 700 cattle during a 20,000-acre fire near Dietrich, with a value of at least half a million dollars. Insurance will cover about 25 percent for one of the ranchers. The other rancher had no insurance on his herds.

President Clinton responded to requests from the Governors of Idaho and Montana and declared the two states as disaster areas, making them eligible for Federal relief. One-stop centers are being established so that citizens can obtain service and financial assistance from all relevant agencies.

Damage to Natural Resources

In addition to these types of direct, out-of-pocket impacts on citizens, it is likely that losses in resource values will total billions of dollars.

The consequences of this year's wildfires on our country's natural resources are as vast as they are varied.
The wildland fires of 2000 fires have burned both public and private lands over a broad spectrum of semi-arid rangeland and forested ecosystems, often encompassing entire watersheds critical to community water supplies. Compared to historic fire events, recent fires have burned with such intensity that the ecosystems of many of these

extensively burned areas have been drastically changed. Without intervention, these burned lands will recover slowly and be susceptible to undesirable changes in vegetation composition. For example, plant species such as cheatgrass often become established in burned areas, creating additional fire risks and disrupting natural systems.

The immediate problems associated with the severity of fire will extend well into winter. With a lack of vegetation on hillsides, for example, the likelihood that rain and snowfall will create flooding and mudslides increases. In turn, the water quality of streams and rivers are damaged, which can kill native fish. Many wildlife populations also have been killed or disrupted.

Non-native invasive plant species—weeds—thrive on both public and private lands in the wake of wildland fires, presenting several problems. These opportunistic plants compete with and can overtake native plant communities. In addition, their proliferation provides powerful fuel for wildfires, increasing the likelihood of and severity of future wildfires. Cheatgrass, in particular, has spread throughout the West on degraded rangelands, increasing in density on burned areas. In the Great Basin ecosystem alone, one out of every three acres is either dominated or threatened by cheatgrass.

Harvesting Burned Trees

The appropriate harvest of fire-damaged timber can provide a means of recovering some of the economic value of forest stands and improving landscape health, but it is not a panacea for reducing wildfire risk. Removal activities that do not comply with environmental requirements can add to the damage associated with fire-impacted landscapes.

The Departments will continue to consider the option of harvesting fire-damaged trees when appropriate, with priority placed on those areas where roads already exist and where risks to communities from future wildfire are greatest. However, as has been the Departments' practice, such timber sales should proceed only after all environmental laws and procedures are followed and the affected communities are afforded the opportunity to participate in the process.

In the past, some Congressionally mandated salvage logging resulted in the harvest of green, healthy trees in addition to dead and dying timber. Congressional direction contained in the 1995 Rescissions Act—known as the "Salvage Rider"—placed priority on salvage logging over environmental protection. This is not an acceptable approach to harvesting fire-damaged trees.

V. Key Points and Recommendations

1. Continue to Make All Necessary Firefighting Resources Available.

As a first priority, the Departments will continue to provide all necessary resources to ensure that fire suppression efforts are at maximum efficiency in order to protect life and property. The United States' wildland firefighting organization is the finest in the world and deserves our strong support. To ensure continued readiness of the firefighting force, the Departments recommend providing additional resources for firefighting activities.

Wildland firefighting is a difficult and dangerous job, and it is essential that our firefighters continue to be well trained, with the appropriate equipment and resources they need to do their job. Safety of our firefighters and members of the public is, and always will be, the Administration's number one priority. We will continue to provide all necessary resources that our firefighting force need to continue the battle against this year's fires in as safe a manner as possible.

To fully fund the fire management preparedness programs, the Departments recommend additional resources in FY 2001 of about $337 million, including $204 million for the Forest Service and $133 million for the Department of the Interior over the President's request. This continuing funding would provide the Departments' fire management organizations with the capability to prevent, detect, and take prompt, effective action to control wildfires. These funds also would support the personnel, equipment, and technology necessary to conduct proper planning, prevention, detection, information, education, and training.

2. Restore Damaged Landscapes and Rebuild Communities.

After ensuring that suppression resources are sufficient, invest in the restoration of communities and landscapes impacted by the year 2000 fires. The Departments also recommend that investments in the treatment of landscapes through thinning and the restoration of fire be continued and expanded to help reduce the risk of catastrophic fires.

Providing Economic Assistance to Hard-Hit Communities

As discussed above, the year 2000 fires have hit many communities hard. Both the Federal Emergency Management Agency (FEMA) and the Small Business Administration (SBA) are responding to the immediate need for assistance. FEMA anticipates that more than 10,000 citizens from Idaho and Montana may qualify for disaster unemployment assistance, and it is anticipated that the SBA may offer more than $50 million in small business loans to assist affected businessmen. The USDA's Forest Service and rural development program also are preparing to provide immediate economic assistance, using existing resources. In receiving grant or loan applications under these programs, the Department of Agriculture will fully consider the impact of the season's wildfires on communities seeking assistance, giving such communities a competitive advantage in the USDA grant-making and loan-making.

In addition to these short-term actions, the Departments recommend that stabilization and restoration investments be made in areas that have been damaged by fire and which are at risk of erosion, invasive species germination or water supply contamination. These investments should be made in a manner that provides maximum benefit to hard-hit communities with local contractors and the local workforce being utilized to maximum extent possible.

In a similar vein, the Departments also are recommending below that forest treatment activities be stepped up in intensity. These activities can be labor intensive and, once again, the Departments intend to involve local communities and the local workforce in implementing these activities.

Key aspects of these programs are set forth below.

Burned Area Stabilization and Restoration

Stabilization

Stabilization activities include short-term actions to remove hazards and stabilize soils and slopes. Examples of specific actions or "treatments" might include the removal of hazards; seeding by helicopter, plane, or by hand; constructing dams or other structures to hold soil on the slope; placing bundles of straw on the ground, parallel to the slope to slow the movement of soil down hill; contour furrowing or trenching (ditches cut into the mountain or hillsides to catch soil moving down hill); correcting road drainage by realigning poorly designed roads and culvert replacement to manage water and soil movement after the fire; and temporarily fencing cattle and people out of burned areas.

Priorities for stabilization activities include protecting human life and property; protecting public health and safety; stabilizing municipal watersheds; stabilizing steep slopes and unstable terrain; protecting archeological resources; and replacing culverts.

Restoration

Restoration activities include longer-term actions to repair or improve lands that are unlikely to recover naturally from severe fire damage. Examples of specific actions or "treatments" might include planting or seeding native species; reforesting desired tree species; chemical or mechanical treatment to reduce competition; and other efforts to limit the spread of invasive species.

Priorities for restoration activities include preventing introduction of non-native invasive species; promoting restoration of ecosystem structure and composition; rehabilitating threatened and endangered species habitat; and improving water quality.

Because of the large amount of acreage affected by this year's fires, the Departments propose to develop a stabilization and restoration plan that is coordinated with all affected agencies, including appropriate state and local agencies.

Responsibility for implementation of individual projects lies at the field-level. Projects covering multiple jurisdictions will be planned and implemented on an interagency basis. The Departments recognize that the scope of this effort will require additional resources. Three specific aspects of the program may require special support:

(1) *Native plant/seed sources*: Availability of native seeds and plant materials is limited. Significant effort will be needed to encourage the production of seeds and plant materials by the private sector and develop agency seed storage capabilities to support restoration activities.

(2) *Science and research*: Significant information collection, research, and data analysis is required to assess the effectiveness of restoration techniques and develop improved techniques. Current technologies and techniques are largely based on experiences from agricultural practices in the early part of the 20th Century. Special attention will be focused on techniques applicable to non-agricultural lands and to treatments using native seeds and plants.

(3) *Capital equipment*: The current post-fire program relies on a limited amount of capital equipment (e.g., drill-seeders), much of which is not dedicated to this program. Additional equipment will be needed to support the expanded requirements, especially in the application of native seeds.

3. Investments in Projects to Reduce Fire Risk

As discussed above, the Departments have been implementing new approaches to address the long-term buildup of hazardous fuels in our forests and rangelands. The fires of 2000 have underscored the importance of pursuing an aggressive program to address the fuels problem with the help of local communities, particularly those in wildland-urban interface areas, where threats to lives and property are greater and the complexity and costs of treatments higher.

The Departments recommend continuing current fuel reduction strategies and seeking additional budgetary resources to treat additional acreage. The Departments are requesting $257 million for fuels reduction activities in FY 2001, over the President's request including $115 million for the Forest Service and $142 million for the Department of the Interior. These funds will cover accelerated treatments, especially in the wildland-urban interface area and will work to support additional research and eradication of invasive species. Funding will be available to support Endangered Species Act consultation work by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service.

Implementation of Fuels Reduction Program

The most significant implementation challenge for the Departments is to substantially increase the number of acres of forestlands that receive fuels treatment. Both Departments are utilizing one aspect of fuels treatments, prescribed fires, increasingly. That program will continue to play a key role, although the lessons from the Cerro Grande fire demand that this strategy be implemented with great care. In that regard, the Departments will implement recommendations from the independent review of the Cerro Grande fire.

In addition to prescribed burns, the physical removal of undergrowth and other fuels needs to be stepped up in intensity in order to have a more significant impact on dangerous fuels buildup. Because of the importance of this activity, the Departments recommend that experienced personnel be dedicated full time to this activity, with direct chains of command to the Secretaries of Agriculture and the Interior. The Secretaries, in turn, should meet periodically to assess the progress of these efforts.

Markets for Removed Materials

Because much of the hazardous fuels in forests are excessive levels of forest-based biomass—dead, diseased and down trees—and small diameter trees, there are several benefits of finding economical uses for this material, including helping offset forest restoration cost; providing economic opportunities for rural, forest-dependent communities; reducing the risks from catastrophic wildfires; protecting watersheds; helping restore forest resiliency, and protecting the environment.

USDA Forest Service research teams are working to develop new uses for small tress and new ways to process them. A need exists to transfer and commercialize new technology as it comes on line and to develop and expand local markets for these products. Both Departments propose to partner with communities, universities, and businesses to conduct additional research on the stimulation of small diameter and other vegetative products industries.

Small diameter logs, for example, can be used for housing material such as trim, siding, and sub-flooring. Recent technology now makes it possible for wood composites—fibers, flakes and strands—from lower quality species of trees such as juniper, pinion pine, and insect-killed white fir to be used successfully for particleboard and replacement filler for thermoplastic composites that make up a wide range of consumer products such as highway signs. Similar uses are being expanded for pulp chips. The woody residues that make up a forest's undergrowth has historically been burned or allowed to accumulate in huge piles on the forest floor. This material could potentially be economically used as compost and mulch material.

Research Needs

Given the severity of this year's fires and the additional fuels management and restoration activities recommended by this report, the Departments have a number of additional research needs. They recommend research on the relationship between invasive species and fires and the effectiveness of various treatment efforts. They also recommend research based on recent fire seasons regarding relationships between land management practices and the occurrence and intensity of fires.

Budget

The two Departments request additional resources of $130 million in FY 2001 over the President's request to fully fund a burned area restoration program as described above, including $45 million for the Forest Service and $85 million for the Department of the Interior.

4. Work Directly with Local Communities.

Working with local communities is a critical element in restoring damaged landscapes and reducing fire hazards proximate to homes and communities. To accomplish this, the Departments recommend:

a. **Expanding the participation of local communities in efforts to reduce fire hazards and the use of local labor for fuels treatment and restoration work.**

b. **Improving local fire protection capabilities through financial and technical assistance to state, local, and volunteer firefighting efforts.**

c. Assisting in the development of markets for traditionally underutilized small diameter wood as a value added outlet for removed fuels.

d. Encouraging a dialogue within and among communities regarding opportunities for reducing wildfire risk and expanding outreach and education to homeowners and communities about fire prevention through use of programs such as Firewise.

As discussed above, the Departments have been working with communities on fire-related activities through a variety of programs. On the operational side, the National Interagency Fire Center provides training opportunities for local firefighters, and the Fire Center has developed cooperative arrangements with many local and state entities to facilitate coordinated firefighting efforts. The Departments also work with local communities to assist in fire protection activities through the Firewise program and other outreach efforts. In addition, the Departments currently work with local communities on fuels treatment and post-fire restoration projects.

Although Federal agencies are engaged in these activities on an on-going basis, the Departments recommend that a significant new initiative be undertaken to coordinate appropriate investments and outreach activities with affected communities. The proposed initiative would focus on three major arenas: (1) improving community-based firefighting capabilities and coordination with state and Federal firefighting efforts; (2) working closely with communities-at-risk in implementing post-fire restoration activities and fuels reduction activities; and (3) expanding joint education and outreach efforts regarding fire prevention and mitigation in the wildlife-urban interface.

Rural and volunteer fire departments provide the front line of defense, or initial attack, on up to 90 percent of the communities. Volunteer fire departments are the backbone of fire protection in America. County, State, and Federal agencies provide immediate backup to local fire departments when a wildland-urban interface fire gets out of control. Strong readiness capability at the state and local levels go hand-in-hand with optimal efficiency at the Federal level. The level of funding being proposed will provide a more optimum efficiency level for the states and local fire departments in the impacted areas.

Budget

To support this initiative for community involvement and participation, additional funding of $88 million in FY 2001 is required. The USDA Forest Service proposes increases of $53.8 million for state and volunteer fire assistance, as well as an additional $12.5 million for economic action programs and $12 million for forest health activity. The Department of the Interior proposes a new program to support rural fire districts, particularly those intermingled with Bureau of Land Management lands. Funding of $10 million is proposed for FY 2001.

5. Be Accountable.

A Cabinet-level management structure should be established to ensure that the actions recommended by the Departments receive the highest priority. The Secretaries of Agriculture and the Interior should co-chair this effort. Regional integrated management teams should be accountable for fuels treatment, restoration, and fire preparedness. Local teams, working closely with communities and other agency partners, would manage projects on the ground.

Wildland fires know no jurisdictional boundaries. It is for that reason that the five primary Federal agencies that have operational responsibility for preparing for, and responding to, wildfires, formed the National Interagency Fire Center. The Fire Center is a model of cross-agency cooperation and accountability, and it provides a key focal point for coordination with state and local firefighting efforts.

As with fighting fires, Federal, State and local governments will have to cooperate to restore damaged lands, invest in protecting affected communities, and reduce hazardous fuel loads.

A number of existing, regional integrated management teams are in place to assist in the setting of regional priorities for land restoration, fuels treatment, and community cooperation and outreach. The Departments recommend that these regional structures be utilized and/or retooled, as appropriate, to provide a focal point for these initiatives.

The Departments would also establish locally led teams with the Department of Commerce and other appropriate agencies. These integrated teams would identify specific land restoration, fuels treatment, and preparedness projects; coordinate environmental reviews and consultations; facilitate and encourage public participation; and monitor and evaluate project implementation.

Because of the critical importance of these matters, the Departments recommend Cabinet-level oversight of the implementation of these initiatives, co-chaired by the Secretaries of Agriculture and the Interior. Among other things, the new management team would be responsible for ensuring that appropriate performance objectives are established and met, ensuring that adequate financial and other resources are made available, establishing a system for identifying and addressing implementation issues promptly, and ensuring that the environmental reviews required by the National Environmental Policy Act, and all other environmental requirements, are undertaken and completed on a timely basis.

The Departments recommend that the Cabinet-level group assess the progress towards implementing these tasks, and provide periodic reports to the President.

Appendix: Funding Summary

Nearly $1.6 billion in additional resources over the President's FY2001 Budget requests for the USDA Forest Service and the US Department of the Interior will be required in FY 2001 to meet the objectives of this report. This includes $897 million more for the USDA Forest Service, and $682 million more for the US Department of the Interior.

To continue the momentum gained by the additional FY 2001 resources, future funding for fiscal year 2002 and the out years will need to be maintained for these same program components. Tables 1 through 3 summarize these needs for FY2001, by totals and by each Department.

Table 1. FY 2001 Funding Summary, USDA Forest Service and the US Department of the Interior

USDA Forest Service and the US DOI	FY 2000 final	FY 2001 President's budget	FY 2001 additional needs	FY 2001 total needs	FY 2001 House action	FY 2001 Senate action
		...Dollars in thousands...				
Fire preparedness	$584,618	$586,433	$336,381	$922,814	$586,433	$586,683
Fire operations	323,995	331,136	677,711	1,008,847	320,107	579,394
Emergency fire contingency	290,000	150,000	476,000	626,000	200,000	150,000
State fire assistance	23,929	30,006	42,994	73,000	25,000	28,042
Volunteer fire assistance	3,240	2,510	10,790	13,300	5,000	5,000
Rural fire assistance	0	0	10,000	10,000	0	0
Forest health management	62,075	62,842	12,000	74,842	63,794	63,383
Economic action programs	20,198	17,267	12,500	29,767	14,246	23,486
Total	**$1,308,055**	**$1,180,194**	**$1,578,376**	**$2,758,570**	**$1,214,580**	**$1,435,988**

Table 2. FY 2001 Funding Summary, USDA Forest Service

USDA Forest Service	FY 2000 final	FY 2001 President's budget	FY 2001 additional needs	FY 2001 total needs	FY 2001 House action	FY 2001 Senate action
		...Dollars in thousands...				
Fire preparedness	$408,768	$404,343	$203,547	$607,890	$404,343	$404,593
Fire operations	208,888	216,029	338, 971	555,000	210,000	333,300
Emergency fire contingency	90,000	150,000	276,000	426,000	0	150,000
State fire assistance	23,929	30,006	42,994	73,000	25,000	28,042
Volunteer fire assistance	3,240	2,510	10,790	13,300	5,000	5,000
Rural fire assistance	0	0	0	0	0	0
Forest health management	62,075	62,842	12,000	74,842	63,794	63,383
Economic action programs	20,198	17,267	12,500	29,767	14,246	23,486
Total	**$817,098**	**$882,997**	**$896,802**	**$1,779,799**	**$722,383**	**$1,007,804**

Table 3. FY 2001 Funding Summary, US Department of the Interior

US Department of the Interior	FY 2000 final	FY 2001 President's budget	FY 2001 additional needs	FY 2001 total needs	FY 2001 House action	FY 2001 Senate action
		...Dollars in thousands...				
Fire preparedness	$175,850	$182,090	$132,834	$314,924	$182,090	$182,090
Fire operations	115,107	115,107	338,740	453,847	110,107	246,094
Emergency fire contingency	200,000	0	200,000	200,000	200,000	0
State fire assistance**	0	0	0	0	0	0
Volunteer fire assistance**	0	0	0	0	0	0
Rural fire assistance*	0	0	10,000	10,000	0	0
Forest health management**	0	0	0	0	0	0
Economic action programs**	0	0	0	0	0	0
Total	**$490,957**	**$297,197**	**$681,574**	**$978,771**	**$492,197**	**$428,184**

*New program proposed in the Report to the President.

**No DOI equivalent to these USDA Forest Service programs.

The following briefly describes each program component, including total funding requirements for FY 2001 (President's request plus additional resources now being requested):

Fire Preparedness

Provides the fire management organization with the capability to prevent, detect, or take prompt, effective initial attack suppression action on wildfires. Preparedness activities include planning, prevention, detection, information and education, pre-incident training, equipment and supply purchase and replacement, and other preparedness activities. Funding estimates are based on prediction models that determine a cost-effective level of preparedness for initial and extended attack.

- For the USDA Forest Service $608 million for recurring readiness and program management costs, including fire science and research.
- For the US Department of the Interior $315 million for recurring readiness and program management costs; one-time readiness and program management costs; fire science and research; and fire management facilities repair.

Fire Operations—Suppression

Provides costs directly associated with fire suppression activities (personnel costs, contracts, aviation, supplies, and so on)

- For the USDA Forest Service $320 million.
- For US Department of the Interior $153 million.

Fire Operations—Fuels Management

Use of prescribed fire, mechanical removal, and other techniques to remove/reduce hazardous levels of fuels in order to reduce risks to communities and to restore natural fire regimes to wildlands. Includes funding to support non-fire disciplines (biology, wildlife, hydrologists, etc.) necessary to conduct planning and assessment activities.

- For the USDA Forest Service $190 million including $20 million for research and $11.5 million to support environmental clearances.
- For US Department of the Interior $195 million, including at least $20 million to support environmental clearances.

Fire Operations—Burned Area Rehabilitation

Provides for post-fire stabilization and restoration of burned lands. Short-term stabilization efforts remove hazards and address erosion, flooding, and mudslide problems. Longer-term rehabilitation are targeted on those portions of fires that burned severely, thus less likely to revegetate naturally. Special attention focused on lands subject to non-native, invasive species.

- For the USDA Forest Service $45 million.
- For US Department of the Interior $105 million.
- Both Departments will have flexibility to increase these levels if estimated needs in other fire-related activities are less than currently projected.

Emergency Fire Contingency

Provides additional emergency funds for Fire Suppression activities that are only released to the agency upon Presidential declaration that regular suppression funds are insufficient. These funds ensure that funding is always available to fight wildfires.

- For the USDA Forest Service $426 million, of which $276 is to repay the Knutsen-Vandenberg (K–V) Fund.
- For US Department of the Interior $200 million, including estimated $75 million to repay a September 2000 Section 102 transfer.

State and Volunteer Fire Assistance

State fire assistance in the USDA Forest Service provides technical training, financial assistance, and equipment to States to ensure that Federal, State, and local agencies can deliver a uniform and coordinated suppression response to wildfire. Special emphasis will be placed on a Wildland-Urban Interface component.

- For the USDA Forest Service $86 million including $20 million for incentives for high priority forest management practices on their lands to reduce fire risk and fuel loads and $4 million for high priority fire education and prevention programs in the wildland-urban interface.
- US Department of the Interior has no equivalent program; see Rural Fire Assistance program below.

