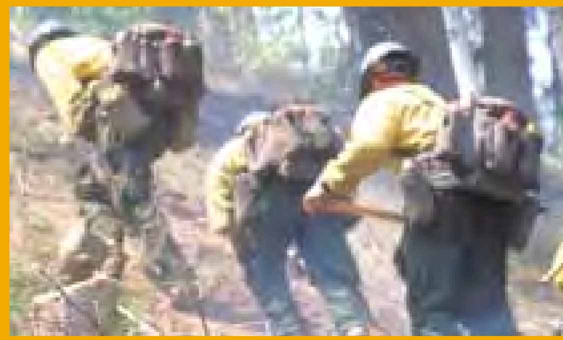
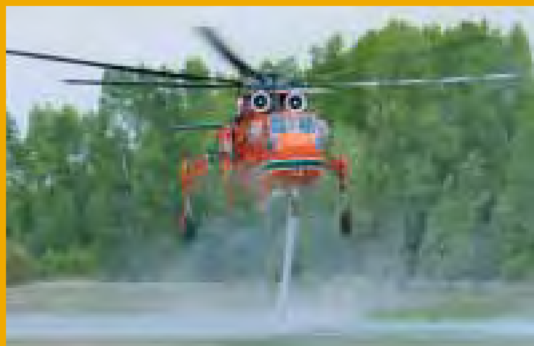
Background and Research

A Report by a Panel of the
National Academy of Public Administration
for the U.S. Congress and the Departments of Agriculture and the Interior

Wildfire Suppression:

Strategies for Containing Costs

September 2002

NATIONAL ACADEMY OF PUBLIC ADMINISTRATION

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November 2002

WILDFIRE SUPPRESSION: STRATEGIES FOR CONTAINING COSTS

BACKGROUND AND RESEARCH

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PREFACE

The Panel Report, *Wildfire Suppression: Strategies for Containing Costs* (September 2002), presents the Panel's findings and conclusions as well as the full set of recommendations for containing the rising costs of wildfires. In the course of developing and adopting its recommendations, the Panel considered a much wider array of background and research information than could be included in the Panel Report itself.

This *Background and Research Report* makes available the extensive body of information upon which the Panel Report was based. It contains 8 Chapters and 11 Appendices that provide a wealth of facts and insights about how wildfires are fought, what drives their costs, and what is being done to help contain them. The Academy study team has organized and simplified this complex mass of information, so that it can inform policy deliberations and support progress toward increasingly efficient and effective implementation of federal and intergovernmental wildland fire goals and objectives.

Appendix B lists the more than 300 persons who supplied vital information needed to support this study, plus more than 150 additional people in the six large-fire case studies. The Panel expresses its heartfelt thanks to all of the individuals who participated in the study. Each made an important contribution to the Panel's work

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APPENDICES

BOXES, CHARTS, FIGURES AND TABLES

ACRONYMS

AA	Agency Administrator
AC	Area Command
BAER	Burned Area Emergency Rehabilitation
BehavePlus	Decision Support System that Can Predict Fire Behavior
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BuRec	Bureau of Reclamation
CEQ	Council on Environmental Quality
CWN	Call-When-Needed
DFPZs	Defensible Fuel Profile Zones
DOD	Department of Defense
DOI	Department of the Interior
EA	Environmental Assessment
EPA	Environmental Protection Agency
ERI	Ecological Restoration Institute
ESA	Endangered Species Act
ESR	Emergency Stabilization and Rehabilitation
FARSITE	A fire area simulation model
FEMA	Federal Emergency Management Agency
FMO	Fire Management Officer
FMP	Fire Management Plan
FMU	Fire Management Unit
FUMT	Fire Use Management Team
FWS	Fish and Wildlife Service
FY	Fiscal Year
GACC	Geographic Area Coordinating Center
GAO	General Accounting Office
GeoMAC	Geospatial Multi-agency Coordination System
GIS	Geographic Information System
GPRA	Government Performance and Results Act
GPS	Global Positioning System
GTG	Geospatial Task Group
HAZUS	Hazards United States (a nationwide loss estimation model)
HFQLG Act	Herger-Feinstein Quincy Library Group Forest Recovery Act
IA	Initial Attack
IAP	Incident Action Plan
IBA	Incident Business Advisor
IC	Incident Commander
ICARS	Incident Cost Accounting and Reporting System (part of I-SUITE)
ICP	Incident Command Post
ICS	Incident Command System
IFCI	International Fire Code Institute
IFEMG	Interagency Fire Emergency Management Group