Rural Fire Assistance

Rural fire district assistance in the Department of the Interior is a new program to provide technical and financial support to volunteer fire departments that protect communities with populations of less than 10,000. Emphasis is on areas intermingled with lands managed by the Interior Department (especially the Bureau of Land Management).

- USDA Forest Service has no equivalent program; see State and Volunteer Fire Assistance above.
- For US Department of the Interior $10 million.

Forest Health Management

Provides forest health technical and financial assistance to all Federal agencies, Tribal governments, and States in carrying out a coordinated nationwide program of detecting, monitoring, evaluating, preventing and suppressing invasive forest insects and diseases.

- For the USDA Forest Service $75 million, including funding for the management and control of invasive species as a result of the fires and are based on estimates of detection, evaluation, and high priority management and control treatments.
- US Department of the Interior has no equivalent program.

Economic Action Program

Provides technical and financial assistance to address the long-term health of rural areas, by helping communities develop opportunities and enterprises through diversified uses of forest resources.

- For the USDA Forest Service $30 million, including funding for rural community assistance, forest products conservation and recycling, and market development and expansion.
- US Department of the Interior has no equivalent program.

Attachment A

Wildland Preparedness Funding History

Department of the Interior and USDA Forest Service

(BA in millions)

	FY 1999 enacted	FY 2000 enacted	FY 2001 request
Department of the Interior	$157	$176	$182
USDA Forest Service	325	360	404*
Total	**$482**	**$536**	**$586**

*BA reflects the revised USDA Forest Service budget structure in FY 2001.

Attachment B—Acres Treated

Year	USDA Forest Service	Department of the Interior
	Acres in thousands	
1993	385	368
1994	384	334
1995	570	348
1996	617	298
1997	1,097	503
1998	1,489	620
1999	1,412	765

Appendix B—List of Workshop Attendees

Allen, Craig D.
USGS-BRD
USGS Jemez Mountain Field Station
Los Alamos, NM 87544
Phone: 505–672–3861, ext. 541
Email: craig_allen@usgs.gov
Fax: 505–672–9607

Atkinson, R. Dwight
US EPA
401 M St., SW (4504–F)
Washington, DC 20460
Phone: 202–260–2771
Email: atkinson.dwight@epa.gov
Fax: 202–260–9960

Balice, Randy G.
Ecology Group
Los Alamo National Lab, MS M887
Los Alamos, NM 87545
Phone: 505–665–1270
Email: balice@lanl.gov
Fax: 505–667–0731

Barber, Skip
FEMA, Region X
6616 Lakeway Dr.
Anchorage, AK 99502–1950
Phone: 907–243–3584
Email: sbarber@alaska.net
Fax: 907–243–4294

Betancourt, Julio L.
USGS-WRD
1675 W. Anklam Road
Tucson, AZ 85745
Phone: 520–670–6821
Email: jlbetanc@usgs.gov
Fax: 520–670–6806

Beyers, Jan
USDA Forest Service
4955 Canyon Crest Dr.
Riverside, CA 92507
Phone: 909–680–1527
Email: jbeyers@fs.fed.us
Fax: 909–680–1501

Bigio, Erica
USGS
DFC, Box 25046, MS 966
Denver, CO 80225
Phone: 303–273–8604
Fax: 303–273–8600

Britton, Linda
USGS
DFC, Box 25046, MS 406
Denver, CO 80225
Phone: 303–236–5950, ext. 210
Email: lbritton@usgs.gov
Fax: 303–236–5919

Calfee, Robin D.
USGS-BRD-CERC
4200 New Haven Road
Columbia, MO 65201
Phone: 573–875–5399
Email: robin_calfee@usgs.gov
Fax: 573–876–1896

Cannon, Susan
USGS
DFC, Box 25046, MS 966
Denver, CO 80225
Phone: 303–273–8604
Email: cannon@usgs.gov
Fax: 303–273–8600

Casadevall, Thomas J.
USGS
DFC, Box 25046, MS 150
Denver, CO 80225
Phone: 303–202–4740
Email: tcasadev@usgs.gov
Fax: 303–202–4742

Case, Lee
USGS
2329 West Orton Circle
Salt Lake City, UT 84119–2047
Phone: 801–908–5003
Email: hlcase@usgs.gov
Fax: 801–908–5003

Chong, Geneva
USGS-BRD
NREL, CSU
Ft Collins, CO 80523–1499
Phone: 970–491–5835
Email: Geneva Chong@usgs.gov
Fax: 970–491–1965

Colof, Stan
USGS-BRD
12201 Sunrise Valley Dr., MS–300
Reston, VA 20192
Phone: 703–648–4083
Email: stan_coloff@usgs.gov
Fax: 703–648–4238

D'Erchia, Frank
USGS BRD
DFC, Bldg, 20, MS 300
Denver, CO 80225
Phone: 303–236–2730, 246
Email: frank_derchia@usgs.gov
Fax: 303–236–2733

Davis, Bob
USGS-WRD
Helena, MT 59601
Phone: 406–457–5901
Email: rdavis@usgs.gov
Fax: 406–457–5990

Despain, Don G.
USGS
Box 173492
Bozeman, MT 59717–3492
Phone: 406–994–7257
Email: ddespain@montana.edu
Fax: 406–994–6556

DiNardo, Thomas P.
USGS
DFC, Box 25046, MS 516
Denver, CO 80225–0046
Phone: 303–202–4106
Email: tpdinardo@usgs.gov
Fax: 303–202–4020

Donato, Mary
USGS
230 Collins Road
Boise, ID 83702
Phone: 208–387–1350
Email: mdonato@usgs.gov
Fax: 208–387–1372

Douglas, Jim
DOI/MRPS
1849 C St NW, MS 7356
Washington, DC 20240
Phone: 202–208–7963
Email: Jim_Douglas@IOS.DOI.gov
Fax: 202–208–5078

Edminster, Carl
USDA Forest Service
2500 South Pine Knoll Dr.
Flagstaff, AZ 86001
Phone: 520–556–2177
Email: cedminster@fs.fed.us
Fax: 520–556–2130

Elliott, John G.
USGS WRD-CO
DFC, Box 25046, MS 415
Denver, CO 80225
Phone: 303–236–4882, ext. 296
Email: jelliott@usgs.gov
Fax: 303–236–4912

Eppinger, Robert G.
USGS
DFC, Box 25046, MS 973
Denver, CO 80225
Phone: 303–236–2468
Email: eppinger@usgs.gov
Fax: 303–236–3200

Ethridge, Max
USGS
1400 Independence Road
Rolla, MO 65401
Phone: 573–308–3800
Email: methridge@usgs.gov

Evans, David
NIST
100 Bureau Dr., Stop 8640
Gaithersburg, MD 20899–8640
Phone: 301–975–6897
Email: dave.evans@nist.gov
Fax: 301–975–4052

Ferreira, Rodger F.
USGS WRD-NM
5338 Montgomery NE
Albuquerque, NM 87109
Phone: 505–830–7902
Email: ferreira@usg.gov
Fax: 505–830–7998

Fitzpatrick, Dan
USGS
1608 Mt. View Road
Rapid City, SD 57702
Phone: 605–355–4560
Email: djfitzpa@usgs.gov
Fax: 605–355–4523

Fitzpatrick, Joan
USGS
DFC, Box 25046, MS 150
Denver, CO 80225
Phone: 303–202–4746
Email: jfitz@usgs.gov
Fax: 303–202–4742

Grace, Susan L.
USGS
200 Cajun Dome Blvd.
Lafayette, LA 70506
Phone: 337–266–8618
Email: sue_grace@usgs.gov
Fax: 337–266–8592

Haire, Sandra
USGS
4512 McMurry Ave.
Ft. Collins, CO 80525
Phone: 970–226–9367
Email: sandy_haire@usgs.gov
Fax: 970–226–9230

Hamilton, Larry
BLM
3833 S. Development Ave.
Boise, ID 83705
Phone: 208–387–5446
Email: Larry_Hamilton@nifc.blm.gov
Fax: 208–387–5376

Hamins, Anthony
NIST
NIST, Stop 8640
Gaithersburg, MD 20899–8640
Phone: 301–975–6590
Email: anthony.hamins@nist.gov
Fax: 301–975–4052

Harden, Jennifer
USGS
345 Middlefield Rd, MS–962
Menlo Park, CA 94025
Phone: 650–329–4949
Email: jharden@usgs.gov
Fax: 650–329–4920

Haugh, John R.
BLM, Wash, DC
DOI, BLM, 1849 C St. NW, MS–1050LS
Washington, DC 20240
Phone: 202–452–5071
Email: john_haugh@blm,gov
Fax: 202–452–5112

Hutt, Mike
USGS
DFC, Box 25046, MS 516
Denver, CO 80225–0046
Phone: 303–202–4296
Email: mehutt@usgs.gov
Fax: 303–202–4354

Jachowski, Richard L.
USGS
P.O. Box 173492
Bozeman, MT 59717–3492
Phone: 406–994–5304
Email: richard_jachowski@usgs.gov
Fax: 406–994–6556

Jackson, Bill
National Park Service
1201 Oakridge Dr.
Ft. Collins, CO 80525
Phone: 970–225–3503
Email: bill_jackson@nps.gov
Fax: 970–225–9965

Jarrett, Bob
USGS
DFC, P.O. Box 25046, MS 412
Denver, CO 80225
Phone: 303–236–6447
Email: rjarrett@usgs.gov
Fax: 303–236–5034

Kelley, Michael A.
USGS
USGS National Center
12201 Sunrise Valley Dr., MS 105
Reston, VA
Phone: 703–648–4635
Email: mkelley@usgs.gov
Fax: 703–648–5068

Kelmelis, John A.
USGS
516 National Center
Reston, VA 20192
Phone: 703–648–6133
Email: jkelmeli@usgs.gov
Fax: 703–648–5792

Key, Carl
USGS
Glacier Fld Sta, c/o Glacier Nat'l Park, West Glacier
MT 59936
Phone: 406–888–7991
Email: carl_key@usgs.gov
Fax: 406–888–7990

Klaver, Jacqueline M.
USGS EROS
47914 252nd Street
Sioux Falls, SD 57198–0001
Phone: 605–594–6961
Email: jklaver@edcmail.cr.usgs.gov
Fax: 605–594–6529

Kokaly, Raymond
USGS
DFC, Box 25045, MS 973
Denver, CO 80225
Phone: 303–236–1359
Email: raymond@speclab.cr.usgs.gov
Fax: 303–236–3200

Kotliar, Tasha
USGS BRD
4512 McMurry Ave.
Ft. Collins, CO 80525
Phone: 970–226–9446
Email: tasha_kotliar@usgs.gov
Fax: 970–226–0230

Larson, Diane
USGS
100 Ecology Bldg, 1987 Upper Buford Cir.
St Paul, MN 55108
Phone: 612–625–9271
Email: dlarson@usgs.gov
Fax: 612–624–6777

Leavesley, George H.
USGS
DFC, Box 25046, MS 412
Denver, C0 80225
Phone: 303–236–5026
Email: george@usgs.gov
Fax: 303–236–5034

Leenheer, Jerry A.
USGS
DFC, Box 25046, MS 408
Denver, CO 80225
Phone: 303–278–0377
Email: leenheer@usgs.gov
Fax: 303–278–3936

Leenhouts, Bill
US Fish & Wildlife
3833 S. Development Ave.
Boise, ID 83705
Phone: 208–387–5584
Email: Bill_Leenhouts@fws.gov
Fax: 208–387–5668

Lemen, Robert M.
USGS-NMD/MCMC
1400 Independence Rd.
Rolla, MO 65401
Phone: 573–308–3736
Email: rlemen@usgs.gov
Fax: 573–308–3652

Livingston, Russ
USGS, CR
DFC, Box 25046, MS 406
Denver, CO 80225
Phone: 303–526–5627
Email: rkliving@usgs.gov
Fax: 303–236–5919

Love, David W.
NM Bureau of Mines
NM Inst of Mining & Tech
801 Leroy Pl.
Socorro, NM 87801–4796
Phone: 505–835–5148
Email: dave@gis.nmt.edu
Fax: 505–835–6333

Manies, Kristen
USGS
345 Middlefield Rd, MS 962
Menlo Park, CA 94025
Phone: 650–329–5010
Email: kmanies@usgs.gov
Fax: 650–329–4920

Martin, Deborah A.
USGS
3215 Marine St., Suite E–127
Boulder, CO 80303–1066
Phone: 303–541–3024
Email: damartin@usgs.gov
Fax: 303–447–2505

McWreath, Harry
USGS
570 National Center
Reston, VA 20192
Phone: 703–648–5454
hmcwreath@usgs.gov

Miller, Melanie
BLM
3833 Development Ave.
Boise, ID 83705–5354
Phone: 208–387–5165
Email: melanie_miller@usgs.gov
Fax: 208–387–5179

Moody, John A.
USGS-NRP
Regional Center
Lakewood, CO 80225
Phone: 303–236–0606
Email: moody@usgs.gov
Fax: 303–236–5034

Murray, Dan
USDA
6200 Jefferson NE
Albuquerque, NM 87109
Phone: 505–761–4436
Email: dan.murray@nm.usda.gov

Myers, Nathan
USGS-WRD NM
5338 Montgomery NE
Albuquerque, NM 87109
Phone: 505–830–7942
Email: nmyers@usgs.gov
Fax: 505–830–7998

Ohlen, Donald
USGS
EROS Data Center
Sioux Falls, SD 57198
Phone: 605–594–6026
Email: ohlen@edcmail.cr.usgs.gov
Fax: 605–594–6529

O'Shea, Thomas J.
USGS
4512 McMurry Ave.
Ft. Collins, CO 80525
Phone: 970–226–9397
Email: Tom_O'Shea@usgs.gov
Fax: 970–226–9230

Parrett, Chuck
USGS-WRD
Helena, MT 59601
Phone: 406–457–5918
Email: cparrett@usgs.gov
Fax: 406–457–5990

Pierce, Ken
USGS
P.O. Box 173492
Montana State Univ.
Bozeman, MT 59717
Phone: 406–994–5085
Email: kpierce@usgs.gov
Fax: 406–994–5122

Plumlee, Geoff
USGS-GD
DFC, MS 935
Denver, CO 80225
Phone: 303–236–1200
Email: Gplumlee@usgs.gov
Fax: 303–236–1229

Ponce, Stan
USGS-HQ
Reston, VA
Phone: 703–648–7043
Email: sponse@usgs.gov
Fax: 703–648–7031

Posson, Douglas
USGS
4512 McMurry Ave.
Ft. Collins, CO 80525
Phone: 970–226–9398
Email: douglas_r_posson@usgs.gov
Fax: 970–226–9230

Prince, Keith
USGS,WRD-WR
345 Middlefield Rd., MS 470
Menlo Park, CA 94025
Phone: 650–329–4087
Email: krprince@usgs.gov
Fax: 650–329–4463

Rees, Terry F.
USGS
333 West Nye Lane, Rm 228
Carson City, NM 89701–6775
Phone: 775–887–7635
Email: tfrees@usgs.gov
Fax: 775–887–7621

Rehm, Ronald
NIST
Bldg 224, Rm B260
Gaithersburg, MD 20899
Phone: 301–975–2704
Email: ronald.rehn@nist.gov
Fax: 301–975–4052

Robichaud, Peter
USDA-Forest Service
1221 S. Main St.
Moscow, ID 83843
Phone: 208–883–2349
Email: probichaud@fs.fed.us
Fax: 208–883–2318

Rohde, Wayne G.
USGS EROS
Mundt Federal Bldg.
Sioux Falls, SD 57198
Phone: 605–594–6126
Email: rohde@usgs.gov
Fax: 605–594–6154

Root, Ralph R.
USGS
DFC, Box 25046, MS 302
Denver, CO 80225
Phone: 303–202–4232
Email: ralph_root@usgs.gov
Fax: 303–202–4219

Ryan, Kevin C.
USFS
Rocky Mtn Research Sta, Box 8089
Missoula, MT 59807
Phone: 406–329–4807
Email: kryan@fs.fed.us
Fax: 406–329–4877

Simpson, Stuart
USDA-NRCS
655 Parfet St., Room E–200C
Lakewood, CO 80215
Phone: 303–236–2886
Email: stuart.simpson@co.usda.gov
Fax: 303–236–2817

Slate, Janet L.
USGS
DFC, Box 25046, MS 913
Denver, CO 80225
Phone: 303–236–1284
Email: jslate@usgs.gov
Fax: 303–236–0214

Sloan, Jeff
USGS
DFC, Box 25046, MS 516
Denver, CO 80225–0046
Phone: 303–202–4355, ext. 232
Email: jlsoan@usgs.gov
Fax: 303–202–4354

Snyder, James R.
USGS
Big Cypress Field Sta, HCR 61, Box 110
Ochopee, FL 34141
Phone: 941–695–2000, ext. 321
Email: jim_snyder@usgs.gov
Fax: 941–695–3007

Stephen, Douglas
National Park Service
12795 W. Alameda Pkwy, P.O. Box 25287
Denver, CO 80225
Phone: 303–969–2947
Email: doug_stephen@nps.gov
Fax: 303–969–2037

Tate, Cathy M.
USGS
DFC, Box 25046, MS 415
Denver, CO 80225
Phone: 303–236–4882 ext. 277
Email: cmtate@usgs.gov
Fax: 303–236–4912

Taylor, Jonathan
USGS
4512 McMurry Ave.
Ft. Collins, CO 80525
Phone: 970–226–9438
Email: jonathan_taylor@usgs.gov
Fax: 970–226–9230

van Wagtendonk, Jan
USGS WERC
Yosemite Field Station
El Portal, CA 95318
Phone: 209–379–1885
Email: jan_van_wagtendonk@usgs.gov
Fax: 209–379–1886

Veenhuis, Jack
USGS-WRD-NM
5338 Montgomery NE
Albuquerque NM 87109
Phone: 505–830–7957
Email: veenhuis@usgs.gov
Fax: 505–830–7998

Waltemeyer, Scott
USGS-WRD-NM
5338 Montgomery NE
Albuquerque, NM 87109
Phone: 505–830–7953
Email: sdw@usgs.gov
Fax: 505–830–7998

Wickland, Kimberly
USGS
3215 Marine St., Suite E–127
Boulder, CO 80303–1066
Phone: 303–541–3072
Email: kpwick@usgs.gov
Fax: 303–447–2505

Wilds, Stan
USGS
DFC, Box 2504, MS 516
Denver, CO 80225
Phone: 303–202–4073
Email: swilds@usgs.gov
Fax: 303–202–4354

Wilkinson, Scott
USDA-Forest Service
Jemez Ranger District
Post Office Box 150
Jemez Springs, NM 870235
Phone: 505–829–3535
Email: scottwilkinson@fs.fed.us

Wilson, Gary
USGS
University of Missouri
Columbia, MO 65211
Phone: 573–882–8645
Email: gary_willson@usgs.gov
Fax: 573–884–5133

Woodruff, Laurel
USGS
2280 Woodale Dr.
Mounds View, MN 55112
Phone: 763–783–3291
Email: woodruff@usgs.gov
Fax: 763–783–3103

Zelt, Ronald B.
USGS
2617 E. Lincolnway, Suite B
Cheyenne, WY 82001
Phone: 307–778–2931, ext. 2712
Email: rbzelt@usgs.gov
Fax: 307–778–2764

Zhu, Zhiliang
USGS
EROS Data Center
Sioux Falls, SD 57198
Phone: 605–594–6131
Email: zhu@usgs.gov
Fax: 605–594–6529

Zimmerman, Tom
NPS
National Interagency Fire Center
3833 South Development Avenue
Boise, ID 83705
Phone: 208–387–5215
Email: Tom_Zimmerman@nps.gov

Appendix C—Workshop Material and Information

Thanks and gratitude go out to the following people without whom the Second USGS Wildland Fire Workshop would not have taken place:

Organizing Committee

Russ Livingston, Chairman
Sue Cannon
Frank D'Erchia
Rodger Ferreira
Mike Hutt
John Moody

Acknowledgments (the key people "behind the scenes")

Linda Britton	Abstracts, and so forth
Carole Connolly	Accounting
John Evans	Cover design for binders
Barbara Henson	Name tag assembly
Cecelia Ortiz	Registration, transportation
Darla Straka	Name tag design and assembly
Anne Sueur	Registration
Ed Swibas	Document printing support

U.S. Department of the Interior
U.S. Geological Survey
Wildland Fire Workshop

October 31–November 3, 2000
Los Alamos, New Mexico

Purpose: The purpose of the workshop was to bring together those in USGS and other Federal agencies who are involved in some aspect of fire science in order to better understand the scope of collective activities and needs, and thus to begin to develop a plan for the future role of USGS in fire science.

Objectives: (1) To review current USGS, DOI, and USDA–Forest Service wildland-fire-science activities, issues, and policies; (2) to open a dialog between bureau and agency activities leading to improved communications; (3) to identify potential wildland-fire activities and customers; and (4) to develop a plan of action leading to improved cooperation and coordination between bureau and agency wildland-fire-science, research, and operational activities that effectively meets the needs of wildland-fire customers.