IFRCC	Interagency Fire Research Coordination Council
IMET	Incident Meteorologist
IMT	Incident Management Team
IRSS	Incident Resource Status System (part of I-SUITE)
I-SUITE	An integrated set of three incident management software applications
IT/IM	Information Technology/Information Management
ITS	Incident Time System (part of I-SUITE)
JFSP	Joint Fire Science Program
LMP	Land Management Plan
MEL	Most Efficient Level
MIST	Minimum Impact Suppression Techniques
MOU	Memorandum of Understanding
NASA	National Aeronautics and Space Administration
NASF	National Association of State Foresters
NEPA	National Environmental Policy Act
NFES	National Fire Equipment System
NFMAS	National Fire Management Analysis System
NFP	National Fire Plan
NFPA	National Fire Protection Association
NICC	National Interagency Coordination Center
NIFC	National Interagency Fire Center
NOAA	National Oceanic and Atmospheric Administration
NP	National Park
NPS	National Park Service
NWCG	National Wildfire Coordinating Group
NRWG	Natural Resources Working Group
NWS	National Weather Service
QLG	Quincy Library Group
RAMS	Risk Assessment and Mitigation Strategies
RAWS	Remote Automated Weather Stations
RD&A	Research, Development and Applications
RFD	Rural Fire District
ROSS	Resource Ordering and Status System
SRAs	State Responsibility Areas
T&E	Threatened & Endangered Species
UC	Unified Command
USGS	U.S. Geological Survey
UTF	Unable-to-Fill
UWIC	Urban-Wildland Interface Code
VFD	Volunteer Fire Department
VHFHSZs	Very High Fire Hazard Severity Zones
WFSA	Wildland Fire Situation Analysis
WUI	Wildland-Urban Interface

CHAPTER 1
ORIGIN AND APPROACH OF THE STUDY

The American taxpayer, watching television or reading the newspaper, receives a daily dose of wildland fires consuming thousands of acres of vegetation, dwellings and other structures—and millions of dollars. Occasionally, the stories mention evacuations and firefighters lost. Perhaps the trees will come back healthier and more natural, and the houses will be rebuilt. But the money and lives lost will not be restored. Recent trends and current forecasts indicate that the federal government will be called upon to provide even more funds to fight fires in succeeding years.

Wildland fire historically has been described as an inevitable natural force and, therefore, not necessarily evil. Fire helps develop ecosystems; many plants, in fact, depend on its presence. Native Americans actively used fire to foster their goals for the land and the plants and animals that lived on it. They used "prescribed" fires before the land management agencies came along and developed the definition.

Today, planned fires are not unusual; they are used to achieve ecosystem objectives much as the early Native Americans did, and also to reduce the risk of devastatingly severe firestorms. Where possible, land managers try more and more to use naturally-caused fires, such as by lightning, for these purposes. The taxpayer, however, does not know or care how or why a fire started. The taxpayer stares at the television set and sees tax dollars going up in flames.

Congress and the Office of Management and Budget, confronted with conflicting demands for federal funds, increased appropriations for the wildland fire program significantly in recent years. The main federal land management agencies—the Forest Service in the Department of Agriculture; and the Bureau of Land Management (BLM), National Park Service (NPS), Bureau of Indian Affairs (BIA), and Fish and Wildlife Service (FWS) in the Department of the Interior—have proposed an ambitious long-range plan for restoring the nation's wildlands to a more natural condition less prone to severe wildfires. The prognosis is for many years of rapidly rising fire suppression costs. The concern is that these expected costs will be too high to be sustained in the federal budget as Congress and other political leaders face "short-term" budget shortfalls and seek solutions and options that will bring benefits more quickly.

The rising suppression costs caused Congress to ask the Forest Service and Interior to jointly fund a "thorough, independent review of wildfire suppression costs and strategies." The agencies turned to the Academy and asked that its study provide analysis of the agencies' suppression policies for adequacy and consistency, research on the factors that drive wildland fire suppression costs, the cost implications of Federal Wildland Fire Policy provisions, recent cost experience, and alternative firefighting methods and technologies. Congress and the agencies required the study to be based on case studies of six large fires from the 2001 fire season to assess whether policies were substantially followed and whether firefighting costs could have been reduced.

Data from the Forest Service[1] show that the annual cost of wildland fire-related expenditures during the 1970's averaged slightly over $420 million per year. During the 1980's, the average was about $460 million. During the 1990's it increased to almost $700 million annually. In Fiscal Year 2000, Forest Service expenditures exceeded $1.4 billion. And these increasing costs are in inflation adjusted 2000 dollars. [2]

Is this a taste of what may come? Many in the wildland firefighting community predict that 2000 may eventually turn out to be one of the less expensive years of the decade.

The Academy's long-term analysis indicates that these climbing expenditures are a cause of concern taxpayers, budget examiners, and appropriators alike. Fighting wildland fires consumes a lot of money. There are two obvious questions: "Why?" and "What can be done about it?"

This report addresses both questions.

WHY ARE COSTS RISING?

During the course of the study, Academy field teams identified 30 primary factors that affect fire costs. Some are more significant than others. Experts in the fire management field emphasize three primary factors, (1) fuels build-up, (2) the interface with human activity (commonly referred to as the wildland-urban interface, or WUI),[3] (3) and drought and weather conditions. The Panel agrees with this conclusion, but also believes it is important to consider how management improvements can contribute to cost savings as well as how equitably the costs of firefighting are distributed between those who benefit from firefighting efforts and those who pay.

It is generally agreed that fuels build-up in many cases is the result of decades of wildland management that inadequately maintained the appropriate balance of old and new trees, undergrowth and other flammable materials. All-out fire suppression for decades contributed to allowing fuels to increase and the "natural balance" to tilt. However, fire is not the only tool for keeping fuels in check. Mechanical thinning is another. Chemical treatment is also an option. One by-product of timber harvesting may also be fuels reduction. Chapter 6 describes the challenges and the potential solutions to the hazards caused by the build up of fuels in the forests and wildlands.

The human interface represents a more recent factor. The rush of Americans to build homes among the trees and "return to nature," along with limited measures to fireproof their houses (such as installing metal roofs rather than cedar shake, and creating space between their house and the trees rather than having houses literally wrap around trees) created an environment where

[1] Precisely comparable data from the Department of the Interior four land management agencies are not readily available, but generally follow the same trends.

[2] See Appendix C for additional details.

[3] Wildland-urban interface generally is identified as that location where a forest intersects with residences, watersheds, power line right-of-ways, satellite towers, and other similar structures or locations that affect people and their livelihoods. It may be only a few structures; it is not necessarily an "urban" area in the usual sense.

firefighting costs escalated to protect those structures. Chapter 7 addresses the interface challenges of mingling people with trees.

The two factors above are controllable to varying degrees. That is, given the will and the resources, fuels build-up and the community interface can be better managed to help control costs. The third factor, weather (including drought) is beyond human control; we can only predict and prepare. Most people agree that the current conditions are such—several years of severe drought throughout the United States—that we will experience more and larger fires. Some predict the era of million-acre fires is not far away. The case study write-ups (see Appendix F) of the six large fires reviewed by the Academy demonstrate the dominant effects of weather and how wildfires, once started, can escape and spread rapidly. They bring new meaning to that old phrase that "it's not nice to fool with Mother Nature."

Chapter 2 shows how federal fire policy has evolved over recent years. Factors such as changing wildland conditions, severe fire seasons, and the increased understanding of fire's relationship to the ecosystem prompted the federal land management agencies to alter their management operations and develop common approaches. The 1995 interagency Federal Wildland Fire Management Policy affirmed the role fire plays and the need to plan in advance how fire might be used to support land management goals. It took a long step toward institutionalizing a much improved interagency approach to how fire is viewed in the ecosystem and how the agencies can jointly plan, develop, and implement their individual and cross-boundary fire management programs.

Everyone once agreed that "the only cheap fire was the one that never started." There is still some truth in that statement. However, as the land management agencies discovered that better use of fire could improve the ecosystem, the saying changed slightly: "The fire that enhances the environment as nature intended is cheaper than no fire at all." The issue then shifted toward better determining how large wildfires are fought and paid for. Chapter 3 looks at the current practices for managing a fire—from initial attack (when the fire first starts) to long-term restoration after the fire is extinguished.

Chapter 4 summarizes the six large-fire case studies and 30 factors that affected their costs. These factors are defined in Appendix J. This chapter serves as a bridge between the general system for how wildland fires are fought and the challenges of fighting them illuminated by the cases.

Chapter 5, Incident Management Challenges, analyzes the six case studies, outlines the primary cost-related issues raised by them, and summarizes what can be learned from these fires about where cost savings might be possible.

WHAT CAN BE DONE TO CONTAIN COSTS?