Tuesday, October 31, 2000

Moderators—*Stan Ponce, Senior Liaison for Science Partnerships, USGS;*
Russ Livingston, Program Officer, Central Region, USGS

1:00–1:10 Introductory Remarks/Announcements/and so forth

1:10–1:25 Welcome—*Dr. Chick Keller, Los Alamos National Laboratory*

1:25–1:40 Keynote Address—*Tom Casadevall, Central Regional Director, USGS*

1:40–2:00 Keynote Address—*Jim Douglas, Office of Managing Risk and Public Safety, Office of the Secretary, Department of the Interior*

"Insights on Federal and DOI Fire Policies"

2:00–2:30 Break

2:30–4:30 Discussion of Customer Fire-Science Needs (two panels, each with 20-minute representative remarks and followed by 20-minute discussion)

Panel I

John Haugh, representative of Bureau of Land Management
Bill Leenhouts, representative of U.S. Fish and Wildlife Service
Hal Luedtke, representative of Bureau of Indian Affairs
Tom Zimmerman, representative of National Park Service
Dave Cleaves, representative of USDA—Forest Service

6:00–9:00 Reception Icebreaker

Wednesday, November 1, 2000

Moderator—*John Moody, Research Hydrologist, USGS*

8:00 – 9:20	Discussion of Customer Fire-Science Needs—Continued
	Panel II
	Pete Robichaud, representing the U.S. Forest Service Rocky Mountain Research Station Bob Clark, representing the Joint Fire Science Program Dwight Atkinson, representing U.S. Environmental Protection Agency
9:20–9:50	Break
9:50–10:20	Biologic/Ecologic Overview—*Sue Grace, Research Ecologist, USGS*
10:20–10:50	Cartographic/Geographic Overview—*John Kelmelis, Chief Scientist for Geography, USGS*
10:50–11:20	Hydrologic Overview—*Julio Betancourt, Research Physical Scientist, USGS*
11:20–11:50	Geologic Overview—*Sue Cannon, Research Geologist, USGS*
11:50–12:50	Lunch
1:00–4:00	Field Trip 1—Overview of Fire-Science Issues Host—*Craig Allen, Research Ecologist, USGS*
5:00–6:30	Poster Session
6:30	Dinner
	Master of Ceremonies—*Stan Coloff, Joint Fire Science Program Governing Board Representative, USGS*
	Speaker—*Larry Hamilton, Bureau of Land Management, Director of the National Office of Fire and Aviation*
	"Bridges to Build"

Thursday, November 2, 2000

Moderators—*Rodger Ferreira, Associate District Chief, New Mexico District, USGS; Sue Cannon, Research Geologist, USGS*

8:00–10:00 Concurrent Technical Sessions (five presentations, each for 20 minutes and followed by 20-minute discussion)

Technical Session I—Tools and Techniques
(Moderator—*Rodger Ferreira*)

- GeoMac Wildland Fire Support—*Michael Hutt*
- Rapid Update of Digital Raster Graphics for Fire Support—*Jeff Sloan*
- Fire Potential Index to Assess Forest Fire Hazard—*Jacqueline Klaver*
- A Decision Support System for Impact Analysis of Wildland Fires—*George Leavesley, Steven Markstrom, and Roland Viger*

Technical Session II—Post-Fire Watershed Response—Physical and Biological
(Moderator—*Sue Cannon*)

- Wildfire Flood-Hazard Research in the Rocky Mountains—*Robert Jarrett and Tom Browning*
- Twenty Years of Post-Fire Vegetation Development in Yellowstone National Park—*Don Despain and Eric Miller*
- The Effects of Fire on Avian Communities in Western Forests: General Patterns and Sources of Variation—*Natasha Kotliar*
- The Effects of Wildfire on the Magnitude and Frequency of Occurrence of Large Peak Flows, Bandelier National Monument, New Mexico—*Jack Veenhuis (presented by Craig Allen)*
- Conditions for Debris-Flow Generation from Recently Burned Watersheds—*Sue Cannon*

10:00–10:30 Break

10:30–12 :00 Concurrent Breakout Sessions

Breakout Session I—Tools and Techniques
(Moderator—*Rodger Ferreira;* Facilitator—*Linda Britton*)

Breakout Session II—Post-Fire Watershed Response—Physical and Biological
(Moderator—*Sue Cannon;* Facilitator—*Russ Livingston*)

12:00–1:00 Lunch

1:00–5:00 Field Trip 2—Upper Rendija Canyon Research Activities
Hosts—*John Moody, Research Hydrologist, USGS; Deborah Martin, Research Hydrologist, USGS; Sue Cannon, Research Geologist, USGS*

Friday, November 3, 2000

Moderators—*Frank D'Erchia, Associate Regional Biologist, USGS;*
Mike Hutt, Chief of Systems Technology and Development, USGS

8:00–9:40 Concurrent Technical Sessions (four presentations, each for 20 minutes and followed by 20-minute discussion)

Technical Session III—Post-Fire Watershed Response—Chemical
(Moderator—*Frank D'Erchia;* Facilitator—*Stan Coloff*)

- A Comprehensive Approach to Post-Fire Water-Quality Monitoring and Decision Making—*Deborah Martin*
- Wildfire Hazards and Risks are More Than Debris Flows and Floods: A Big Picture Perspective—*Cathy Tate*
- Environmental Implications of Fire-Fighting Chemicals—*Susan Finger, Steven Hamilton, Diane Larson, Barry Poulton, and Nimish Vyas*
- The Biogeochemistry of Fire: Modeling and Measuring the Impact of Fire on Carbon, Nutrients, and Atmospheric Emissions—*Jennifer Harden and A. David McGuire*

Technical Session IV—Large-Scale Integrated Approaches
(Moderator—*Mike Hutt;* Facilitator—*Joan Fitzpatrick*)

Possible Fire-Science Program: Ecosystem Response to Wildfire—The Sediment Story—*John Moody and Deborah Martin*

- Wildfires and Climatic History—*Ken Pierce, Don Despain, and Dick Jachowski*
- Fire, Thresholds, and USGS: Local to Global-Scale Research Opportunities—*Craig Allen*
- The Wildland/Urban Human Fire Interface—The WUFI Revisited—*Jonathan Taylor*

9:40–11:20 Concurrent Breakout Sessions (including morning break)

Breakout Session III— Post-Fire Watershed Response—Chemical
(Moderator—*Frank D'Erchia*)

Breakout Session IV— Large-Scale Integrated Approaches
(Moderator—*Mike Hutt*)

11:20–12:00 Customer Priorities/Discussion/Wrapup
Moderator—*Joan Fitzpatrick, Deputy, Central Region Director, USGS*

12:00–1:00 Lunch

1:00– Ad Hoc Discussion of Future Role of USGS in Wildland Fire Science

Appendix D—Poster Session

Fuels Management and Wildlife Habitat Relationships in the Northwest and Southeast

R. Bruce Bury (Bruce_Bury@usgs.gov), USGS Forest and Rangeland Ecosystem Science Center, Corvallis, Oregon (541–758–7788)

Don J. Major (djm@nr.usu.edu), Department of Fisheries & Wildlife, Utah State University Logan, Utah (435–797–3892)

We are midway into a major research project examining how terrestrial, forest-floor wildlife (mostly salamanders) respond to different fire regimes in both the Pacific Northwest and Southeastern United States. Our research objectives are to: (1) Evaluate the fire vulnerability of structural components (for example, downed wood) used by herpetofauna; (2) compare structural components of the forest floor and their use by herpetofauna across burned and unburned sites; and (3) determine the diversity, abundance and population demographies of species related to forest-floor structure. We are examining the effects of wildfire in a retrospective study less than 5 years post burn (Pacific Northwest only), and prescribed fire with pre- and post-fire surveys (Pacific Northwest and Southeast).

Products and technical assistance from the project include: Web Site at FRESC with an "Annotated Bibliography on the Effects of Fire on Herpetofauna," a manuscript in preparation (Fire Effects Research on Amphibians and Reptiles: A Critique), and presentations (for example, invited paper at The Wildlife Society, Nashville, Tennessee, September 2000). New sampling protocols and results of field research will be submitted to peer-reviewed journals.

Our research studies are supported by the Joint Fire Science Program (BLM/USFS/and so forth) with supplemental funding and cooperation from the BLM Oregon State Office, USGS FRESC, U.S. Forest Service (Klamath and Siskiyou National Forests), and others.

The Effects of UVB Radiation on Fire-Fighting Chemicals

Robin D. Calfee (robin_calfee@usgs.gov), U.S. Geological Survey, Columbia Environmental Research Center
4200 New Haven Road, Columbia, MO 65201

Edward E. Little (edward_little@usgs.gov), U.S. Geological Survey, Columbia Environmental Research Center
4200 New Haven Road, Columbia, MO 65201

The interactive effects of UV and fire-retardant chemicals were evaluated by exposing juvenile rainbow trout (*Onchorhyncus mykiss*) and Southern leopard frog (*Rana sphenocephala*) tadpoles to six fire-retardant formulations with and without sodium ferrocyanide (YPS) and to YPS alone under three simulated UV light treatments. The chemical concentrations tested represented a range of concentrations that may result following field application. The underwater UV intensities approximated 2 to 10 percent of surface irradiance measured in various aquatic habitats and were within tolerance limits for the species tested. Mortality of rainbow trout and Southern leopard frog tadpoles exposed to Fire-Trol GTS–R, Fire-Trol 300–F, Fire-Trol LCA–R, and Fire-Trol LCA–F was significantly increased in the presence of UV radiation when YPS was present in the formulation. Limited tests indicate that the endangered boreal toad and Southern leopard frog were similar in their sensitivity to these chemicals. Photoenhancement of fire-retardant chemicals can occur in a range of habitats and may be of concern even when optical clarity is low.

Developing a Recurrence Probability for Post-Fire Floods by Using Alluvial Stratigraphy

John G. Elliott (jelliott@usgs.gov), U.S. Geological Survey, Lakewood, Colorado
(303–236–4882 ext. 296)

Randolph S. Parker (rsparker@usgs.gov), U.S. Geological Survey, Lakewood, Colorado
(303–236–4882 ext. 295)

Stratigraphic and geomorphic evidence indicates floods that occur after forest fires have been intermittent but common events in many mountainous areas during the past several years. The recurrence of these fire/flood events reflects the joint probability between the recurrence of fires and of subsequent rainfall of varying magnitude and intensity. During the first several months following the May 1996 forest fire in Buffalo Creek, Colorado, precipitation amounts and intensities that generated very little surface runoff outside of the burned area resulted in severe hillslope erosion, floods, and streambed-sediment entrainment in the rugged, severely burned, 48-square-kilometer area.

Floods following the 1996 fire added sediment to many existing alluvial fans and simultaneously incised other fans and alluvial deposits in the Buffalo Creek watershed. Incision of older fans revealed alternating sequences of charcoal-rich, loamy sediments overlain by sandy gravel that represent periods of quiescence and subsequent burning, followed by intervals of high sediment transport and aggradation. An alluvial sequence at the mouth of a tributary draining a 1.3-square-kilometer area indicated at least five previous fire/flood cycles in the watershed. Dendrochronologic and radiocarbon dating of material in this deposit spans approximately 2,900 years, with dates clustering in three general periods. Within these date clusters, the interval between dark, loamy horizons and the overlying alluvial sediment ranges from 2 to 9 decades. The three clustered radiocarbon dates and the uppermost horizon, dated by dendrochronology, are separated by three longer intervals of approximately 9 to 10 centuries. Results from Buffalo Creek suggest that stratigraphic interpretation combined with dendrochronologic and carbon-14 dating of alluvial deposits can be used to develop a recurrence probability for large-magnitude fire/flood events in forested foothills regions.

Pre-Fire Baseline Stream-Sediment and Stream-Water Geochemical Data from a Recently Burned Area in Central Idaho, and Suggestions for Application of Geochemical Data to Wildfire Science

Robert G. Eppinger (eppinger@usgs.gov), U.S. Geological Survey
Lakewood, CO (303–236–2468)

A baseline sediment and water-sampling geochemical study was undertaken by the USGS in central Idaho in 1996. During the summer of 2000, much of the previously studied area was burned by the Clear Creek (>206,000 acres) and Wilderness Complex (>182,000 acres) fires. These pre-fire baseline geochemical data may be useful in determining chemical effects on the geochemical landscape resulting from the widespread wildfires.

Bedload stream-sediment and stream-water samples were collected from most of the Panther Creek drainage, from the Main Salmon River between Wagonhammer and Corn Creeks, and from the Middle Fork of the Salmon River between Boundary Creek and confluence with the main Salmon River. The samples were collected from 93 sites during a 3-week period in July 1996. Sites chosen included the main river channels and major tributaries. Composite bedload stream sediments were sieved in the laboratory to minus-80 mesh. Composite stream-water samples collected included subsamples of both filtered and unfiltered water that were analyzed for cations and anions. Samples were analyzed for a broad suite of elements by ICP mass spectrometry, ICP atomic-emission spectrometry, and ion chromatography. While USGS Water Resources Division ppb-protocol procedures were not followed, clean procedures were used in this reconnaissance study. Quality-assurance/quality-control concerns were addressed through the use of site duplicates, analytical duplicates, and standards. Current plans are to reoccupy these sampling sites in 2001 and collect samples during similar flow-level conditions to allow for comparison of pre-fire and post-fire geochemical effects on the streams and associated sediment.

Geochemistry thus far has been underutilized in the area of wildfire science. Stream-sediment and water data may identify unusual enrichments of geologically derived nutrients such as potassium, phosphorus, sodium, and magnesium available in the drainage basin upstream. After a wildfire in the basin, these nutrients would likely become mobilized and redistributed during subsequent runoff and landslide events. Similarly, pre-fire sediment and water data may provide clues to the presence of metals in the drainage basin that could, when mobilized, become potential contaminants downstream. For example, bedrock alteration haloes around mineral deposits can be widespread, with exposures covering hundreds to thousands of acres. These haloes can contain high concentrations of metals such as As, Cu, Fe, Hg, Mn, Pb, S, Se and Zn. Abandoned or active mines in a given basin could produce an additional potential environmental problem but would, as a minimum, indicate the presence of elevated metal concentrations in the basin.

Vegetation, although not sampled during the 1996 study, could provide further clues to metals that could be mobilized following wildfires. It is well known that some plant species can accumulate high concentrations of certain elements in their tissues. In the past, this feature has been utilized as a biogeochemical prospecting tool because the elements in most plants ultimately have underlying geologic sources. Following a wildfire, non-volatile elements that were present in the plant tissues will become concentrated in the remaining ash. These concentrations in ash would be significantly greater than those in the unburned vegetation. Further, some of these elements could become bioavailable to aquatic biota during subsequent runoff. A simple laboratory water leach of the ash and upper soil profile, from samples collected immediately following the fire, would provide an indication of metals present in the ash. This information could be useful for those involved in remediation efforts.

Ecological and Economic Consequences of the 1998 Florida Wildfires

Sue Grace (sue_grace@usgs.gov), U.S. Geological Survey, National Wetlands Research Center
Lafayette, LA (337–266–8618)

Dale Wade (rxfire@ix.netcom.com), U.S. Forest Service, Southern Research Station
Athens, GA (706–559–4307)

During June and July of 1998, over 2,200 wildfires burned almost 500,000 acres in Florida and destroyed 126 homes and 25 businesses, damaging another 219. In the wake of these wildfires, researchers from Federal, State, and private organizations joined forces to form an interdisciplinary team to assess some of the ramifications of these fires. Study sites were established on Federal, State, and industrial lands. The overall study was composed of nine separate components: (1) comparison of actual fire behavior to predicted fire behavior as recorded on fire reports; (2) correlation of daily fire behavior to the Lavdas Dispersion Index and the Haines Index; (3) determination of effectiveness of previous fuel treatments (herbicide, partial harvest, prescribed fire) on wildfire behavior from a suppression and firefighter safety standpoint; (4) determination of effects of previous fuel treatments on wildfire severity as they affect overstory mortality by species, size class, stand density, and stand origin; (5) determination of status and first-year response of known populations of groundcover species of special concern including exotic species; (6) determination of relative abundance and timing of foraging insects along a fire intensity gradient and correlation of infestation rates to tree mortality over time; (7) assessment of effects of habitat fragmentation on the federally listed threatened and endangered Florida scrub-jay; (8) quantification of the utility of commonly recommended home protection strategies; and (9) determination of economic impacts and evaluation of efficacy of fuel-reduction treatments to reduce economic impacts of catastrophic forest fires. Research results of each of these studies will be briefly summarized.

A Fire Atlas for the U.S. Rocky Mountains: Phase I

Sandra L. Haire (sandy_haire@usgs.gov), USGS-BRD, Midcontinent Ecological Science Center
Fort Collins, Colorado, USA (970–226–9367)

People need maps of fire locations and characteristics in order to manage economic resources and to protect human settlements over the long term and in an emergency response. As ecologists, our motives for understanding fire are based on its role as a primary disturbance process that substantially alters landscape pattern and process. In our research on the ecological effects of fire, we are identifying information gaps that can be filled using remotely sensed data, and developing data sets that will address our specific research questions. We defined an atlas of map data that would help us understand the dynamic nature of fire regimes and specific effects on landscape structure and function. The set of maps, derived from remotely sensed data sources included in the atlas would link to data on animal and plant communities.

Phase I of our atlas is a coarse-scale map of fire regimes in the U.S. Rocky Mountains. This map would potentially provide a regional view of the fire regime, enabling examination of patterns over space and time without the restriction of political boundaries. Here we describe the data sets, processing methods, and preliminary results for Phase I.

GeoMAC Wildland Fire Support

Michael E. Hutt (MEHUTT@usgs.gov), U.S. Geological Survey
Lakewood, Colorado 80225 (303–202–4296)

The need for information on the status, location, and proximity of wildfires to values at risk has prompted the formation of the Geospatial Multi-Agency Coordination Group (GeoMAC). The GeoMAC team, with representatives from the DOI–USGS, BLM, F&WS, BIA, NPS and USDA–FS, consists of technical experts in the application and utilization of the information and mapping sciences. The GeoMAC team produced an internet-based mapping application that allows firefighting coordination centers and incident command teams to access online maps of current fire locations and perimeters by using standard Web browsers such as Netscape or Explorer. Fire perimeter data are updated daily based upon input from incident intelligence sources, Global Positioning System (GPS) data, and imagery from fixed-wing and satellite platforms. This discussion will focus on the technological challenges faced by the team, the innovative solutions devised, and the challenges ahead.

Measuring and Remote Sensing of Burn Severity

Carl H. Key (carl_key@usgs.gov), U.S. Geological Survey, Northern Rocky Mountain Science Center
Glacier Field Station, West Glacier, Montana (406–888–7991)

Nate C. Benson (nate_benson@nps.gov), National Park Service, Glacier National Park
present location: Everglades National Park, Homestead, Florida (305–246–9613)

The Composite Burn Index (CBI): Objectives to correlate remote sensing data with observed fire effects require definition of burn severity and sampling strategies that match recorded field characteristics to sensor capabilities. The Composite Burn Index (CBI) is designed to define burn severity ecologically and measure ground effects that collectively provide a signal detected at moderate resolution by the Landsat Thematic Mapper (TM). Average conditions of the community are evaluated visually by vegetative strata within relatively large heterogeneous plots. Attributes are rated by criteria that correspond to identified burn levels along a gradient from unburned to extremely burned conditions. The criteria scale considers not only specific physical properties but also the distribution of traits within plots. Attribute scores then are segregated hierarchically by strata and averaged into understory, overstory, and overall composite ratings. Sampling confirms variable burn responses by strata consistent with observations over the range of severity, suggesting the criteria and rating scale are appropriate. Ratings that incorporate all strata seem to improve the overall measure of severity and emphasize the importance of considering a broad range of factors when summarizing burns. We suggest the CBI is transferable and a basis for studying or comparing burns across broad geographic regions. The strategy facilitates direct correlation of burn severity to radiometric-response variables and may be used in modeling other environmental factors, such as fuel loading or erosion potential. At the same time, the methodology could be used in the absence of remote sensing data to describe and evaluate localized burn sites for a variety of purposes.

The Normalized Burn Ratio (NBR): We used the CBI (above) to test performance of radiometric measures as estimators of burn severity. Two 1994 fires occurring at Glacier National Park, Montana, were investigated. Indices incorporated band ratios and multitemporal differencing derived from the Landsat Thematic Mapper, including: (1) post-fire band 7 reflectance; (2) pre- and post-fire differenced band 7 reflectance; (3) differenced Normalized Difference Vegetation Index (NDVI); and (4) differenced Normalized Burn Ratio, a new index formulated from TM band 7 and band 4 reflectance. Seasonal effects also were tested, with indices obtained from spring and late summer data, for a total of eight models. Evaluation of performance considered amplitude of index response, direct correlation to field-rated burn severity, and visual characteristics of derived images. NBR differenced from early in the growing season was judged the most effective measure of burn severity. Greater amplitude of response and correlation to field-rated burn severity led to better contrast, broader range of severity levels, and sharper delineation of burn perimeters. NDVI differenced late in the growing season exhibited the poorest resolution of burn severity overall. In general, results were improved for all indices when derived early in the growing season. Seasonal differences, however, were influenced by phenology and not strictly by date. Spring scenes performed best at low elevations, while late summer results were stronger at high elevations, where snowmelt and plant growth were delayed by at least 2 months. To facilitate assessment of burn conditions through mapping and summary tabulation, differenced NBR was partitioned into 7 ordinal levels (including meadow, forest, and unburned classes) which exhibited strong relationships to burn severity rated on field plots. Advantages of differenced NBR include: (1) a standard, transferable measure with reduced influence from image- or observer-dependent qualities; (2) utility on large, remote burns and potential to compare multiple burns regionally or nationally; (3) direct correlation to field-estimated fire effects and other quantitative environmental variables; and (4) flexibility to apply the measure as a continuous or discrete variable in modeling, research, and management.

Post-Fire Burn Assessment by Remote Sensing on National Park Service Lands

Carl H. Key (carl_key@usgs.gov), U.S. Geological Survey
Northern Rocky Mountain Science Center
Glacier Field Station, West Glacier, Montana (406–888–7991)

Nate C. Benson (nate_benson@nps.gov), National Park Service, Glacier National Park
present location: Everglades National Park, Homestead, Florida (305–246–9613)

This project is ongoing, in the first year of a three-year study funded by the Park Oriented Biological Support program of the National Park Service.