There is no "magic bullet" for reducing the costs of wildland fire management. It took decades for federal wildlands to reach their current level of fire hazards. It will require a long-term coordinated and committed effort on the part of all the parties—federal, state, tribal, local, and private—to make material inroads on the issues. The things that will move the land management agencies ahead in meeting this challenge will involve a coordinated strategy, better defined performance goals and accountability measures, improved management systems that ensure consistent policy implementation, and demonstrated results. These accomplishments will be neither cheap nor quick.

The bulk of this study centers on what can be done to contain wildfire costs. In addition to Chapters 2-7, described above, Chapter 8 concentrates on the potential for science and technology to provide help. Appendix D summarizes the many previous recommendations that others have made over the past seven years to help contain wildfire suppression costs, underscoring the point this is not a new issue. Appendix E provides details of an updated National Association of State Foresters survey that explores state views on wildfire cost-containment issues. Appendix G describes how the Wildland Fire Situation Analysis process, which is used to select cost-effective strategies for fighting large wildfires, works and how it could be improved. Appendix H reports on how the Hazards United States (HAZUS) lost-estimation model could be used to begin providing data on community values that may be at-risk of wildfire damage. And Appendix I contains three papers describing how communities are working to manage the interface between people and wildlands.

THE PANEL'S APPROACH TO THE STUDY

The background and research chapters and appendices provided a foundation for the Panel's findings and recommendations included in the previously published Panel Report, *Wildland Suppression: Strategies for Containing Costs.* In the course of preparing this report, interviews were conducted with more than 160 people in 13 states and the District of Columbia who represent the federal land management agencies and their wildland fire programs, plus other federal agencies; the legislative branch of the federal government; state, local, and tribal governments; and the private sector organizations. In addition, many government reports, policies, manuals, other documents, and relevant literature were reviewed. Many helpful comments on various drafts of the report were received from Interior and Forest Service reviewers. The Panel held four meetings to consider these materials, develop findings and conclusions, and approve related recommendations.

Appendix A provides brief biographical sketches of the Academy Panel members who directed this study and the study staff. Appendix B lists the persons interviewed or contacted for this study.

CHAPTER 2
POLICY CONTEXT FOR WILDFIRE SUPPRESSION

This chapter focuses on the provisions of the Federal Wildland Fire Management Policy that relate to wildland fire suppression and associated costs. It also outlines the steps taken by the land management agencies to comply with the Policy, and their efforts to develop performance measures to track implementation.

EVOLUTION OF THE FIRE POLICY

Federal wildland fire management policy is contained in two documents: the December 1995 Federal Wildland Fire Management Policy & Program Review, and the January 2001 Review and Update of the 1995 Federal Wildland Fire Management Policy. Prior to 1995, fire management policy emphasized quick response in order to suppress all wildfires as rapidly as possible, with the goal of controlling the majority of wildland fires by 10:00 a.m. the morning following the start.

During the 1960s and early 1970s, the effects of decades of fire suppression coupled with past land-use practices increased fire hazards by disrupting natural fire cycles. Recognizing this problem, by 1982 the land management agencies eliminated the "out by 10 a.m." strategy, replacing it with a process that allowed fires to play a more natural ecological role under appropriate conditions.

The genesis of the 1995 Wildland Fire Management Policy was the 1994 fire season during which 34 firefighters died, including 14 in the South Canyon Fire. That severe fire season raised concern that the potential for catastrophic wildfires was increasing beyond the nation's capability to respond. At the request of the secretaries of Agriculture and the Interior, the federal land management agencies re-examined their programs "to ensure that uniform Federal policies and cohesive interagency and intergovernmental fire management programs exist."

An interagency Steering Group directed the review process. The group's membership included representatives from DOI, USDA, the U.S. Fire Administration, the National Weather Service (NWS), the Federal Emergency Management Agency (FEMA), and the Environmental Protection Agency (EPA). A core staff from Interior and Agriculture supported the Steering Group. During the review process, the team gathered input from internal and external subject-matter experts. External input was sought via the *Federal Register*. The final report, *Federal Wildland Fire Management Policy & Program Review*, published December 18, 1995, became the first interagency policy for federal wildland fire management.

The 1995 Policy affirmed the valuable role that fire plays in managing ecosystem health and reducing the risk of catastrophic fires. It also institutionalized common rules for all five land management agencies to follow when assessing whether to allow a fire to burn for resource benefit purposes. This policy shift called for dramatic changes in how the agencies viewed the role of fire in ecosystems.

The 1995 Policy included 9 guiding principles, 13 policy statements, and 83 action items. The action items were categorized into four major policy areas:

- Role of Fire in Resource Management
- Use of Wildland Fire
- Preparedness and Suppression
- Coordinated Program Management

The Policy recognized the need for more scientific information about current ecosystem conditions and the consequences of various management strategies to ensure reintroducing fire safely and beneficially. The Policy also required all units with burnable vegetation to develop fire management plans (FMPs) using these data. Without an FMP in place, the Policy precluded managers from using fire-use management options; they could take only suppression action. In addition, the Policy called for integrating fire into land and resource management plans on a "landscape" scale that crosses agency boundaries. It called for conducting fire management planning, preparedness, suppression, fire use, monitoring, and research on an interagency basis with the involvement of all appropriate partners. This placed a heavy emphasis on interagency communication and collaboration.

Within this overall context, the Policy addressed large-fire suppression costs as follows:

> A growing concern shared by Members of Congress, agency administrators, and the public is the cost of fighting large wildfires. Some critics believe expenditures are excessive and that the crisis nature of wildfire has led to imprudent use of personnel, equipment and supplies. Others believe that firefighting practices are not as effective as some natural forces in bringing wildfires under control and that fire suppression efforts should take better advantage of weather, terrain, fuel, and other natural conditions. **In the future, there will be less tolerance for excessive expenditures on large-fire suppression (**emphasis added**).** The costs and benefits of fire suppression activities must be analyzed. Analyses done so far have not resulted in improved practices or reinforced confidence in current suppression strategies. [1]

In the area of Program Management, the Policy established a goal developing a system to analyze the relative efficiency of specific activities of the fire management agencies, and directed Federal agencies to:

> …jointly develop a standard methodology for measuring and reporting fire management efficiency that includes commodity, non-commodity, and social values. This methodology should specifically address, among other considerations, the costs and benefits of large-fire suppression.

This item was later dropped as a specific action item, however.

[1] *Federal Wildland Fire Management, Policy and Program Review*, December 18, 1995, p. 29.

Following the Cerro Grande Fire in May 2000—which destroyed 235 structures in and around Los Alamos, New Mexico, and consumed over 47,000 acres—the secretaries of Agriculture and the Interior requested that the federal wildland fire community review the 1995 policy and its implementation.[2] They appointed an interagency work group that included several individuals from the 1995 team. The number of signatory agencies for the 2001 Fire Policy expanded from two (Agriculture and the Interior) in 1995 to include, in addition, the Departments of Commerce, Defense and Energy, the U.S. Geological Survey (USGS), the Bureau of Reclamation (BuRec), and the National Association of State Foresters (NASF). The new work group found that the 1995 policy was basically sound, but that some aspects were unclear, incomplete, unrealistic, or no longer appropriate. Although, this led to several modifications and additions, the revised policy retained the same general format of interlocked principles, policies, and action items.

The "guiding principles" were changed only to recognize the growing importance of international mutual aid and international exchanges of technology, training, skills, and knowledge. The current guiding principles are summarized in Box 2-1.

Box 2-1. Guiding Principles: 2001 Federal Fire Policy

- Firefighter and public safety is the first priority in every fire management activity.
- The role of wildland fire as an essential ecological process and natural change agent will be incorporated into the planning process.
- FMPs, programs, and activities support land and resource management plans and their implementation.
- Sound risk management is a foundation for all fire management activities.
- Fire management programs and activities are economically viable, based upon values to be protected, costs, and land and resource management objectives.
- FMPs and activities are based upon the best available science.
- FMPs and activities incorporate public health and environmental quality considerations.
- Federal, state, tribal, local, interagency, and international coordination and cooperation are essential.
- Standardization of policies and procedures among federal agencies is an ongoing objective.

Source: *2001 Federal Wildland Fire Management Policy*, pp. 21-22.

The 2001 policy statements flowing from the general principles addressed the following five areas:

- the role of fire in ensuring ecosystem sustainability
- the need for restoration and rehabilitation of fire-damaged lands and ecosystems
- the role of science in developing and implementing fire management programs

[2] June 27, 2000 memorandum.

- the importance of communication and education internally and externally
- the critical need for regular, ongoing evaluation of policies and procedures

Within these areas, the 2001 update lists 17 policies, two of which mention wildand suppression costs. First, Policy 6, Protection Priorities, links the costs of protection to the values being protected, and to human health and safety as follows:

> The protection of human life is the single, overriding priority. Setting priorities among protecting human communities and community infrastructure, other property and improvements, and natural and cultural resources will be based on the values to be protected, human health and safety, and the costs of protection. Once people have been committed to an incident, these human resources become the highest value to be protected.