The project addresses the assessment of wildfires and fire use on National Park Service lands through remote sensing of burn severity. We consider severity as a measure of effect, based on conditions and ecological impacts following fire. Recognizing a need to standardize methodologies and provide comparable results between Parks over time, strategies previously developed at Glacier National Park are being tested in Yosemite, Bandelier and Everglades. In addition, we are working with Fire Monitors at Yellowstone. Implementation of techniques there has resulted in completion of a Masters thesis that tested our methods on five fires occurring in 1994 and 1997. At Glacier, recent burns in 1998, 1999, and 2000 are also being investigated to broaden sample size and enhance results in that area. In such cases, the Normalized Burn Ratio (NBR) is calculated and differenced between pre- and post-fire Landsat TM (or ETM+) scenes. The Composite Burn Index (CBI) is then used to quantify severity on the ground, and correlation is made with the differenced NBR. By working with knowledgeable individuals in targeted Parks, we hope to ascertain the suitability of the CBI in different ecosystems, particularly whether field attributes and criteria are appropriate. We will also test robustness of differenced NBR and determine what calibration requirements may be needed across regions. The objective is a transferable approach that is not dependent on particular site or Landsat image characteristics, one that demonstrates reasonable feasibility on regional to national levels. Ultimately, such efforts may lead to implementing a national protocol for routine post-fire assessment, to monitor and compare burns across NPS lands.

2000 Wildfires of Western Montana and Northern Idaho

Carl H. Key (carl_key@usgs.gov), U.S. Geological Survey, Northern Rocky Mountain Science Center
Glacier Field Station, West Glacier, Montana (406–888–7991)

Western Montana and northern Idaho were particularly impacted by wildfires in 2000. This poster, a mosaic of Landsat ETM+ browse images acquired through August, demonstrates the size and distribution of that burning. The region also provides a backdrop for an interagency study set to begin in 2001. The National Interagency Fire Center (NIFC), through its Joint Fire Science Program, has funded the 2-year project entitled ***"Monitoring fire effects at multiple scales: Integrating standardized field data with remote sensing to assess fire effects."*** The study proposes to develop a comprehensive monitoring system called FIREMON (Fire Effects Monitoring System). It is designed to satisfy many monitoring requirements of fire-management agencies. FIREMON will consist of sampling manuals, databases, field forms, analysis programs, and image analysis tools that will allow managers to design a fire-effects monitoring project, collect and store sampled data, statistically analyze and summarize the data, link the data with satellite imagery, and map the data across the landscape by using image processing. FIREMON will allow consistent and comprehensive sampling so results can be shared and compared across all fire-management agencies, leading to the update and refinement of fire-management plans and prescriptions. A yet to be determined subset of the 2000 burns, mostly occurring on U.S. Forest Service lands in Montana and Idaho, will serve as study areas for testing and development. The Principal Investigator is Bob Keane, USDA–Forest Service, Rocky Mountain Research Station, with co-investigators Wendel Hann, USDA–Forest Service, Washington Office of Aviation and Fire Management; Carl Key, U.S. Geological Survey, Northern Rocky Mountain Science Center; and Larry Gangi and John Caratti, both of Systems for Environmental Management.

Fire Potential Index to Assess Forest Fire Hazard

Jacqueline M. Klaver (jklaver@edcmail.cr.usgs.gov), Raytheon Systems Company
USGS EROS Data Center, Sioux Falls, SD 57105 (605–594–6961)

The Fire Potential Index (FPI) was developed by the USGS/EROS Data Center, the U.S. Forest Service and the Pan-American Institute of Geography and History (PAIGH) in a project entitled "Digital Imagery for Forest Fire Hazard Assessment (FHA) of the Mediterranean Ecosystems of Argentina, Chile, Mexico, Spain, and the United States." The FPI assess the probability of occurrence of fire, at a 1-kilometer resolution over large areas on a daily basis. The FPI calculation is based on the percentage of live and dead fuel derived from mapped fuel models, daily moisture content of dead fuel derived from weather variables (temperature, humidity, precipitation, and cloudiness), and the partitioning of live and dead fuel using Relative Greenness derived from the Normalized Difference Vegetation Index (NDVI). The FHA project found a high correlation between fire occurrence and high FPI values in many other ecosystems within the Americas. The FPI was calculated and validated for the conterminous United States for the period of 1992–99. Since 1998, the daily calculation of the FPI has been done for the conterminous United States and is available to the public and to fire and land managers over the Internet. The FPI was customized and implemented at 13 Federal and State land-management organizations within the conterminous Western United States and for the State of Alaska. The European Union (EU), through the Joint Research Center (JRC) in Ispra, Italy, has calibrated the FPI for all of Europe and is presently calculating the FPI on a near-time daily basis. The EU has adopted the FPI as one of its fire-prediction tools for Europe.

Application of Airborne Imaging Spectroscopy to Areas Impacted by Wildfires

Raymond F. Kokaly (raymond@speclab.cr.usgs.gov), Trude V.V. King, and Laurie C. Morath
USGS, MS 973 Box 25046
Denver Federal Center, Denver CO 80225

Recent advances in remote sensing technology have resulted in airborne imaging spectrometers and portable field spectrometers with enhanced capabilities for characterizing surface materials. These capabilities are useful for studying the wildland fire areas by characterizing forest structure, species composition and distribution, and canopy moisture status before fires occur. Post-fire vegetation regrowth may also be monitored. Additionally, fire effects on soils may be investigated. Accurate characterization of vegetation can be made using spectroscopic remote sensing data. Previous investigations in Yellowstone National Park have revealed that different forest cover types can be discriminated and mapped using data collected by the Airborne Visible and InfraRed Imaging Spectrometer (AVIRIS). The ability to map forest cover types may make a significant contribution to fire modeling because each cover type has different fire potential and behavior. Maps of forest cover may be used as a base layer in fire-prediction models. Imaging spectroscopy also offers the ability to characterize forest recovery. In Yellowstone, analysis of AVIRIS data resolved the variable regrowth rates of lodgepole pine. The spectral reflectance of vegetation arises from the presence of organic molecules that absorb at specific wavelengths. Thus, the biochemical composition of plant canopies may be quantified (for example, chlorophyll, nitrogen, lignin, cellulose, and water content). Maps of canopy water, derived from remote sensing data, may be integrated with other spatial data, leading to the development of fire-potential maps. Spectral reflectance data can be used for post-fire investigations defining fire effects on soils. The high temperatures of wildland fires impact the composition and structure of surface materials. Observations by other researchers have shown that hydrophobic substances remain on the surface after fires, increasing water runoff. Minerals, such as clays, may become dehydrated or structurally and chemically altered to some ceramic form. With high temperatures, devitrification of materials may occur, resulting in "glassy" surface material. Such changes of surface materials may vary with fire temperature and may be linked to post-fire declines in the quality of local water bodies and/or drinking-water sources. With small, portable field spectrometers we propose that these effects on organic and mineral constituents of soils may be investigated on a site-specific basis. Furthermore, if such alterations of surface material are present, it may be possible to extend the analysis to regional scales by using airborne spectral remote-sensing techniques.

Effects of Burning and Two Fire Fighting Chemicals on Terrestrial Vegetation

Diane Larson (dlarson@usgs.gov), USGS, Northern Prairie Wildlife Research Center
St. Paul, Minnesota (612–625–9271)

Wesley Newton (Wesley_Newton@usgs.gov), USGS, Northern Prairie Wildlife Research Center
Jamestown, ND (701–253–5523)

Patrick Anderson (Patrick_Anderson@usgs.gov), USGS
Fort Collins, Colorado (970–226–9488)

Two studies were carried out in 1993 and 1994 to assess the effects of fire-retardant chemical (Phos-Chek G75–F) and fire-suppressant foam (Silv-Ex) application, alone and in combination with fire, on Great Plains mixed-grass prairie and Great Basin shrub steppe vegetation. Response variables included aspects of plant growth, flowering, herbivory by insects, and community characteristics. In mixed-grass prairie, Silv-Ex treatment resulted in a small depression in plant species accumulation over the growing season, greater leaf herbivory of some woody species, and increased leaf growth but decreased shoot growth in the shrub, *Symphoricarpos occidentalis*. Phos-Chek application in this habitat resulted in a marked fertilization effect in the dominant grass, *Poa pratensis*, but not in other species. Herbaceous biomass increased in response to treatment the first season but was indistinguishable from the control by the second season. Plant species richness was depressed by Phos-Chek application. In contrast, in shrub steppe vegetation, we saw no effect of either chemical on growth, flowering, or herbivory of woody species. Number of live stems per square meter was depressed by Silv-Ex at 1 percent concentration but not at 0.5 percent; this was the only effect (not related to community composition) to persist through the end of the study. Species richness initially declined with Phos-Chek application, but was indistinguishable from the control by the end of the growing season. A canonical variate analysis indicated that burning had a greater influence on plant community composition than did the chemical treatments. In general, riparian vegetation in the Great Basin study showed more significant responses to the treatments than did upland vegetation, and late-spring applications produced greater changes in species richness and stem density than did midsummer applications. Taken together, the two studies suggest that effects of the chemicals may vary with moisture availability.

Fire-Induced Changes in Soil Organic Matter Properties that Contribute to Hydrophobic Soils

Jerry A. Leenheer (leenheer@usgs.gov), U.S. Geological Survey, Lakewood, Colorado (303–236–3977)

Deborah A. Martin (damartin@usgs.gov), U.S. Geological Survey, Boulder, Colorado (303–541–3024)

David W. Rutherford (dwruther@usgs.gov), U.S. Geological Survey, Lakewood, Colorado (303–236–3978)

Paired (burned and unburned) soil samples were obtained under similar vegetation types at the Cerro Grande, New Mexico, and High Meadows, Colorado, fires. Physical properties of water repellency, surface area, and water vapor uptake were measured. Soil organic matter was isolated, fractionated, and characterized by infrared and ^{13}C-nuclear magnetic resonance spectrometry. The most hydrophobic (water-repellent) soil was found under lodgepole pine vegetation that burned in the High Meadows fire. This soil had lower surface-area and greater water-vapor uptake than the paired unburned soil. Spectroscopic characterizations of organic matter in burned compared to unburned soils indicated conversion of hydrophilic hydroxyl groups that are common in cellulose and lignins to less hydrophilic esters and ethers. Hydrophobic plant resins, which were a chemically separate fraction in unburned soils, were chemically bonded with the organic matter humin fraction in the burned soil. The above data indicate that hydrophobic soil properties may partially result from chemical changes that selectively preserve and chemically combine hydrophobic plant resins while hydrophilic components such as cellulose are converted to less hydrophilic esters and ethers. Hydrolysis reactions of esters and ethers are hypothesized to explain the increase in water-vapor uptake of hydrophobic soils.

Geology of the Year 2000 Central Idaho Forest Fire Areas

Karen Lund (klund@usgs.gov), U.S. Geological Survey, Lakewood, CO (303–236–5600)

Gregory N. Green (ggreen@usgs.gov), U.S. Geological Survey, Lakewood, CO (303–236–5390)

Geologic maps of the Payette and Salmon National Forests have been prepared as Arc/Info databases by the Headwaters Province Project in the Mineral Resources Team (Central Region) of USGS. These geologic databases cover all of central Idaho (an area of about 6 million acres). The geologic databases are compiled from new geologic investigations and previously published sources. ARC-Info geologic databases and geologic expertise for most public lands in western Montana and Idaho north of the Snake River Plain are also available or being developed as part of the Headwaters Province Project.

Arc/Info databases for year 2000 forest-fire perimeters in the Payette and Salmon National Forests, as prepared by GeoMAC (Geospatial Multi-Agency Coordination Group), are used to show geologic units underlying burn areas. Large forest fires in the Payette National Forest are Burgdorf Junction (visited by President Clinton in July), Three Bears, Flossie, Diamond-Shellrock, and Little Pistol. Large fires in the Salmon National Forest are Aparejo (which connects with Diamond-Shellrock to the west) and Clear Creek (for which 1,000 U.S. Army and Marine troops were deployed). The total acreage burned on these forests is greater than 500,000 acres.

The geologic maps and derivative lithologic maps of areas that have been burned are useful for predicting post-fire effects and recovery and are useful for potential collaborative efforts between solid-earth science and many different aspects of hydrology, wildlife biology, and forestry. These data are equally useful in cases of either forest fire or prescribed burns.

- Underlying rock units, together with climate, slope, and aspect, directly determine the soil type on a site and may be useful for predicting success of different types of revegetation efforts.
- Lithology, climate, slope, and aspect also determine the size-fraction, mineralogy, and chemistry of weathering products. Likewise, these factors determine erodibility and slope stability of a site. Prediction of areas of mass wasting, based on geology, is useful for estimating impact on watersheds and for revegetation efforts.
- Mineralogy and grain size of the geologic units and soils formed from underlying rocks determine the permeability and porosity of a burned area. Severity and persistence of hydrophobic soils in burn areas may relate to underlying geology.
- Underlying geologic units are reflected in geochemistry of ground water and surface water. Studies combining information about geology and stream sediment and water geochemistry before and after forest fires and prescribed burns may predict water geochemical changes that may affect public watersheds or riparian habitats.

CINDI—Focal Point of USGS for Hazards and Disaster Information

Harry McWreath (hmcwreath@usgs.gov)
USGS Center for Integration of Natural Disaster Information
Reston, VA (703–648–5454)

The U.S. Geological Survey's Center for Integration of Natural Disaster Information (CINDI) is a research and operational facility that collects, integrates, and communicates information about the risks posed by natural hazards and the effects of natural disasters. To carry out its mission, the CINDI has identified three areas of emphasis: USGS hazards focal point, research, and outreach.

Before, during, and after a disaster, the CINDI focuses on near-real time monitoring to keep the USGS and other agencies apprised of the nature and extent of the disaster phenomenon. The CINDI, working with other USGS hazards programs, integrates data from multiple sources within the USGS hazards programs and from external sources with spatial data sets of the disaster area to provide a comprehensive and synergistic perspective of the disaster phenomenon for emergency response, for follow-up recovery, and for analysis and assessment of the effects of the disaster as an aid to planning mitigation strategies for possible recurrences.

The CINDI research program promotes interdisciplinary research for hazards response and mitigation. Grants are awarded to lead USGS investigators through a competitive proposal evaluation process. The outcomes of awarded research proposals are expected to be applied to the CINDI's need to develop data integration capabilities, information processing and delivery, and analytical tools for decision support systems.

Outreach is a natural derivative of the CINDI's other two roles. The outreach component of CINDI's mission strives to enhance the visibility of the USGS as a leader in natural hazards information and to promote the activities of USGS hazards programs through the CINDI's Web site, visitor briefings, and tours of the CINDI facility.

Post-Fire Biological Resources Research at the Cerro Grande Site: A Synopsis and Progress Report

Midcontinent Ecological Science (Tom_O'Shea@usgs.gov Center), U.S. Geological Survey, 4512 McMurry Ave. Fort Collins, CO 80525 (970–226–9397)

The Midcontinent Ecological Science Center (MESC) initiated several biological resources studies in summer 2000 following the Cerro Grande fire. These studies were selected from a larger set of needs identified by an *ad hoc* interdivisional USGS team. Studies involved: determination of the distribution, abundance, and population responses of DOI species of concern for which there were pre-fire data (salamanders and bats); assessment of habitat use by migratory birds and elk; and estimation of post-fire runoff impacts on stream-associated biota. We present a brief overview of this work under five groupings.

1. The endemic Jemez Mountains salamander (*Plethodon neomexicanus*) is thought to require downed logs and associated terrestrial invertebrate prey. It is the subject of a multiagency management plan designed to avoid listing under the Endangered Species Act. Areas known to be important to the species burned severely, but the impact on salamanders must be assessed. Similarly, a second endemic salamander (*Aneides hardii*) occurs in the Sacramento Mountains of New Mexico, which also experienced major burns in 2000, and this provided a broader opportunity to compare fire impacts on salamanders. Studies underway by Michelle Cummer and Craig Allen of the Jemez Mountains Field Station are assessing impacts of the fire on abundance of Jemez Mountains salamanders and invertebrate prey. Cynthia Ramotnik of the Albuquerque Field Station, who has 10 years of *Aneides* abundance data collected with support of the U.S. Forest Service, is using a coordinated approach in the Sacramento Mountains. The salamander work will continue into 2001.

2. Bats play important ecological roles as insect consumers in western forests, but nothing is known of their responses to burns. MESC bat researchers at Albuquerque and Fort Collins used mist-net surveys to determine distribution, relative abundance, and reproduction in bats (including eight former FWS C–2 species) of the Jemez Mountains from 1995 to 1998. Repeat surveys were carried out in selected areas in 2000 by Paul Cryan, Michael Bogan, and Thomas O'Shea, and echolocation-detector-based activity data were collected in burned and unburned sites by Laura Ellison and O'Shea. No notable differences in bat species presence, relative abundance, or female reproduction were observed, including concentrated samples from a severely burned site in ponderosa pine forest. Bat echolocation activity was also detected at similar levels in burned and unburned sites within ponderosa pine forests but was lower in mixed coniferous forest.

3. Avian ecology studies were conducted by Tasha Kotliar and Ellison of MESC in Fort Collins and Cynthia Melcher of the Colorado Natural Heritage Program. Comparisons of avian use of four burn-severity classes (severe, moderate, low, unburned) and two cover-type classes (ponderosa pine, mixed conifer) in late summer indicated that species richness varied with burn severity. In addition, there appeared to be an interaction between burn severity and cover type. In winter 2000–2001 this group plans to investigate wintering bird use of post-fire forests, a neglected aspect of fire effects studies.

4. The fire occurred during the last year of a BRD–NRPP-funded study of movements and seasonal habitat use of elk that winter on or near Bandelier National Monument (BAND). Eric Wolf of Texas Technical University, Stephen Fettig of BAND, and Craig Allen will use radiotelemetry and aerial survey to determine elk habitat use in response to burns.

5. Post-fire abundances of aquatic invertebrates and fish are being determined in Guaje Canyon by Nicole MacRury of Colorado State University, who has established pre-fire survey data for this location and has studied responses of similar communities to the runoff from the 1996 Dome fire in canyons at BAND. Guaje Canyon experienced major runoff after the Cerro Grande fire, with nearly all aquatic fauna killed.

Wildfires and Earth-Surface Processes

Ken Pierce (kpierce@usgs.gov), U.S. Geological Survey
Northern Rocky Mountain Science Center, Bozeman, MT (406–994–5085)

Don Despain (don_Despain@usgs.gov), U.S. Geological Survey
Northern Rocky Mountain Science Center, Bozeman, MT (406–994–7257)

Dick Jachowski (Richard_Jachowski@usgs.gov), U.S. Geological Survey
Northern Rocky Mountain Science Center, Bozeman, MT (406–994–5304)

Earth-surface processes include the integration of both geologic and life processes at and near the surface of the Earth. Fires and their aftermath integrate these biotic and abiotic processes and have been part of ongoing Earth-surface processes for millions of years.

In addition to their effect on vegetation, wildfires commonly result in floods and debris flows that erode upland slopes, erode channelways, and deposit material lower along drainages. These processes are hazardous to people, buildings, roads, and bridges. The extensive Western fires of the summer of 2000 are likely to result in continued hardship for people in the burned areas as well as downstream floods and debris flows. Loss of vegetation in the burned areas results in increased runoff, soil mobilization by processes such as rain splash, and loss of soil strength. Intense rainfall, particularly late in snowmelt when soils are saturated, can produce disastrous floods and debris flows.

To understand and predict the extent of the hazard, geologic factors and consequent effects of fire on Earth-surface processes need to be known and evaluated and include the following three factors: (1) Relation between geologic terrain and floods and debris flows, particularly fine-grained, relatively impermeable bedrock, and surficial materials. For example, the Beaver Creek fire north of Hebgen Lake, MT, burned an extensive high-altitude area underlain by fine-grained, shaley rocks that are prime candidates to produce debris flows under intense rainfall such as that in the same area on July 18, 2000. (2) Steep slopes are more likely to erode or fail, and steep, long slopes have greater overland flow, thus resulting in soil erosion and debris flows. (3) Fine-grained, impermeable material is most likely to be entrained in overland flow and aid in initiation of gully erosion to produce downstream flooding and debris flows. Topsoil in many Western areas consists of windblown silt that, once eroded, will not be replenished until another ice age generates more silt.

In addition, differing geologic terrains determine how fires burn and what hazards are created after they burn. (1) Some substrates hold lesser amounts of soil moisture and reach the wilt point much earlier, making them susceptible to more intense, rapid burning and post-fire erosion. (2) Geomorphic histories of landscapes produce terrain with different fire potential. For example, uplift and erosion of the eastern Greater Yellowstone Area have produced deeply incised terrain with high, steep valley walls conducive to rapid burning.

The area of northeastern Yellowstone National Park has been shown to have a strong positive relation between forest fires and debris flows onto alluvial fans during the last 6,000 years. Intervals of fire-related debris flows cause buildup of debris fans outward into the axial valley, whereas intervals with few fires result in axial streams trimming back the debris fans to form wider flood plains that are later incised to form terraces (Meyer and others, 1995, General Services Administration Bulletin, p. 1211–1230). This area in northeastern Yellowstone has several geologic characteristics that enhance fire and fire-related sedimentation: (1) steep, long slopes associated with deep, young incision, (2) extensive Pleistocene glaciation that has resulted in steep valley walls, and (3) readily erodible Absaroka volcanic rock with sufficient fines (silt and clay, as well as soils with a thin loess cap) to produce debris flows. In contrast to this steep, Absaroka volcanic terrain with a significant amount of fine sediment, central Yellowstone is underlain by rhyolite that has much gentler slopes and forms sandy, more permeable soils. After the 1988 fires, nevertheless, debris flows were generated on local steep slopes on this rhyolite terrain. A topsoil supplemented with loess and aerosolic dust may have enhanced runoff and generation of debris flows.

We need to study the areas burned in the summer of 2000 that have contrasting geology, terrain, and fire-severity to determine how the character of debris flows and floods produced by severe precipitation events relates to these different geologic terrains.

Hyperspectral Analysis of Multi-Temporal Landsat TM Data for Mapping Fuels in Yosemite National Park

Ralph Root, USGS, BRD, Center for Biological Informatics (303–202–4232)

Jan van Wagtendonk, USGS, BRD, Western Ecological Research Center
Yosemite Field Station (209–379–1885)

In recent years, wildland fires have become more intense, resulting in increased loss of life and resource damage. Critical to resolving this problem is better information on the amount and condition of fuels on the ground. With this information, fire managers can better predict potential fire behavior, make more informed tactical and strategic decisions, and plan and conduct fuel treatments.

Jan van Wagtendonk, from BRD's Western Ecological Research Center stationed at Yosemite, and Ralph Root, from the Division's Center for Biological Informatics in Denver, have been examining the use of multitemporal Landsat Thematic Mapper (TM) imagery for developing a technique for identifying fuel types based on season changes in plant phenology. Six ortho-corrected and registered TM scenes representing approximately one-month intervals during the 1992 growing season are being examined using hyperspectral analysis.

Using temporal sequences, changes in annual grasslands, for instance, can be traced as the grasses green up in the spring and cure during the summer. This fuel type can thus be distinguished from alpine meadows, which cure at a different rate. Similarly, deciduous hardwood fuels that drop to the ground in the fall are differentiated from evergreen hardwoods, which retain their leaves.

Van Wagtendonk has used single-scene TM images to classify fuels in the past. Maps produced from this analysis have been used to predict the behavior of two large wildland fires that were being allowed to burn to meet resource objectives, to plan for extensive prescribed fires set by managers, and to make tactical decisions on a wildland fire that was being actively suppressed. In each case, operations were enhanced by the availability of information on fuels. The analysis of temporal data should increase the accuracy of the resultant maps.

As Landsat 7 data become available, additional information on forest fuel conditions should become discernible. This information will be incorporated into enhanced mapping techniques. With accurate fuels information in hand, fire managers should be able to make informed decisions about ongoing wildland fires and fuels management. These decisions will result in safer conditions for firefighters and less resource damage.

Use of Geologic Maps Before, During, and After Wildfires

Janet L. Slate (jslate@usgs.gov), U.S. Geological Survey, Earth Surface Processes Team
Denver, CO 80225 (303–236–1284)

Using geologic maps and derivative products before, during, and after wildfires can help land managers make informed decisions and save taxpayers money. Interpreting the maps is key to their effective use.

In planning for a prescribed burn or evaluating potentially fire-prone areas, understanding how geology, topography, and soil may influence the path that a fire may take or the severity of a fire in a given area will help forest managers assess the situation. For example, during the Yellowstone fires of 1988, fire raced through well-drained rhyolitic areas and then slowed down or stopped in areas of high soil moisture. Knowing the geology of an area before a prescribed burn and during a fire can be used to predict fire behavior and design firebreaks.

Following a fire, a landslide map could be used along with a geologic map to indicate the rock type(s) most susceptible to landsliding. Such rock type(s) could be identified using a digital geologic map database. In conjunction with a DEM (digital elevation model), the areas where landsliding is most likely to occur in the burned area(s) could be predicted by displaying areas where the susceptible rock type(s) is (are) at a threshold slope angle and higher. These areas might then be the focus of more intensive mitigation efforts.

Lithologic maps that portray physical properties of materials can be made of burned areas. In combination with monitoring of sediment movement in burned areas, the relationship among rock type(s), physiographic parameters, and debris flows/landslides could be modeled. Plans are underway to begin work on this aspect in Rendija Canyon (Los Alamos area) and another instrumented watershed in the area of the High Meadow Fire (Front Range of Colorado) in collaboration with Sue Cannon (USGS–GD) and Deborah Martin (USGS–WRD). This sort of research will help land-management agencies plan to mitigate hazards before and after wildfires.

Tree Mortality Following Three Seasons of Prescribed Burns in Unlogged South Florida Slash Pine (*Pinus Elliottii* var. *Densa*) Stands

James R. Snyder (jim_snyder@usgs.gov), U.S. Geological Survey
Ochopee, Florida (941–695–2000 ext. 321)

Holly A. Belles (holly_belles@usgs.gov), U.S. Geological Survey
Ochopee, Florida (941–695–2000 ext. 334)

The most aggressive management-ignited prescribed fire program in the National Park Service is carried out in Big Cypress National Preserve, Florida. During the last ten years an average of 18,000 hectares (ha) has been burned annually. Much of the area burned is dominated by South Florida slash pine.

A series of 16 research burns has been conducted as part of a long-term study of season and frequency of burning in South Florida slash pine forest. The study area is a mosaic of unlogged pine forests and cypress wetlands. Burn units are relatively large (>50 ha) and contain three 1.0-ha permanent tree plots. More than 16,000 trees have been mapped and tagged. Prescribed burns are conducted in the dry season (winter), early wet season (spring), or middle wet season (summer). Fuels consisting of litter <2.54-cm-diameter herbs, shrubs (leaves and stems <6-mm diameter), and palm leaves <2.0 m above ground level were measured before and after burning. Fire temperatures were measured with temperature-sensitive paints on small steel plates placed at ground level.

Fuel loadings averaged 10,421 g/m^2. Fine litter, dominated by pine needles, accounted for 78 percent of the mass consumed, and herbs, palms, and coarse litter (>0.6 cm and <2.5 cm) each made up 5 to 10 percent. Fuel consumption averaged 730 g/m^2 and was lowest during the middle wet-season burns. Fire temperatures were relatively mild, with means ranging from a low of 219°C during middle wet-season burns to a high of 232°C after dry-season burns. Mortality of pine trees >5 cm in diameter in the first year after the burns was low, including trees in which all the needles were scorched. The greatest number of trees (3.9 percent) died after middle wet-season burns, and the fewest died (1.8 percent) after early wet-season burns. South Florida slash pine is highly resistant to fire at any season. Patterns of mortality are commonly associated with localized fuel conditions rather than season of burning.

Paleostage Indicators Used to Estimate Peak Discharge in the Rito de los Frijoles in Bandelier National Monument Resulting from the La Mesa Wildfire

Scott D. Waltemeyer (sdw@usgs.gov), U.S. Geological Survey
Albuquerque, New Mexico (505–830–7953)

Paleostage indicators were used to estimate peak discharge in the Rito de los Frijoles in Bandelier National Monument, New Mexico. Streamflow-gaging station 0813350 recorded a peak discharge of 3,030 cubic feet per second July 21, 1978. The high flow was a result of flood runoff from the area burned in the 1977 La Mesa wildfire. Maximum observed peak discharge relations were applied to the 17.5-square-mile drainage area of the gaging station (0813350). The peak discharge is 8,500 cubic feet per second, which is an estimate based on streamflow-gaging stations in the region.

Flood bar and boulder bar sediment deposits in the channel were used as paleostage indicators. A channel cross section 0.25 mile below the streamflow-gaging station was surveyed for application of the slope-conveyance method to determine the peak discharge. A 2-percent channel slope was measured from a 7.5-minute topographic map for a 1-mile stream reach in the vicinity of the gaging station. A peak discharge of 2,890 cubic feet per second was estimated from the paleostage. Flood runoff from the 1977 La Mesa wildfire burn area is apparently the greatest discharge in recent time.

Effects of Fire on Carbon Cycling

Kimberly P. Wickland (kpwick@usgs.gov), U.S. Geological Survey
Boulder, Colorado (303–541–3072)

Jennifer W. Harden (jharden@usgs.gov), U.S. Geological Survey
Menlo Park, California (650–329–4949)

Soil respiration, the emission of carbon dioxide produced by tree and plant roots and soil organisms, is the second largest flux in the global carbon cycle. Because respiration integrates biologic inputs from the entire soil profile, it is one indicator of the general health and fitness of soil ecosystems. Temperature, moisture, and disturbance such as forest clear-cutting and soil compaction are factors known to affect the rate of soil respiration. The immediate and long-term effects of fire on the biological production of carbon dioxide in soils is unclear, however, especially in the context of understanding fire effects on overall ecosystem carbon cycling. We measured pre- and post-burn soil respiration of dry and moist soils in a boreal black spruce forest as part of the International Crown Fire Modeling Experiment in the Northwest Territories, Canada. Soil respiration from the dry soils increased an average of 60 percent one day after burning, then decreased below pre-burn rates within three days of burning. There was no significant short-term change in soil respiration from the moist soils after burning. The long-term effects on respiration in these soils are unknown at this time.

A Burn-Based Model for Smooth Brome Management in Degraded Tallgrass Prairie

Gary Willson (Willson_Gary@usgs.gov), U.S. Geological Survey, Northern Prairie Wildlife Research Center
Missouri Project Office, University of Missouri–Columbia, Columbia, MO (573–882–8645)

James Stubbendieck (jstubben@unlnotes.unl.edu), Department of Agronomy, University of Nebraska
Lincoln, NE (402–472–1519)

Smooth brome (*Bromus inermis* leyss.) is a Eurasian grass widely planted in the northern Great Plains and Midwest as a forage and cover crop. Smooth brome invades warm-season pastures and prairie remnants where it is a serious management problem. We developed a burn-based model for smooth brome management following research conducted in degraded tallgrass prairie in Nebraska and Minnesota. The model is built on two factors particularly important in smooth brome management: seasonal timing of fire, and post-fire competition from native tall grasses. Managers need to inventory sites selected for smooth brome management to determine species composition before a prescribed burn treatment is applied. In situations where smooth brome is the dominant species and warm-season tall grasses are absent, or nearly so, burning will have no long-term negative effect on smooth brome and may further degrade the site by increasing smooth brome biomass production following the removal of litter by the fire. Where competing warm-season tall grasses are present, managers need to monitor smooth brome tiller development to determine when smooth brome tillers are elongating. Annual burns after tiller emergence, but before tiller elongation begins, may result in a progressive decline in smooth brome. However, burning smooth brome during tiller elongation provides the most immediate and persistent reduction in both tiller density and biomass.

Channel Characteristics and Large Organic Debris in Adjacent Burned and Unburned Watersheds

Ronald B. Zelt (rbzelt@usgs.gov), U.S. Geological Survey
Cheyenne, Wyoming (307–778–2931)

Fire affects not only vegetation communities but also hydrologic and geomorphic processes. Fire-caused changes in vegetation and soils can impact stream channels through altered hydrology, sediment inputs, and riparian disruption and produce effects on channel erosion, sediment storage and transport, and large organic debris (LOD). Many fire effects are immediate or short term, while other impacts are delayed or long-term effects.

Late in the 1988 wildfire season, the Clover-Mist Fire spread eastward from Yellowstone National Park and burned nearly all of the 6,680-ha (hectare) Jones Creek watershed of the North Fork Shoshone River Basin. However, less than 8 percent of the adjacent, 4,950-ha watershed of Crow Creek was burned. These two watersheds are very similar in topographic, geologic, and vegetation characteristics except for recent fire-disturbance level and the modest size difference. During 1998–99, ten reaches of each stream were studied to quantify differences in width, substrate, residual pool volume and percentage of that volume occupied by fine sediment (V^*), and LOD load and characteristics, that may be attributed to wildfire disturbance.

A multiple-regression model explained 87 percent of the variability in reach-average bankfull width as a function of drainage area, number of large LOD jams, and a dummy-variable for the difference between streams. Average width of Jones Creek was 6.6 percent greater than that of Crow Creek. Bankfull widths of pools and riffles also were analyzed separately, and for riffles, the difference between streams was smaller: average width for Jones Creek was 5.4 percent greater than that of Crow Creek. A multiple-regression model explained 69 percent of the variability in median particle diameter of substrate on riffles as a function of reach gradient and the dummy-variable for difference between streams. Average d_{50} (median particle size) of Jones Creek riffles (58 mm) was 16 mm, or 28 percent, coarser than that of Crow Creek. Increases in channel width and riffle substrate coarseness are consistent with theoretically predicted channel responses to increased runoff following fire.

Residual pool volume and reach-average V^* (V^*_w) did not significantly differ between streams. Median V^*_w was 17 percent for Crow Creek and 23 percent for Jones Creek overall. Results from regression models indicate that for both streams, deeper pools, larger pools, and more closely spaced pools are all associated with greater filling by fine sediment. Multiple regression results for pool-fines size distribution indicate that reach-average gradient explains 64 percent of the variability in median diameter, with no significant difference between the streams.

Smaller size of LOD pieces in Jones Creek (mean diameter 10 percent less, and mean volume 16 percent less) reflects increased loading from younger, fire-killed trees. LOD was better anchored and more frequently occurred in contact with other LOD in Crow Creek. LOD jams were larger and a greater percentage of the debris present occurred in large jams (accumulations of 10 or more pieces) in Jones Creek. Although mobility was not measured directly in 1998–99, these differences suggest that LOD mobility continues to be greater in Jones Creek, as was reported by M.K. Young (USDA–Forest Service) from a study during 1990–91.

The Roles of Satellite Imagery and Mapping in Management and Recovery Process for Jasper Fire, South Dakota

Zhiliang Zhu (zhu@usgs.gov), USGS EROS Data Center, Sioux Falls, SD (605–594–6131)

Donald Ohlen (ohlen@usgs.gov), Raytheon, EROS Data Center, Sioux Falls, SD (605–594–6026)

Monte Williams (mlwilliams01@fs.fed.us), USFS Black Hills National Forest, Custer, SD (605–673–2251)

Tom Gushue (tgushue@fs.fed.us), USFS Black Hills National Forest, Custer, SD (605–673–2251)

Jasper Fire is the largest recorded forest fire to have occurred in Black Hills of South Dakota, with over 83,000 acres (33,588 hectares) of forested land burned between August 23, 2000, and September 8, 2000. Both the Black Hills National Forest (BHNF) and the Jewel Cave National Park experienced extensively burned resources. The U.S. Geological Survey (USGS) EROS Data Center (EDC), located in Sioux Falls, SD, is working with the BHNF to assist with the post-fire recovery and restoration by using satellite imagery and GIS analysis. Pre-and post-fire Landsat 7-enhanced thematic mapper plus (ETM+) sensor 30-meter data were acquired to identify the fire perimeter and to model burn severity. With an improved acquisition and delivery system, the post-fire Landsat 7 imagery was acquired, processed, and delivered to BHNF with less than two days turnaround. Fine-resolution (1–4 meters) IKONOS commercial satellite data are being used to depict mosaic patterns of different crown and ground burns and to map fire lines for rehabilitation. These satellite data, combined with extensive fieldwork, are expected to yield a large amount of useful spatial information for use by BHNF management, field operations staff, and the general public. Long-term research has been planned to look into mapping forest species composition and the modeling of tree mortality patterns as a result of the fire. Additionally, this poster illustrates two areas of fire-related activities where the USGS capabilities and expertise can be the most effective: (1) quick response with spatial data technologies, and (2) long-term science support for post-fire recovery.

Appendix E—Abstracts of Presentations

Fire, Thresholds, and USGS: Local To Global-Scale Research Opportunities

Craig D. Allen (craig_allen@usgs.gov), U.S. Geological Survey
Midcontinent Ecological Science Center, Los Alamos, New Mexico (505–672–3861 ext. 541)

Many biological, hydrological, and geological patterns and processes are interactively linked in ecosystems. These ecological phenomena normally vary within bounded ranges, but rapid changes to markedly different conditions can be triggered by even small differences if threshold values are exceeded. Disturbances, including fire, often trigger large threshold responses. Many fire-related threshold responses of biological, hydrological, and geological phenomena are of societal importance but are poorly characterized or understood—research opportunities for USGS exist in these areas. Examples spanning local to global scales are provided, including:

- Changes in runoff, erosion, and sediment transport from burned watersheds;
- Effectiveness of emergency treatments to burned watersheds, ranging from seeding and mulching to emplacement of water-retention structures;
- Post-fire vegetational succession, including expansion of noxious exotic weeds and conversions to new vegetation types (for example, crown fire alteration of pine forests to persistent shrublands);
- Responses of sensitive wildlife species (for example, Jemez Mountains salamander, Mexican spotted owl) to fire-induced habitat changes;
- Climate/vegetation/fire linkages, including drought-induced mortality episodes and El Niño/Southern Oscillation relationships to fire activity;
- N-cycling, tree rooting patterns, and changes in surface fire impacts in human-altered ponderosa pine ecosystems;
- Percolating networks and thresholds for fire transmissibility, runoff generation, and erosion, with implications ranging from treating desertified, semiarid woodlands to determining what level of thinning is needed to safeguard overgrown ponderosa pine forests from crown fires (both within-stands [crown-to-crown] and between stands [landscape distribution of treatments]) to conserving tropical moist forest in the face of increased anthropogenic fire activity; and
- Carbon budgets, local to global, and potential for carbon sequestration "credits" under the Kyoto treaty protocols.

Conditions for Debris-Flow Generation from Recently Burned Watersheds

Susan H. Cannon (cannon@usgs.gov), U.S. Geological Survey, Denver, CO (303–273–8604)

Rainfall on areas recently burned by wildfires can potentially produce destructive debris flows. Debris flows can erode hillslopes and channels and deposit thick accumulations of material along drainages and on fans, posing considerable hazards to people and infrastructure in their paths. Evaluation of the erosional response of 95 recently burned drainage basins in Colorado, New Mexico, and southern California to storm rainfall provides information on the conditions that result in fire-related debris flows.

Contrary to expectations, debris flows were produced from only 37 of the 95 (about 40 percent) basins examined. The remaining basins produced either sediment-laden streamflow or no discernible response. Although some hillslopes continued to erode and supply material to channels in response to subsequent rainfall events, debris flows were uncommon following the initial erosive event. The factors that best define the difference between debris-flow-producing drainages and those that produced sediment-laden streamflow are drainage-basin morphology and lithology and the presence or absence of water-repellent soils. Basins underlain by sedimentary rocks were most likely to produce debris flows that contain large material, and sand-and gravel-dominated flows were generated primarily from terrain underlain by decomposed granite. Basin-area and relief thresholds define the morphologic conditions under which both debris flows occur. Debris flows containing large material are more likely to be produced from basins without water-repellent soils than from basins with water repellency. The occurrence of sand-and-gravel-dominated debris flows depends on the presence of water-repellent soils. Debris flows containing large material originated by runoff-dominated progressive sediment bulking of storm runoff and by infiltration-triggered soil slips. Sand-and-gravel-dominated debris flows originated exclusively through the process of progressive sediment bulking.

Ongoing work presently focuses on the development of a multivariate statistical model to define the probability of fire-related debris-flow susceptibility from individual drainage basins and the development of a physically based model for fire-related debris-flow initiation. The development of tools that can be used in quantitative assessments of post-fire hazards are important contributions to the USGS fire-research effort.

Twenty Years of Post-Fire Vegetation Development in Yellowstone National Park

Don G. Despain (don_despain@usgs.gov), USGS, Northern Rocky Mountain Science Center (406–994–7257)

Eric Miller (eric_miller@nps.gov), NPS, Yellowstone National Park (307–344–2474)

Much of what we know of the effects of wildfire on plant community succession comes from plots established prior to low-intensity, prescribed fires or from plots sampled immediately after high-intensity crown fires. There seems to be little information on the effects of crown fire where pre-fire vegetation conditions are well documented. Moreover, little information exists regarding plant community succession in the extensive areas of Yellowstone National Park that burned in 1988. We address these issues by analyzing a set of permanently marked vegetation sampling plots that were established ahead of wildfires in the late 1970's and in 1988. Some plots were sampled prior to burning, annually for five years, and every several years thereafter. Others were established post-fire in forest types where we were unable to establish pre-fire plots. It is hoped that these plots can be continually sampled into the future.

We present data on three sites with vegetation records spanning 21 years, two of which re-burned in 1988. Two plots were installed before burning in 1979, one of which re-burned in 1988. One was installed post-fire in 1977. We used Detrended Correspondence Analysis (DCA) to reduce the complexity of the dataset allowing us to analyze trends in plant communities. By using DCA we hope to be able to plot gross trends in community composition with time. We used simple plots of species abundance (cover) and frequency relative to time to track changes in individual species. Our preliminary findings indicate an obvious change in community structure. Species associated with older forest (for example, *Erythronium gradiflorum, Thallictrum occidentale, Pyrola secunda, Pedicularis racemosa*) that are present but not common drop out altogether. Other species survive and become more abundant at first then begin to decrease but still dominate during early post-fire succession (for example, Arnica *cordifolia, Epilobium angustifolium, Aster* spp., *Senecio* sp.) Fire-sensitive species such as *Vaccinium scoparium* and *Fragaria virginiana* initially decrease in abundance after fire and recover slowly, particularly at the re-burned sites. Some native species appear (for example, *Collinsia parviflora* and Collomia *linearis*). We see invasion by some exotics at all three sites, particularly by *Cirsium arvense* and *Taraxacum spp.* After the re-burn in 1988 we see invasion of some new exotic species (for example, *Rumex acetosella*) and an increase in cover of existing exotics. We also see increases in post-fire graminoid cover (for example, *Carex geyeri, C. rossii, Poa* sp., *Bromus* sp., *Calamagrostis* sp.)

Environmental Implications of Fire-Fighting Chemicals

Susan E. Finger (susan_finger@usgs.gov), U.S. Geological Survey
Columbia Environmental Research Center, Columbia, Missouri (573–876–1850)

Steven Hamilton (steve_hamilton@usgs.gov), U.S. Geological Survey
Columbia Environmental Research Center Yankton Field Station
Yankton, South Dakota (605–665–9217)

Diane Larson (dlarson@biosci.umn.edu), U.S. Geological Survey
Northern Prairie Wildlife Research Center Minnesota Field Station
St. Paul, Minnesota (612–625–9271)

Barry Poulton (barry_poulton@usgs.gov), U.S. Geological Survey
Columbia Environmental Research Center
Columbia, Missouri (573–876–1873)

Nimish Vyas (nimish_vyas@usgs.gov), U.S. Geological Survey
Patuxent Wildlife Research Center
Laurel, Maryland (301–497–5721)

Fire retardants and suppressants are used extensively in the United States for suppression and control of range and forest fires. Each year, fire control agencies utilize millions of gallons of these mixtures on a wide array of ecosystems. These chemicals are often applied in environmentally sensitive areas, which may contain endangered, threatened, or economically significant plant and animal species. Select chemicals (Fire-Trol GTS–R, Phos-Chek D75–F, Fire-Trol LCG–R, Silv-Ex, and Phos-Chek WD–881) were tested under laboratory conditions to determine their toxicity to two fish, two aquatic invertebrates, algae, three birds, a mammal, and a terrestrial invertebrate. This basic information was then used to design and implement studies to evaluate potential ecological consequences resulting from fire chemical application in the aquatic, terrestrial, and vegetative communities. These ecological studies were conducted during separate years in a prairie wetland habitat in North Dakota and in an area in the Great Basin region of northern Nevada. All five chemicals were of comparatively low order of toxicity to terrestrial species. Tests with aquatic organisms indicated the two foam suppressants (Silv-Ex and Phos-Chek WD–881) were similar in toxicity and were significantly more toxic than were the three non-foam chemicals. Degradation of all five chemicals was more rapid in soils with high organic content than in soils with low organic content. Responses of organisms in field studies were similar to laboratory results. Small mammals and insects showed no measurable response to application of either Phos-Chek or Silv-Ex. Sensitivity of fathead minnows was similar between in-situ field exposures and standard laboratory tests with the most significant decrease in survival occurring during the first 24 hours. Effects on species diversity and growth were documented in the vegetative community. During this recent fire season, information from these studies assisted fire managers and policy developers to formulate sound decisions concerning fire-fighting activities on private, State, and Federal lands.

The Biogeochemistry of Fire: Modeling and Measuring the Impact of Fire on Carbon, Nutrients, and Atmospheric Emissions

Jennifer W. Harden (jharden@usgs.gov), U.S. Geological Survey, Menlo Park, CA (650–329–4949)

A. David McGuire (ffadm@uaf.edu), U.S. Geological Survey, Fairbanks, AK (907–474–6242)

with contributions by

William F. Cannon (U.S. Geological Survey), Kristen L. Manies (U.S. Geological Survey)
Rose A. Meier (University of Alaska, Fairbanks), Qianlai Zhuang (University of Alaska, Fairbanks)
Jason C. Neff (Colorado State University), Kathy O'Neill (Duke University)
Roger D. Ottmar (U.S. Forest Service), David V. Sandberg (U.S. Forest Service)
Jim T. Randerson (Calif. Institute of Technology), Brian J. Stocks (Forestry Canada)

Fires in boreal forests play a key role in carbon dioxide budgets, atmospheric emissions of nutrients and potential air pollutants, forest regrowth, and ecosystem status or health. Studies of carbon cycling in Alaska have led to interdisciplinary research in climate, fire science, hydrology, atmospheric sciences, remote sensing, and ecological and biological sciences. Key tools for studying boreal forests include ecosystem/atmosphere models and field studies that address processes at both plot and landscape scales.

MODELING

We introduced fire dynamics to the Terrestrial Ecosystem Model (TEM) in order to examine the importance of fire on the carbon budget for Alaska. The TEM model uses a combination of climate data, vegetation-climate associations, and thermal-biological relationships to simulate the temporal dynamics of the fluxes and pools of carbon and nitrogen fluxes in terrestrial ecosystems at large spatial scales. This version of TEM uses the fire-scar database maintained by the Alaska Fire Service (AFS) to model at 1-km^2 resolution the timing and location of emissions associated with fire and the subsequent ecosystem dynamics associated with the regrowth of vegetation and with ongoing soil processes subsequent to fire. We have also developed a long-term carbon model for key boreal forest systems that is driven by field measurements of carbon storage and exchanges. Based on both of these modeling approaches, we have recently concluded that:

1. Historical (pre-1950) Fire Return Intervals have a profound impact on the uptake or release of carbon dioxide in these systems.

2. The spatial resolution of simulated emissions and post-fire carbon dynamics is limited by the availability of spatially explicit data available for fire severity, vegetation distribution, and climate.

3. Thermal and moisture profiles of forest floor/soil/permafrost exert a strong control on vegetation and carbon storage. As a result, fire severity substantially affects revegetation and carbon exchange through thermal and moisture responses to fire.

4. The fate of nutrients over the fire cycle is largely dependent on volatilization potentials and fire severity.

MEASUREMENTS

Using field measurements and landscape characterization, we have begun to test and refine the model results. Our methods include a variety of site-selection techniques such as sequences of stand ages, comparisons of soil drainage/vegetation/soil relationships, mapping techniques used in conventional soil surveys, and biogeochemistry of experimental burns in Alaska and Northwest Territories, Canada. Current measurement results conclude that:

1. Regional models should also include characterization of soil drainage class because of associations of soil drainage with fire severity, soil temperature and moisture, and vegetative species.
2. Carbon models, which are specifically parameterized for individual ecosystem types, can be used to estimate potential emissions of nutrients and potential pollutants by characterizing stand and forest-floor chemistry.
3. Predictive models of vegetation, hydrology, and nutrient flow paths require a mechanistic understanding of soil-plant-thermal interactions, which must be studied in situ and in context of fire disturbance over significant time intervals and in key ecosystem locations.

The potential contributions of our modeling-measurement campaign to USGS Fire research include a variety of approaches for improving our understanding of the relationships among soil-plant-atmosphere-hydrosphere systems and their fate in a changing climate and management structure.

GeoMAC Wildland Fire Support

Michael E. Hutt (MEHUTT@USGS.Gov), U.S. Geological Survey
Lakewood, Colorado 80225 (303–202–4296)

The need for information on the status, location, and proximity of wildfires to values at risk has prompted the formation of the Geospatial Multi-Agency Coordination Group (GeoMAC). The GeoMAC team, with representatives from the DOI–USGS, BLM, F&WS, BIA, NPS, and USDA–FS, consists of technical experts in the application and utilization of the information and mapping sciences. The GeoMAC team produced an internet-based mapping application that allows firefighting coordination centers and incident command teams to access online maps of current fire locations and perimeters using standard Web browsers such as Netscape or Explorer. Fire perimeter data are updated daily based upon input from incident intelligence sources, Global Positioning System (GPS) data, and imagery from fixed-wing and satellite platforms. This discussion will focus on the technological challenges faced by the team, the innovative solutions devised, and the challenges ahead.

Wildfire Flood-Hazard Research in the Rocky Mountains

R.D. Jarrett (rjarrett@usgs.gov), U.S. Geological Survey
Lakewood, Colorado (303–236–6447)

T. W. Browning, Colorado Water Conservation Board
Denver, Colorado

As residential communities encroach into forested-mountain areas in many parts of the United States, the risk of wildfire and flood hazards to people significantly increases. Although wildfire is a natural component of healthy ecosystems, resultant flooding and debris flows, particularly in recently burned watersheds, can pose a serious threat to human life, property, and the environment. Substantial resources and efforts have been directed toward the mitigation of runoff and sediment production from burned areas. To date, there is limited scientific data about the effectiveness of watershed-restoration practices on water and sediment runoff after a wildfire. Limited resources preclude extensive instrumented data-collection efforts. Multidisciplinary scientific data are needed for wildfire management and allocation of hazard-mitigation resources. Collaborative research began in 1996 for the wildfire sites in Buffalo Creek, Colorado, and Bandelier National Monument, New Mexico, and in 2000 for the sites in Bobcat, High Meadow, and Mesa Verde National Park, Colorado, Cerro Grande, New Mexico, and Bitterroot, Montana. Other recent wildfires in the Rocky Mountains also are being investigated.

The primary research objective of our research is to help mitigate the loss of life and property damage from water and sediment runoff from burned areas by developing an approach to quickly identify areas of flood risk. In conjunction with the National Weather Service, rainfall-threshold amounts that could produce hazardous flood conditions are determined immediately after the wildfire and in subsequent years as the watershed recovers. Additional research objectives are to: (1) document rainfall-runoff relations that are a function of post-fire infiltration rates, which can substantially decrease due to hydrophobicity and loss of vegetation; (2) determine the length of time for the basin to return to pre-fire hydrologic conditions; (3) assess the effectiveness of watershed-management practices used to mitigate water and sediment runoff; (4) collect data that are needed for subsequent ecosystem assessments; and (5) develop cost-effective methods that can be used to conduct similar flood-mitigation assessments in other burned watersheds. Data collection needs to begin immediately after a wildfire because important data are lost with each successive storm and from post-fire recovery efforts.

Rainfall runoff from recently burned watersheds is more than an order of magnitude larger than for unburned watersheds. Modest convective rainstorms (less than 2-year events) over burned areas produce extremely hazardous flooding; in some basins, debris flows also occur. Larger rainstorms produce catastrophic flooding (40 cubic meters per second per square kilometer) and geomorphic change. Watershed-management practices used to reduce water and sediment runoff often are overwhelmed by runoff from as little as 10 to 20 millimeters of rain in one hour. In contrast, unburned basins in areas of maximum rainfall (50 to 100 millimeters in one hour) have minimal water and sediment runoff. Expanded hydrometeorologic research related to wildfire flood hazards is vital for: (1) understanding the effects of wildfires on water and sediment runoff; (2) maximizing benefits from emerging technologies; (3) improving hydrologic modeling capabilities; and; (4) reliably transferring knowledge to other watersheds. Research results also can be used to help develop post-fire management practices and policy for prescribed burns.

Fire Potential Index to Assess Forest Fire Hazard

Jacqueline M. Klaver (jklaver@edcmail.cr.usgs.gov), Raytheon Systems Company
USGS EROS Data Center, Sioux Falls, SD 57105 (605–594–6961)

The Fire Potential Index (FPI) was developed by the USGS/EROS Data Center, the U.S. Forest Service and the Pan-American Institute of Geography and History (PAIGH) in a project entitled "Digital Imagery for Forest Fire Hazard Assessment (FHA) of the Mediterranean Ecosystems of Argentina, Chile, Mexico, Spain, and the United States." The FPI assess the probability of occurrence of fire, at a 1-kilometer resolution over large areas on a daily basis. The FPI calculation is based on the percentage of live and dead fuel derived from mapped fuel models, daily moisture content of dead fuel derived from weather variables (temperature, humidity, precipitation, and cloudiness), and the partitioning of live and dead fuel using Relative Greenness derived from the Normalized Difference Vegetation Index (NDVI). The FHA project found a high correlation between fire occurrence and high FPI values in many other ecosystems within the Americas. The FPI was calculated and validated for the conterminous United States for the period of 1992–99. Since 1998, the daily calculation of the FPI has been done for the conterminous United States and is available to the public and to fire and land managers over the Internet. The FPI was customized and implemented at 13 Federal and State land-management organizations within the conterminous Western United States and for the State of Alaska. The European Union (EU), through the Joint Research Center (JRC) in Ispra, Italy, has calibrated the FPI for all of Europe and is presently calculating the FPI on a near-time daily basis. The EU has adopted the FPI as one of its fire-prediction tools for Europe.

The Effects of Fire on Avian Communities in Western Forests: General Patterns and Sources of Variation

Natasha B. Kotliar (tasha _kotliar@usgs.gov)
U.S. Geological Survey, Biological Resources Division, Midcontinent Ecological Science Center
4512 McMurry Ave., Fort Collins, CO 80525 (970–226–9446)

Past and current fire-management policies have significantly altered the historical disturbance regimes of Western coniferous forests with profound ramifications for their ecological integrity. However, the primary focus of fire management is on fuel-load reductions, with relatively little consideration given to the effects on wildlife. A review of the literature on the effects of fire on avian communities in Western forests indicated that nine species were consistently more abundant in severely burned than in unburned forests, whereas seven species showed the reverse pattern. The remaining 25 species showed considerable variation in their response to burns. Here, I discuss how various factors may alter avian species' use of burns including: fire severity, size and shape, proximity to unburned forest, pre- and post-fire forest types, time since fire, and pre- and post-fire management. I also speculate about potential interactions among these factors that may modify a species' response to burns. Results of my ongoing research in Colorado and preliminary data on avian abundance patterns in the Cerro Grande are presented. Implications for management and future research are also discussed.

A Decision Support System for Impact Analysis of Wildland Fires

George H. Leavesley (george@usgs.gov), USGS, NRP
Denver, CO (303–236–5026)

Steven L. Markstrom (markstro@usgs,gov), USGS, NRP
Denver, CO (303–236–3330)

Roland J. Viger (rviger@usgs.gov), USGS, NRP
Denver, CO (303–236–5030)

Assessment of the impacts of wildland fires on water and ecosystem resources requires the integration of a wide variety of data types and sources, analytical tools, environmental and socioeconomic models, and multidisciplinary science and management knowledge and skills. The integration and application of these capabilities can be best accomplished through the development of a database-centered decision support system (DSS). The DSS, constructed using a modular "tool box" approach, will provide tools that enable users to (1) retrieve available time-series map-based, and remotely sensed data from a variety of sources; (2) apply GIS tools to assess pre- and post-fire conditions; (3) develop meteorological time series for use as driving variables in environmental models; (4) select, parameterize, link, and apply environmental and socioeconomic models; (5) apply statistical, analytical, and visualization tools to assess model results; and (6) prepare and disseminate assessment results on Web pages and other appropriate media. The modular system design provides a common framework within which to focus multidisciplinary efforts. Discipline specialists can develop and test system modules in their own areas of expertise and then combine and test these modules with those developed in other disciplines to construct the complete system. The modular system design also provides the flexibility to enhance and update system tools and techniques over time as new science, technology, data resources, and computer capabilities become available. Some of the DSS components have been developed and are currently being applied in water- and ecosystem-resource management systems used by the Bureau of Reclamation and the Bureau of Land Management. These components will be used to establish the initial wildland-fire DSS and will provide the focal point for discussion, design, and development of the complete wildland-fire DSS.

A Comprehensive Approach to Post-Fire Water-Quality Monitoring and Decision Making

Deborah A. Martin (damartin@usgs.gov), U.S. Geological Survey
Water Resources Division, Boulder, CO (303–541–3024)

The water-quality consequences of both wildfire and prescribed fire may produce significant and immediate impacts on fish and other aquatic organisms and on downstream drinking-water supplies. These impacts are the cumulative result of chemicals, such as manganese, mobilized by the fire itself, the use of fire-fighting chemicals, and sediment from post-fire erosion. Understanding the full range of these impacts will require the integrated approach of ecologists, water-quality experts, hydrologists, geologists, and other experts.

I propose that the USGS take the lead in developing a protocol for post-fire water sampling and a decision support system for water managers. The need for a comprehensive approach to post-fire water monitoring and decision making was especially clear in response to the wildfires of 2000. For example, water managers needed to know whether to divert sediment- and ash-laden water from agricultural ditches and water-supply intakes, whether to flush water through streams impacted by the use of fire retardants, and what the impact on drinking-water reservoirs would be.

The development of a comprehensive post-fire monitoring and decision protocol by the USGS would rely on existing expertise developed through the National Water-Quality Assessment Program and other water-quality sampling programs. The approach would synthesize existing information on the impacts of fire on water quality and aquatic organisms, would distinguish effects of underlying geology and vegetation from post-fire impacts, would pinpoint the location of stream and rain gages and existing water-quality and sediment stations, and would lay out in clear detail sampling and analysis procedures. The approach could be directly integrated into the Decision Support System proposed by George Leavesley, USGS, and flood-prediction methods of USGS and other researchers. The protocol and decision-making tools would be available through the Web with pointers to sources of assistance within the USGS. In order to address immediately the post-fire water-quality concerns and participate in the BAER (Burned Area Emergency Rehabilitation) process, the USGS should make available water-quality experts as well as a cache of bottles and sampling equipment. Additionally, the Survey could develop the same set of tools to assist land and water managers in their decisions about pre-fire vegetation treatment and ecosystem restoration.

Possible Fire-Science Program: Ecosystem Response to Wildfire—The Sediment Story

John A. Moody (jamoody@usgs.gov), U.S. Geological Survey, MS 413
Lakewood, CO 80225 (303–236–0606)

Deborah A. Martin (damartin@usgs.gov), U.S. Geological Survey, 3215 Marine St., Suite E–127
Boulder, CO 80303 (303–541–3024)

One thread that links many different components in the ecosystem's response to wildfire is sediment. Sediment erosion and deposition are affected by geological, biological, and physical processes and have significant feedbacks on these processes. The threshold of the erosion response is changed when extreme fire temperatures alter soil properties (chemical and physical) and disturb mycorrhizal[1] communities which may have soil-binding properties. Improved methods are needed to measure and map the spatial distribution of soil properties over entire watersheds. This effort could engage scientists interested in fire behavior, surface mineral geology, and remote sensing, as well as microbiologists. Knowing the spatial distribution of soil properties after a fire will lead to better precipitation-runoff models, better predictions of peak flood discharge, and better prediction of areas with risks from hillslope erosion. Identification of erosion risks could be used to prioritize fuel treatments at the watershed, regional, and national scales.

Post-fire hillslope erosion of soil commonly is associated with nutrient losses that affect ecosystem health and increases in chemical and sediment loadings that can affect water quality at downstream water-treatment facilities. Channel erosion spans the spectrum of sediment concentration, from debris flows that threaten infrastructures to increases in suspended sediment that affect the total maximum daily loads. Critical needs for accurate prediction of hillslope and channel erosion and deposition would include: (1) integration of hydroclimatological assessments that relate precipitation and runoff probabilities, (2) better mapping products that take advantage of new technology such as LIDAR, and (3) modification or development of sediment erosion, transport, and deposition models that link hillslopes and channel and are applicable to the watershed scale.

Sediment deposition of fire-related sediment and its associated nutrients and chemicals can be either detrimental or beneficial. Fire-related sediment sometimes damages aquatic communities, such as smothering aquatic invertebrates, filling beaver ponds, and altering key fish habitat. It also damages public and private property such as water-supply reservoirs, homes, and recreational facilities. However, eroded fire-related sediment also supplies nutrients that are a boon to fish and other aquatic populations within the ecosystem and new deposits of coarse sand and gravel necessary for fish spawning. This and many other effects of sediment are not completely understood and would require an integrated effort that is envisioned as an activity of a USGS fire-science program.

---

[1]Mycorrhizal is the symbiotic relationship between specific fungi with the fine roots of higher plants.

Wildfires and Climatic History

Ken Pierce (kpierce@usgs.gov), U.S. Geological Survey
Northern Rocky Mountain Science Center, Bozeman, MT (406–994–5085)

Don Despain (don_despain@usgs.gov), U.S. Geological Survey
Northern Rocky Mountain Science Center, Bozeman, MT (406–994–7257)

Dick Jachowski (richard_jachowski@usgs.gov), U.S. Geological Survey
Northern Rocky Mountain Science Center, Bozeman, MT (406–994–5304)

The severity of fire episodes relates to the Holocene history of climate and fires. Large, stand-replacing fires are most likely during intervals of severe drought. Climatic instability, such as the ongoing global warming, is likely to be accompanied by greater climatic variation, including intervals of severe drought. From the study of cores of lake sediments, (1) climatic history—in particular, intervals of severe drought—may be determined by study of pollen and other materials, and (2) fire history can be determined from the distribution of fine charcoal. For example, a cooperative study by the USGS and a university group headed by Cathy Whitlock (University of Oregon) and funded by the National Science Foundation, is planned for cores from Crevice Lake in northern Yellowstone National Park. This core is varved with annual layers similar to tree rings, providing a detailed history of drought, fire, and other environmental parameters. For the Crevice Lake study, scientists from the Mountain Research Center at Montana State University plan collaborative work on climate and fire history based on study of tree rings and fire scars on trees. Thus, for the last one thousand years or so, we can correlate and compare histories based on tree-ring and varved-core studies of climate, particularly drought, vegetation, fire, and other environmental factors and reach a more fundamental understanding of the factors leading to severe fires.

Meyer and others (1995, General Services Administration Bulletin, p. 1211–1230) show a strong relation between forest fires and debris flows onto alluvial fans in northeastern Yellowstone Park. They find a 300–450-year cycle of fire-related sedimentation that may also reflect the recurrence interval for extreme drought in northeastern Yellowstone. They also find a 1,300-year cycle where fire-related sedimentation builds out alluvial fans into axial valleys, alternating with intervals of lesser fire-related sedimentation when axial streams widen their valley floors and trim back alluvial fans.

Climate and the related vegetation change through time. This factor is in addition to the common increase in density of vegetation and fuel load associated with fire suppression over the last century. For example, the climate has been changing from that of the Little Ice Age (from about AD 1400 to 1900), which had a cooler, wetter climate, to the present, which is both warmer and generally drier. This natural warming trend seems to have been enhanced, particularly in more recent decades, by increased emission of greenhouses gases. Although warming since the Little Ice Age might be associated with less soil moisture, forests in many areas of Yellowstone show increased density, as documented by repeat photography. Modeling studies by Bartlein and others (1999) suggest that a doubling of carbon dioxide actually increases January precipitation over present. We appear to be in a period of transition, and such periods of transition are thought to be accompanied by greater variation in climate, particularly the severity of droughts and wetter intervals. Studies are needed to determine how vegetation is changing on the landscape in response to this warming. Is the natural balance between meadows and forests changing? Scientists at the Northern Rocky Mountain Science Center have started research to isolate what controls the boundary between meadows and forests. The evaluation of how forest-management practice relates to fires needs to appreciate and account for such ongoing climatic warming and associated vegetation changes and stresses, as well as the possible increase in climatic variation, including more frequent severe droughts.

Rapid Update of Digital Raster Graphics for Fire Support

Jeff L. Sloan (jlsolan@usgs.gov), U.S. Geological Survey
Lakewood, Colorado 80225 (303–202–4355 ext. 232)

The increasing use by the wildfire community of U.S. Geological Survey mapping products for wildfire suppression and Burned Area Emergency Response (BAER) activities has highlighted the need for USGS to develop the capability to capture specific data content and existing conditions. These data are presented using exiting 1:24,000-scale topographic maps as the foundation. The Digital Raster Graphics (DRG's) are the exact digital representation of content from the published map graphic but are often out of date or do not reflect critical information. The USGS has developed methodology that can rapidly update the DRG from available imagery over small areas in a few hours, creating nonstandard base images. The USGS can disseminate the more current data to emergency and environmental managers using internet technology or overnight mail. Topics addressed in this presentation will include: Data Acquisition, Image Sources and Rectification, DRG Revision (addition spin-off products), and Dissemination.

Wildfire Hazards and Risks are More than Debris Flows and Floods—A Big Picture Perspective

Cathy M. Tate (cmtate@usgs.gov), U.S. Geological Survey
Lakewood, Colorado (303–236–4882 ext. 287)

Viewed from various perspectives, the term "wildfire hazards and risk" can have many different meanings. When a wildfire occurs in a landscape, there can be many short-term and long-term consequences, and these consequences also can apply to different spatial scales from local to global. Some obvious risks from fires are increased erosion, debris flows, and potential for increased floods due to vegetation removal. Here are some less obvious consequences to consider. What was the proximity of the fire to critical drinking-water supplies, and how long would it take for sediment and associated contaminants to reach this supply? Will the transport of sediments or other toxic contaminants affect the critical habitat of threatened, endangered, or economically important aquatic species? After fires, seeding can occur to decrease erosion potential, but one unintended consequence could be introduction of non-native species. Does the fire occur in an area containing fractured bedrock that might be an important recharge area for an aquifer that is used for a drinking-water supply? What is the contribution of fires to increased nutrients or carbon in the atmosphere, both locally and globally? Does fire substantially alter nutrient and carbon cycling in the watershed in a way that can affect the recovery of the watershed or affect water quality in the watershed? In the longer term, does a wildfire improve wildlife habitat, and how much time is needed before improvement is measurable? Who and what measures determine whether fire-induced changes constitute an improvement or degradation of habitat? How long does it take for a watershed to recover so that debris flows, erosion, and increased flooding are no longer a potential hazard? One way the USGS can assist resource managers is to think about the many hazards and risks associated with wildfires and create maps to display areas of high risk. This exercise could identify gaps in information and begin to focus collaboration among researchers with diverse interests.

The Wildland/Urban Human Fire Interface—The WUFI Revisited

Jonathan G. Taylor (jonathan_taylor@usgs.gov)
Social, Economic and Institutional Analysis Section
Midcontinent Ecological Science Center, USGS
Fort Collins, Colorado (970–226–9438)

During the decade of the 1980's, research into human factors in wildland fire management was quite active. Research teams in the Southwest studied public knowledge and perceptions of fire and discovered that "prescribed burning" was more widely accepted by the public than most resource managers anticipated. They examined the impacts of fire and fire-management practices on burgeoning recreational uses of wildlands; the effectiveness of different means of educating the public about fire effects, and the effectiveness of educating ourselves about the public responses to fire. The fire manager's perception of risk and willingness to accept risk in making wildfire and prescribed fire decisions were examined and reported in the forestry literature. Finally, the social science fire research community turned its attention to the Wildland/Urban Fire Interface, fondly referred to as the WUFI ("Wuffi").

At the turn of the last decade, support for research along the lines of fire knowledge, perception, and behavior became increasingly scarce, and many of this social science research community turned their attention to other problems. The severe exacerbations to the 2000 fire year, brought about by the increased intrusion of homes and other human structures into wildland fire zones, demonstrated the shortsightedness of the failure to complete more in-depth research into the human WUFI. Many of these research questions fall within the field of landscape perception. What human behavior do we observe and can we anticipate in the WUFI, and what drives those behaviors?

- Why do people move into the interface zone?
- Who are they?
- What are their values?
- If we know what they are moving there for, can we anticipate what they want the environment to look like?
- How much are "nature," "naturalness," "isolation" keys to what they prefer and demand the environment provide?
- How do those perceptions affect risk factors such as:
  - Choice of building materials
  - Preference for forest appearance
  - Ability of others to see their living environment
  - Remoteness, for example, preferences for "dead end" roads, and so forth

These are factors that can and must be investigated. The differences between dealing with severe fire years in wildlands and in wildland/urban interface zones are profound. The differences between dealing with severe fire years in fire-responsible WUFI environments as opposed to irresponsible fire-risk behavior zones can be equally profound.

The Effects of Wildfire on the Magnitude and Frequency of Occurrence of Large Peak Flows, Bandelier National Monument, New Mexico

Jack E. Veenhuis (veenhuis@usgs.gov), U.S. Geological Survey
Albuquerque, New Mexico

In June of 1977, the La Mesa fire burned 15,270 acres in and around Frijoles Canyon, Bandelier National Monument, and the adjacent Santa Fe National Forest in New Mexico. The Dome fire occurred in April of 1996 in Bandelier National Monument and burned 16,516 acres in Capulin Canyon and the surrounding Dome Wilderness area. Both canyons have extensive archeological artifacts, which could be threatened by increased runoff and accelerated rates of erosion after a wildfire. The U.S. Geological Survey (USGS) in cooperation with the National Park Service monitored the fires' effects on streamflow in both canyons.

A continuously recording streamflow gage was operated by the USGS in Frijoles Canyon from July 1963 to September 1969 and from July 1977 until September 1982. From 1983 to present, that gage has been operated by several different agencies. The USGS operated three crest-stage gages in Capulin Canyon from July 1996 until November 1998. A partial-record gage was installed in June 1997, which recorded peak stages until November 1998, transmitting that data by satellite for flood documentation. The National Park Service operated a streamflow-recording gage near the site of that partial-record gage from 1985 until 1996.

The magnitude of large stormflows increased substantially after the fire, with peak flows at the most downstream gage in each of these two watersheds increasing to about 160 times the maximum recorded flood prior to the fire. Maximum peak flow was 3,030 cubic feet per second (ft^3/s) at the Frijoles Canyon gage (drainage area = 18.1 square miles), and 3,630 ft^3/s at the most downstream crest-stage gage in Capulin Canyon (drainage area = 14.1 square miles). The pre-fire maximum peak flows recorded at these two sites were 19 and 25 ft^3/s, respectively. As vegetation reestablished itself in the second year, the annual maximum peak flow was reduced to about 10–15 times the pre-fire, annual maximum peak flow. The third year, maximum annual peak flows were reduced to about 3–5 times the pre-fire maximum peak flow and in the 22 years since the fire, the flood magnitudes have not completely returned to pre-fire size.

Although post-fire flood magnitudes in Frijoles and Capulin are much larger than magnitudes for pre-fire conditions, they do not exceed the maximum floods per drainage area enveloping curves for two of the northern flood regions of New Mexico from Waltemeyer (1996). This suggests that post-fire flood magnitudes are much larger than normal flood magnitudes for a given watershed, as we have noted, but that these recent Bandelier post-fire floods still do not exceed maximum floods per drainage-area envelope curves for this region.

The frequency of larger stormflows also increased in response to the effects of the fires in both canyons. In Frijoles Canyon, the number of peak stormflows greater than the pre-fire maximum flow of 20 ft^3/s is 15, 6, and 8 for 1977 through 1979, respectively. Again, the effects of the wildfire seem to be noticed for the three water years from the date of the fire. After the three recovery years, no more than one peak flow per year was greater than 20 ft^3/s. Similarly, larger stormflows occurred more frequently in Capulin Canyon for the first three years after the fire in 1996.

VIII. Authorities and Related Laws

Protection Act of 1922 (16 U.S.C. 594).
Economy Act of June 30, 1932 (47 Stat. 417; 31 U.S.C. 1535), as amended.
Reciprocal Fire Protection Act of May 27, 1955 (69 Stat. 66; 42 U.S.C. 1856a).
Disaster Relief Act of 1974 (42 U.S.C. 1521).
Federal Land Policy and Management Act of 1976 (43 U.S.C. 1702).
Cooperative Forestry Assistance Act of 1978 (P.L. 95-313, 92 Stat, 365 as amended; 16 U.S.C. 2101 (note), 2101-2103, 2103a, 2103b, 2104-2105).

IX. Publications and Release of Information

It is the intent of the Bureaus that data and information obtained as a result of future interagency agreements pursuant to this MOU will be available for use by the Bureaus in connection with their ongoing programs. This includes publication of results, except in cases prohibited by proprietary or security considerations.

Publications resulting from cooperative fire-science efforts may be prepared by either party, or jointly, provided that both Bureaus have an opportunity to review manuscripts prior to publication. To the extent possible, decisions involving authorship, review of reports, and other conditions and circumstances will be addressed during the preparation of agreements pursuant to this MOU.

Should differences of scientific viewpoint occur, an effort would be made to reconcile them. However, the parties understand that each agency may publish separately the data, information, and interpretations that may be developed as part of future interagency agreements pursuant to this MOU provided appropriate responsibility and attribution are acknowledged.

The BLM and the USGS agree that it is mutually beneficial to acknowledge the work of each agency. Accordingly, each agency shall make every effort to assure the appropriate citation and attribution for all work documents including technical reports, data, publicity, and public information products that may be prepared as part of future interagency agreements pursuant to this MOU.

Any commitment to preserve the confidentiality of information is subject to applicable United States laws and regulations and should include a statement that information may be required to be released under laws such as the Freedom of Information Act.

X. Authorized Representatives

The following individuals shall represent their respective Bureaus for all matters related to the activities conducted under this MOU:

For the Bureau of Land Management:

Director, National Office of Fire and Aviation
National Interagency Fire Center
Boise, Idaho

For the U.S. Geological Survey: Coordinator, Bureau Fire-Science Program

U.S. Geological Survey
Reston, Virginia

XI. Provisions

All signatory parties intend that this MOU and any future agreements referencing it will comply with: the nondiscrimination provisions contained in Title VI and VII of the Civil Rights Act of 1964, as amended; the Civil Rights Restoration Act of 1987 (Public Law 100-259); and other nondiscrimination statutes, such as, Section 504 of the Rehabilitation Act of 1973, Title IX of the Education amendments of 1972, and the Age Discrimination Act of 1975. Regulations of the Secretary of the Interior (43CFR 17) provide that no person in the United States shall, on the grounds of race, color, national origin, age, or disability be excluded from participating in, be denied the benefits of, or be otherwise subject to discrimination under any program or activity receiving Federal financial assistance from the DOI, or any agency thereof; and this MOU and any agreements will be in accordance with such regulations. Furthermore, this MOU shall comply with Executive Order 13087, prohibiting discrimination on the basis of sexual orientation.

XII. Approval

Nina Hatfield — Date
Acting Director, Bureau of Land Management

/s/C.G. Groat
7/2/01

Charles G. Groat — Date
Director, U.S. Geological Survey

Appendix G—President's FY 2001 Fire Initiative

MAKING APPROPRIATIONS FOR THE DEPARTMENT OF THE INTERIOR AND RELATED AGENCIES FOR THE FISCAL YEAR ENDING SEPTEMBER 30, 2001, AND FOR OTHER PURPOSES

WILDLAND FIRE MANAGEMENT

The conference agreement provides $625,513,000 for wildland fire management instead of $292,197,000 as proposed by the House and $292,679,000 as proposed by the Senate.

Changes to the House included increases of $132,834,000 for preparedness and $482,000 for an Alaska rural fire suppression program. The managers have also included a contingent emergency appropriation of $200,000,000 as an emergency contingency reserve to ensure adequate funding is available to fund critical fire programs in fiscal year 2001.

The managers recognize that the severity of the 2000 fire season is attributable to a variety of factors including unusual weather conditions and accumulated wildland fuels that overwhelmed available Federal agency resources. To prepare better for fires in 2001 and beyond, the managers propose significant improvements to preparedness, fuels treatments, and other aspects of fire management. For the Department of the Interior, the managers provide a total of $979,253,000 in both emergency and non-emergency funds for: the Department's revised calculation for normal year readiness and certain one-time improvements to preparedness capability; a greatly expanded fuels treatment program that places primary emphasis on community protection; stabilization and rehabilitation of burned areas; and community assistance programs that may be used to develop local capability and homeowner education. **The following discussion includes instructions pertaining to both the title I wildfire funds as well as title IV wildfire funds.**

The managers have provided $625,513,000 in Title I for wildland fire management, of which $315,406,000 in non-emergency funds for preparedness, an increase of $133,316,000 over the budget request. The conference agreement includes a $200,000,000 emergency contingency reserve, to ensure that adequate funds are immediately available to fund these critical programs in FY 2001. The managers have included in title IV for wildland fire management an emergency appropriation of $353,740,000 which includes $116,611,000 for wildfire suppression, $142,129,000 for hazardous fuels, $85,000,000 for emergency stabilization and rehabilitation, and $10,000,000 for a new rural fire assistance program. The managers strongly believe that this FY 2001 funding will only be of value in increasing the Nation's firefighting capability and ability to protect communities if it is sustained in future years.

The managers direct the Departments of the Interior and Agriculture to continue to work together to formulate complementary budget requests that reflect the same principles and budget organization. In addition, the managers expect the agencies to seek the advice of governors and local and tribal government representatives in setting priorities for fuels treatments, burned area rehabilitation, and public outreach and education.

Wildland Fire Preparedness

For wildland fire preparedness, the managers provide $315,406,000 as a non-emergency appropriation in title I, $132,834,000 above the Senate, including: $254,838,000 for readiness and program management, $8,000,000 for fire sciences, $30,000,000 for deferred maintenance and capital improvement, $22,086,000 for one-time capital investments, and $482,000 for a rural Alaska fire suppression program.

The managers understand that the increased scope and intensity of the 1999 and 2000 fire seasons, as well as the increased frequency and severity of fires over the preceding decade, have led Federal fire managers to reassess the assumptions underlying an average fire season. Based on actual experience, especially over the past two years, Federal fire managers have concluded that the variables used to determine the optimal level of preparedness need to be revised. Numerous variables, including changing assumptions about fire personnel,

Appendix F—Memorandum of Understanding

BLM AGREEMENT #:
USGS AGREEMENT #:

MEMORANDUM OF UNDERSTANDING: SCIENCE IN SUPPORT OF FIRE MANAGEMENT

Between the

BUREAU OF LAND MANAGEMENT

and the

U.S. GEOLOGICAL SURVEY

of the

UNITED STATES DEPARTMENT OF THE INTERIOR

(taken verbatim from its source)

I. Introduction

Fire management in the Nation's wild lands is a matter of continuing concern to the American public and to the Bureau of Land Management (BLM) as a land management agency of the Department of the Interior (DOI). For nearly 100 years, Federal policy has been to suppress all wildfires, regardless of origin. An increasing awareness of the need for fire as a natural agent in the management of ecosystems, coupled with agency activities related to suppression of wildfires in the wild land-urban interface, lead to a need for a better scientific understanding of the role of fire as a natural agent, impacts of fire on ecosystems, natural hazards that can result from wildfires in selected environments, and appropriateness and usefulness of rehabilitation and restoration techniques for burned areas. Although considerable progress has been made in fire management planning, fire use, fire suppression, and fire research by the land management agencies, significantly more progress is possible through additional scientific research of natural processes related to fire and the impacts of human efforts to assist or control those processes.

This Memorandum of Understanding (MOU) establishes the framework for coordination and cooperation between the BLM and the United States Geological Survey (USGS) (collectively "Bureaus") on science in support of fire management. The purpose of this MOU is to provide for collaborative and coordinated fire-science efforts between the two Bureaus to avoid duplication of effort, to ensure that fire-science research provides relevant and applicable information, and to ensure information useful to the programs of both agencies is shared in a timely manner. These efforts will support the National Fire Plan, the Joint Fire Science Program, and activities of the National Wildfire Coordinating Group. A major function of this MOU is to provide a means whereby the two Bureaus may clarify their roles and responsibilities in the national fire science agenda. This MOU also delineates potential mechanisms the Bureaus may pursue in complementing each other's missions and supporting national fire science requirements.

II. Definitions

For the purposes of this MOU, and for all interagency agreements pursuant to this document, the following definitions of terms shall apply:

"Interagency agreement" means an agreement or ordering document between Federal agencies in which one agency transfers its appropriated funds to another agency for the purpose of obtaining products or services.

"Fire science" means scientific research and analysis contributing to understanding fire processes and evaluating needs of fire management and suppression.

"Urban-urban interface" means those locations where humans and their infrastructure development meet or intermix with wild land fuel.

"Fire management" means activities undertaken for the protection of wild lands from fire and the use of prescribed fire to meet land management objectives.

"Fire suppression" means the work of extinguishing or confining a fire, beginning with its discovery.

"Post-fire rehabilitation" means the short- and long-term (no greater than 3 years) activities necessary to repair damage or disturbance caused by wildfire or the wildfire suppression activity.

III. Scope

This MOU provides general terms and conditions for coordination and cooperation between the BLM and the USGS on scientific research and analysis pertaining to fire management and on sharing information regarding fire-management applications. Cooperation and coordination pertaining to fire management applications is encouraged at the national, regional, and local levels, as needed, to ensure that the highest priority scientific information needs of the BLM are addressed. Areas of scientific research and analysis and information sharing may include, but are not limited to:

- The role of fire as a natural agent and disturbance process;
- Fire history of selected areas;
- The impact of fire on natural processes;
- The impact of fire on watersheds and water quality;
- The impact of fire on soils and slope stability;
- The impact of fire and fire suppression chemicals on flora and fauna and aquatic and terrestrial habitats;
- The impact of fire on threatened and endangered species;
- The role of fire in managing invasive species;
- The potential for post-fire flood and debris-flow hazards;
- The impact of fire on cultural and historical resources;
- Fire fuels mapping and vegetation mapping;
- Climate and weather models for planning fuels treatments;
- The effectiveness of post-fire rehabilitation techniques;
- The effectiveness of post-fire restoration policies and techniques;
- The effectiveness of fire suppression techniques;
- Firefighting safety and security techniques, and;
- The psychology and social science of fire management.

IV. Agreements/Responsibilities

The BLM and the USGS have interests in the quality and quantity of scientific information available for decision-making regarding public lands with respect to fire management, including fostering a better understanding of the influences of fire on the physical environment and of the effectiveness of fire suppression and post-fire treatment methods. Increasing such scientific knowledge provides the land managers with an enhanced ability to:

A. Maintain healthy ecosystems;

B. Develop fire management plans and mitigate deleterious effects of wild land fires; especially post-fire hazards such as debris flows and floods; and

C. Facilitate the integration of sound scientific information about fire ecology into the interdisciplinary planning and decisionmaking processes of Federal land management.

As the science bureau of the DOI, the scientific programs of the USGS provide important scientific information about earth surface processes, including wild land fire, which can affect land and resource management policies and practices of the land management agencies, such as the BLM. To ensure the effectiveness of its fire program activities, the BLM conducts studies and analyses of selected fire suppression techniques and post-fire treatment methods. The BLM and the USGS agree to coordinate and communicate to the extent possible regarding their programs of fire science to address information needs related to fire management. Mutual responsibilities as part of this coordination may include:

- Coordinating related programs at appropriate operational levels;
- Cooperating to the extent allowed under existing law in the operational conduct of related programs;
- Exchanging data, information, and findings; and
- Exchanging budget information during the budget-preparation stages and sharing information with budget implications whenever appropriate in order to assure efficient use of Federal funds and facilitate planning for highest priority needs.

V. Implementation

The BLM and the USGS agree to meet annually or more often as needed to:

- Share priority needs;
- Provide updates on science projects, information application, and program developments and policies; and
- Facilitate the gathering of scientific information in a way that is efficient, coordinated, and reduces redundancy. Each Bureau, on a rotational basis, will host the annual meeting, with the first one hosted by the USGS.

The agencies anticipate developing future interagency agreements under the Economy Act that support the goals of this MOU. As appropriate, interagency agreements may be developed for, but not be limited to, the following purposes:

- Information and on-site support for Burned Area Emergency Response (BAER) teams;
- Information and on-site support for fire suppression activities, post-fire assessment, rehabilitation and restoration activities;
- Information to support fire ecology and prescribed fire activities, and geospatial information systems support for fire management, fire suppression, and post-fire activities.

Future Interagency Agreements in support of the goals of this MOU will conform with provisions of the BLM and the USGS Manual sections pertaining to Interagency Agreements. The manuals call for the inclusion of information such as:

- Bureau responsibilities;
- Description of products or services to be supplied;
- Production or delivery schedules;
- Standards and technical specifications, as necessary;
- Duration of the plans or projects;
- Description of financial arrangements; and
- Programmatic or technical points of contact.

This MOU does not preclude the parties from developing independent agreements with other agencies or entities to meet agency-specific fire science needs. However, the BLM and the USGS should share the subject matter of the agreements with each other in advance and shall report at the annual meeting on the progress and results of independent research efforts to ensure the timely sharing of information that may benefit research ongoing under this MOU.

VI. Financial Arrangements

This MOU is neither a fiscal nor funds obligation document. This MOU does not commit the BLM or the USGS to enter into any specific interagency agreements for the purposes of this MOU. Projects involving cost sharing between the two Bureaus, including billing procedures may be included in future interagency agreements. Both parties shall ensure that interagency agreements drafted pursuant to this MOU shall comply with the provisions of the Economy Act.

This MOU does not restrict the BLM and the USGS from participating in similar fire-science arrangements with other public or private agencies, organizations, or individuals. Neither does this MOU require the BLM and the USGS to expend appropriations or enter into any contracts or other obligations.

VII. Terms of Understanding

This MOU will take effect on the date of the last signature and remain in effect for 5 years from that date.

The BLM and the USGS will conduct a formal review of this MOU at least every 5 years. Renewal of this MOU shall be contingent upon a formal review by the BLM and the USGS and the signing of a renewal statement.

Either party may initiate amendments and modifications to this MOU. The amendments or modifications will take effect on the date of the last signature on the documentation of the amendment or modification.

Either party may terminate their participation in this MOU by 30 days written notice to the other.

deployment strategies and other factors affecting cost calculations underlie the recommendations in the agencies' recent report to the President. For example, the duration of the average fire season has steadily increased—by two to three months—over the past several years. The expanded fire season increases the duration of the season for which fire employees are paid and results in increased personnel costs.

The managers support the conclusions of wildfire managers that initial attack capability should be increased to address the number and severity of wildfires that have burned the landscape over the past few years. To address this revised assumption, the managers support full funding for: eight new hotshot crews that will be used for both initial attack on small fires and extended attack on larger fires; twenty new smokejumpers that serve as the primary initial attack force in remote areas; and additional air resources.

Recent experience dictates the need to increase staffing for engines from the current level of five days a week to seven days a week to combat the increasingly volatile fire season. Fire managers have also concluded that more of the firefighting workforce should be permanent seasonal, an employment status that entitles workers to benefits not earned by temporary employees. The managers support the recommendation to convert more than 1,000 positions to permanent seasonal status, as a retention incentive to ensure that a sustained cadre of professional firefighters is available when needed. This increase in overall readiness costs should prove beneficial in the long run to the government's ability to address fire readiness, overall program management, and reduce overall costs by putting out wildfires when they are small.

It is the managers' understanding that readiness and program management cost calculations have increased due to changes in resource objectives such as protection of newly discovered cultural artifacts and new land ownership patterns. In recent years costs associated with human settlement into the urban-wildland interface have risen faster than models could accurately describe and are underrepresented in average cost calculations. The managers also understand that additional wildfire management personnel will require additional equipment and appropriate work environments, and that work conditions must emphasize firefighter and public safety. Therefore, the managers have included within the preparedness activity sufficient resources to provide the equipment, office, and storage space necessary to provide safe and efficient operations. Additional funds provided under this appropriation for facilities are to be used to fund the highest priority health and safety needs, as identified in the Department's five-year plan for deferred maintenance and capital improvements.

The managers support an acceleration of research activities and expanded emphasis for the Joint Fire Science Program and have provided an additional $4,000,000 respectively to the Departments of the Interior and Agriculture to support the recommendations regarding scientific support for fuels treatments and other science needs beyond hazardous fuels. These funds are in addition to the $4,000,000 provided for each agency as part of the Administration's original budget request. Additional funds should be used for such efforts as increased rapid response projects to ensure necessary resources are available for testing and evaluation of post-fire rehabilitation, assessment of post-fire and fire behavior effects, use of aircraft-based **remote sensing** operations, implementation of protocols for evaluating post-fire stabilization and rehabilitation, and the development of effective means for collecting and disseminating information about treatment techniques. The managers expect the increased funds to be made available to the Joint Fire Science activities of the Departments for the direct benefit of fire management programs, including burned area rehabilitation.

One means of directly benefiting wildfire management programs is to address locally and regionally important science and technology needs associated with wildfire management and suppression, fuels management, and post-fire rehabilitation without requiring national-level requests for proposals. Thus, the managers expect the Joint Fire Sciences Governing Board to make a significant portion of the increased funds directly available to the fire management programs of the Agriculture and Interior Departments to fund projects that directly address locally and regionally important science and technology needs associated with fire management and suppression, fuels management, and post-fire rehabilitation. The managers further expect the Departments to ensure that these programs are implemented within existing structures without new program management or other overhead activities that might reduce the direct benefit of funds provided.

The January 1998 Joint Fire Science Plan developed by the two Departments and submitted to the Congress included provisions for a Stakeholder Advisory Group of technical experts from land management organizations, private industry, academia, other Federal agencies, and the public to formulate recommendations for program priorities and advise the Joint Fire Science Program Governing Board. This Group is to be established under the provisions of the Federal Advisory Committee Act. The managers are concerned that nearly three years have passed without establishment of this group. The managers direct the Secretaries to establish the group by December 31, 2000.

Wildland Fire Operations

For wildland fire operations, the managers provide $468,847,000 of which $353,740,000 is funded in title IV as an emergency appropriation. This funding level includes $153,447,000 to cover costs of the ten-year average of suppression, $195,400,000 for hazardous fuels reduction, and $85,000,000 for rehabilitation of burned areas.

The managers encourage continued emphasis on safety as a priority in the suppression program. Funding provided under this appropriation is expected to provide for the most efficient and safe strategy for the protection of life, property, and resources. Funding is included to cover the projected 10-year average of suppression expenditures for the Department.

The managers have provided $195,000,000 for hazardous fuels management activities. These funds are to support activities on Federal lands and adjacent non-Federal lands, which reduce the risks and consequences of wildfire, both in and around communities and in wildland areas. Treatment methods include application of prescribed fire, mechanical removal, mulching, and application of chemicals. In many areas a combination of these methods will be necessary over a period of several years to reduce risks and to maintain healthy and viable forests and rangelands. The increased funding included in this appropriation will expand the existing fuels management program to reduce risks to communities and risks to natural resources in high-risk areas. As proposed by the Senate, the managers have included $120,300,000 for the Department of the Interior to accelerate treatments, planning efforts, and collaborative projects with non-Federal partners in the wildland-urban interface. This funding is provided as part of the Department's ongoing fuels treatment program, but must be dedicated to projects within the urban-wildland interface.

The managers understand that fuels treatment accomplishments have been constrained by a lack of funding to conduct planning, assessments, clearances, consultation, and environmental analyses necessary for the land management and regulatory agencies to ensure that fuels treatments are accomplished quickly and in an environmentally sound manner. The managers agree that additional funding should be made available from this appropriation to conduct such assessments and clearances, in the interests of expediting fuels treatments in an environmentally sound manner. Funds may be used directly by the Bureau of Land Management, or on a reimbursable basis with National Park Service, Fish and Wildlife Service, Bureau of Indian Affairs, or National Marine Fisheries Service, to provide for appropriate planning and clearances. Funding will also be available for supporting community-based efforts to address defensible space and fuels management issues and to support outreach and education efforts associated with fuels management and risk reduction activities. In conducting treatments, local contract personnel are to be used wherever possible. The managers expect the Department to show planned and actual funding and accomplishments for fuels management activities in future budget requests to Congress. The managers understand that actual amounts may differ from planned levels and agree that the agencies have the ability to fund additional projects and amounts based on actual needs.

Within the amounts provided for wildland-urban treatments, $8,800,000 is to be made available to the Ecological Restoration Institute (ERI) of Northern Arizona University, through a cooperative agreement with the Bureau of Land Management, to support new and existing ecologically-based forest restoration activities in ponderosa pine forests. The managers' goal is to develop a scientifically based model that will promote restoration of the ecological health of forests in the southwest, while reducing the threat of wildfire to forest communities. Under this agreement, the managers expect that ERI will: (1) research, develop, monitor, and conduct fuels treatments in partnership with all Federal, Tribal, State, and private landowners to demonstrate the feasibility of restoration-based fuels treatments on a community-level; (2) conduct an adaptive ecosystem analysis of ponderosa pine and related forests as a prototype for larger ecosystem analyses, and to fill the gap between project or district/forest level analyses and regional analyses to support future operational scale treatments; (3) develop options and recommendations for developing markets for by-products of fuels treatment activities; (4) hold community workshops to design suitable treatments, training and information transfer to land managers, and information development and transfer to inform the public and land managers about ecologically-based treatments. Recognizing the importance of cooperative agreements, the managers request that the Bureau place a priority on timely negotiation and implementation of this agreement to ensure the prompt availability of funding pursuant to it, and that the Bureau conduct negotiations at the national level. The agreement shall not include funding for facilities or capital equipment like buildings and vehicles.

Included within the amounts for wildland fire operations is increased funding for burned area rehabilitation to address short term and long-term detrimental consequences of wildfires. The managers note that wildland fires burning under the right conditions, are beneficial and even essential to the health of forests and rangelands. However, some severe wildfires can trigger a wide array of detrimental impacts, ranging from short term floods, debris flow, and loss of water quality to longer term invasion by non-native species and loss of productivity of the land. The increased funding for burned area rehabilitation is designed to prevent further degradation of resources following wildland fire through (1) short-term stabilization activities to protect life and property, protect municipal watersheds, and prevent unacceptable degradation of critical natural and cultural resources, and (2) longer-term rehabilitation activities to repair and improve lands unlikely to recover naturally from severe fire damage. The managers direct the agencies to develop a long-term program to manage and supply native plant materials for use in various Federal land management restoration and rehabilitation needs. The managers recommend that the interagency native plant conservation initiative lead this effort.

It is essential to monitor over the long-term various wildfire operations and rehabilitation activities and use this evaluation to alter future activities where indicated. The managers expect that funding for burned area rehabilitation will be available from this appropriation for only a limited period of time, after which ongoing site maintenance must be funded from the land management bureaus' appropriate operating accounts. In conducting stabilization and rehabilitation treatments, local contract personnel should be used wherever possible. The managers expect the Department to show planned and actual funding and accomplishments for stabilization and rehabilitation activities in future budget requests to Congress. The managers understand that actual amounts may differ from planned levels, and agree that the agencies have the ability to fund additional projects and amounts based on actual needs.

The managers direct the Departments of the Interior and Agriculture to report to the Appropriations Committees, by December 1, 2000, on criteria for rehabilitation projects to be funded from this appropriation.

Rural Fire Assistance

For rural fire assistance, the managers provide $10,000,000 for the Department of the Interior in a pilot effort to enhance the fire protection capability of rural fire districts. Training, equipment purchase, and prevention activities are to be conducted on a cost-shared basis. The managers recognize that safe and effective protection in the urban-wildland interface demands close coordination between local, State, Tribal, and Federal firefighting resources. When large Interior landholdings are present, the managers support an expanded relationship between the Interior Department and other governments for purposes of developing local fire prevention capability on a cost-shared basis.

CENTRAL HAZARDOUS MATERIALS FUND

The conference agreement provides $10,000,000 for the central hazardous materials fund as proposed by the House and Senate.

MAKING APPROPRIATIONS FOR THE DEPARTMENT OF THE INTERIOR AND RELATED AGENCIES FOR THE FISCAL YEAR ENDING SEPTEMBER 30, 2001, AND FOR OTHER PURPOSES

TITLE IV—WILDLAND FIRE EMERGENCY APPROPRIATIONS

DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

WILDLAND FIRE MANAGEMENT

For necessary expenses for fire suppression operations, burned areas rehabilitation, hazardous fuels reduction, and rural fire assistance by the Department of the Interior, $353,740,000 to remain available until expended, of which $21,829,000 is for hazardous fuels reduction, $120,300,000 is for removal of hazardous fuels to alleviate immediate emergency threats to urban wildland interface areas as defined by the Secretary of Interior, $116,611,000 is for wildfire suppression, $85,000,000 is for burned areas rehabilitation, and $10,000,000 is for rural fire assistance: Provided, That using the amounts designated under this title of this Act, the Secretary of the Interior may enter into procurement contracts, grants, or cooperative agreements, for hazardous fuels reduction activities, and for training and monitoring associated with such hazardous fuels reduction activities, on Federal land, or on adjacent non-Federal land for activities that benefit resources on Federal land: Provided further, That the costs of implementing any cooperative agreement between the Federal government and any non-Federal entity may be shared, as mutually agreed on by the affected parties: Provided further, That in entering into such grants or cooperative agreements, the Secretary may consider the enhancement of local and small business employment opportunities for rural communities, and that in entering into procurement contracts under this section on a best value basis, the Secretary may take into account the ability of an entity to enhance local and small business employment opportunities in rural communities, and that the Secretary may award procurement contracts, grants, or cooperative agreements under this section to entities that include local non-profit entities, Youth Conservation Corps or related partnerships, or small or disadvantaged businesses: Provided further, That funds in this account are also available for repayment of advances to other appropriation accounts from which funds were previously transferred for such purposes:

Provided further, That unobligated balances of amounts previously appropriated to the 'Fire Protection' and 'Emergency Department of the Interior Firefighting Fund' may be transferred and merged with this appropriation: Provided further, That persons hired pursuant to 43 U.S.C. 1469 may be furnished subsistence and lodging without cost from funds available from this appropriation: Provided further, That notwithstanding 42 U.S.C. 1856d, sums received by a bureau or office of the Department of the Interior for fire protection rendered pursuant to 42 U.S.C. 1856 et seq., Protection of United States Property, may be credited to the appropriation from which funds were expended to provide that protection, and are available without fiscal year limitation: Provided further, That the entire amount appropriated is designated by the Congress as an emergency requirement pursuant to section 251(b)(2)(A) of the Balanced Budget and Emergency Deficit Control Act of 1985, as amended: Provided further, That this amount shall be made available only to the extent that an official budget request for a specific dollar amount, that includes designation of the entire amount as an emergency requirement as defined by such Act, is transmitted by the President to the Congress.

RELATED AGENCY

DEPARTMENT OF AGRICULTURE

FOREST SERVICE

WILDLAND FIRE MANAGEMENT

For an additional amount to cover necessary expenses for emergency rehabilitation, hazard reduction activities in the urban-wildland interface, support to federal emergency response, repaying firefighting funds borrowed from programs, and wildfire suppression activities of the Forest Service, $619,274,000, to remain available until expended, of which $179,000,000 is for wildfire suppression, $120,000,000 is for removal of hazardous fuels to alleviate immediate emergency threats to urban wildland interface areas as defined by the Secretary of Agriculture, $142,000,000 is for emergency rehabilitation, $44,000,000 is for capital improvement and maintenance of fire facilities, $16,000,000 is for research activities and to make competitive research grants pursuant to the Forest and Rangeland Renewable Resources Research Act, as amended (16 U.S.C. 1641 et seq.), $50,494,000 is for state fire assistance, $8,280,000 is for volunteer fire assistance, $12,000,000 is for forest health activities on state, private, and federal lands, $12,500,000 is for economic action programs, and $35,000,000 is for assistance to non-federal entities most affected by fire using all existing authorities under the State and Private Forestry appropriation; and of which $320,274,000 may be transferred to the 'State and Private Forestry', 'National Forest System', 'Forest and Rangeland Research', and 'Capital Improvement and Maintenance' accounts to fund state fire assistance, volunteer fire assistance, and forest health management, vegetation and watershed management, heritage site rehabilitation, wildlife and fish habitat management, trails and facilities maintenance and restoration: Provided, That transfers of any amounts in excess of those authorized in this title, shall require approval of the House and Senate Committees on Appropriations in compliance with reprogramming procedures contained in House Report No. 105–163: Provided further, That the costs of implementing any cooperative agreement between the Federal government and any non-Federal entity may be shared, as mutually agreed on by the affected parties: Provided further, That in entering into such grants or cooperative agreements, the Secretary may consider the enhancement of local and small business employment opportunities for rural communities, and that in entering into procurement contracts under this section on a best value basis, the Secretary may take into account the ability of an entity to enhance local and small business employment opportunities in rural communities, and that the Secretary may award procurement contracts, grants, or cooperative agreements under this section to entities that include local non-profit entities, Youth Conservation Corps or related partnerships with State, local or non-profit youth groups, or small or disadvantaged businesses: Provided further, That the entire amount appropriated is designated by the Congress as an emergency requirement pursuant to section 251(b)(2)(A) of the Balanced Budget and Emergency Deficit Control Act of 1985, as amended: Provided further, That this amount shall be made available only to the extent that an official budget request for a specific dollar amount, that includes designation of the entire amount as an emergency requirement as defined by such Act, is transmitted by the

President to the Congress: *Provided further*, That:

1. In expending the funds provided with respect to this title for hazardous fuels reduction, the Secretary of the Interior and the Secretary of Agriculture may conduct fuel reduction treatments on Federal lands using all contracting and hiring authorities available to the Secretaries applicable to hazardous fuel reduction activities under the wildland fire management accounts. Notwithstanding Federal government procurement and contracting laws, the Secretaries may conduct fuel reduction treatments on Federal lands using grants and cooperative agreements. Notwithstanding Federal government procurement and contracting laws, in order to provide employment and training opportunities to people in rural communities, the Secretaries may award contracts, including contracts for monitoring activities, to—(A) local private, nonprofit, or cooperative entities; (B) Youth Conservation Corps crews or related partnerships, with State, local and non-profit youth groups; (C) small or micro-businesses; or (D) other entities that will hire or train a significant percentage of local people to complete such contracts. The authorities described above relating to contracts, grants, and cooperative agreements are available until all funds provided in this title for hazardous fuels reduction activities in the urban wildland interface are obligated.

2. Within 60 days after enactment, the Secretary of Agriculture and the Secretary of the Interior shall, after consultation with State and local fire-fighting agencies, jointly publish in the Federal Register a list of all urban wildland interface communities, as defined by the Secretaries, within the vicinity of Federal lands that

are at high risk from wildfire, as defined by the Secretaries. This list shall include: (A) an identification of communities around which hazardous fuel reduction treatments are ongoing; and (B) an identification of communities around which the Secretaries are preparing to begin treatments in fiscal year 2001.

3. Prior to May 1, 2001, the Secretary of Agriculture and the Secretary of the Interior shall jointly publish in the Federal Register a list of all urban wildland interface communities, as defined by the Secretaries, within the vicinity of Federal lands and at high risk from wildfire that are included in the list published pursuant to paragraph (2) but that are not included in subparagraphs (A) and (B) of paragraph (2), along with an identification of reasons, including but not limited to lack of available funds, why there are no treatments ongoing or being prepared for these communities.

4. Within 30 days after enactment of this Act, the Secretary of Agriculture shall publish in the Federal Register the Forest Service's Cohesive Strategy for Protecting People and Sustaining Resources in Fire-Adapted Ecosystems. The documentation required by section 102(2) (C) of the National Environmental Policy Act accompanying the proposed regulations revising the National Forest System transportation policy; proposed roadless area protection regulation; and proposed Interior Columbia Basin Project; and the Sierra Nevada Framework. Sierra Nevada Forest Plan shall contain an analysis and explanation of any differences between the Cohesive Strategy and the policies and rule-making listed in this paragraph. Nothing in this title is intended or should require a delay in the rule-makings listed in this paragraph.

(A) Funds provided to the Secretary of Agriculture by this title and to the Secretary of the Interior, the Secretary of Commerce, and the Council on Environmental Quality by this Act and any other applicable act appropriating funds for fiscal year 2001 shall be used as necessary to establish and implement the expedited procedures set forth in this paragraph for decisions to conduct hazardous fuel reduction treatments pursuant to paragraphs (1) and (2), and any post-burn treatments within the perimeters of areas burned by wildfire, on federal lands. (B) The Secretary of Agriculture, the Secretary of the Interior, the Secretary of Commerce, and the Chairman of the Council on Environmental Quality shall use such funds specified in subparagraph (A) as necessary to evaluate the need for revised or expedited environmental compliance procedures including expedited procedures for the preparation of documentation required by section 102(2) of the National Environmental Policy Act (42 U.S.C. 4332(2)) for treatment decisions referred to in subparagraph (A). The Secretary of Agriculture, the Secretary of the Interior, the Chairman of the Council on Environmental Quality shall report to the relevant congressional committee of jurisdiction within 60 days of enactment of this Act to apprise the Congress of the decision to develop any expedited procedures or adopt or recommend any other measures. Each Secretary may employ any expedited procedures developed pursuant to this subsection for a treatment decision when the Secretary determines the procedures to be appropriate for the decision. These procedures shall ensure that the period of preparation for environmental documentation be expedited to the maximum extent practicable. Each Secretary and the Council shall effect any modifications to existing regulations and guidance as may be necessary to provide for the expedited procedures within 180 days of the date of enactment of this Act. (C) With the funds specified in subparagraph (A), the Secretary, as defined in section 3(15) of the Endangered Species Act of 1973 (16 U.S.C. 1532(15)), may accord priority as appropriate to consultation or conferencing under section 7 of such Act (16 U.S.C. 1536) concerning any treatment decision referred to in subparagraph (A) for which consultation or conferencing is required. (D) With the funds specified in subparagraph (A), administrative review of any treatment decision referred to in subparagraph (A) shall be conducted as expeditiously as possible but under no circumstances shall exceed any statutory deadline applicable to such review. (E) No provision in this title shall be construed to override any existing environmental law.

☆ U.S. GOVERNMENT PRINTING OFFICE: 2002 — 773-096 / 47109 Region No. 8