Then, Policy 11, Suppression, directs that fires be suppressed at minimum cost, considering firefighter and public safety, benefits, and values to be protected, consistent with resource objectives.

However, the revised Implementation Actions flowing from these policies do not address either protection or suppression costs. In fact, in Implementation Action 2, Response to Wildland Fire, agencies are instructed to evaluate risks to firefighter and public health and safety, weather, fuel conditions threats, and values to be protected, without any reference to costs, or a goal of minimizing costs.

Nevertheless, the land management agencies have established requirements for post-fire reviews that include suppression costs as a factor. For example, the Forest Service advises Regional Foresters to formally review selected large fires, and includes the following criteria: (1) incident costs were projected to exceed $5 million; (2) a Type 1 Incident Management Team was assigned; (3) control objectives and predicted times on control exceeded 5 days, and (4) there were significant natural resource concerns. NPS requires that fires be reviewed to determine the cost-effectiveness of a fire operation, and BLM requires a state level review of fires costing $250,000 or more, and a national level review of fires costing $500,000 or more. FWS utilizes both regional and national level reviews, which include cost effectiveness; criteria for these reviews include significant national adverse media or political interest, and substantial loss of national fire asset equipment or property (without any dollar threshold). BIA regional reviews are conducted when issues related to health and safety are raised or as requested by the Director of Trust Responsibilities. The Academy study team did not determine either the frequency or the adequacy of such reviews.

Two provisions of the 1995 Policy and the 2001 update impact wildland fire suppression the most. First is the requirement for each burnable area to have an FMP to help identify the level of risk associated with each burnable acre, including areas bordering the wildland-urban interface, and to outline the land unit objectives to be supported by fire use. The plans describe where and when a fire can be allowed to burn safely as a natural event to regenerate ecosystems and/or reduce fuel loadings.

Second, on the issue of property protection, the Policy clearly defines operational roles for Federal agencies as partners in the wildland-urban interface including wildland firefighting, hazardous fuels reduction, cooperative prevention and education, and technical assistance. It specifically addresses structural fire protection, a high-cost area of growing concern because of the rapid growth of communities in and near fire-prone wildlands, and establishes the roles and responsibilities of the land management agencies *vis a vis* tribal, state and local governments. Under formal fire protection agreements, federal agencies may assist with exterior structural protection before a fire reaches the structures. Structural fire suppression, which includes exterior and interior actions on burning buildings, is generally considered to be the responsibility of tribal, state or local fire departments.

AGENCY IMPLEMENTATION OF THE POLICY

Standard procedures to guide immediate implementation of the 1995 Policy were issued in August 1998. The guide "Wildland and Prescribed Fire Management Policy, Implementation Procedures Reference Guide," was prepared by representatives of NPS and Agriculture, and endorsed by the five land management agencies. It covered all elements of the Policy, and introduced procedures for using "prescribed natural fire." This new practice—essentially using a natural fire for resource benefit purposes—was separated from the prescribed fire element of the fire management program, and was classed as an appropriate management response to wildfires. This change allowed the objectives previously accomplished through prescribed fire to be achieved, instead, through appropriate management of naturally ignited fires. The Guide further stressed, however, that without an approved FMP, the only acceptable response to a wildland fire is suppression.

Using standards in the 1995 Policy, the mutually agreed upon 1998 reference guide, and the 2001 policy update, the five land management agencies continue to issue their own implementing procedures. The various agency documents, summarized in Box 2-2, generally use the same approach in describing the essential elements of the Policy. In particular, they establish procedures for developing Fire Management Units (FMUs) within the land unit showing where the various fire strategies may be appropriate.

Box 2-2. Agency Manuals and Handbooks Providing Directions for Implementing the Fire Policy

USDA FOREST SERVICE

Forest Service Manual (FSM) 5100 provides direction for fire managers and clarifies agency policy for integrating fire use into land and resource management plans and practices. Revisions to FSM 5100 were completed in June 1999 to comply with the 1995 Policy, and an interagency group has drafted changes required by the 2001 Policy Update to make FSM 5100 compatible with state and other federal agency partners. These national guidelines are supplemented by regional office guidelines.

DEPARTMENT OF INTERIOR

Departmental Manual Part 620, Wildland Fire Management, April 10, 1998, established the Interior Fire Coordination Committee, and the requirement that every area with burnable vegetation must have an approved Fire Management Plan. It further requires that wildland fire be used as a natural process and as a management tool. These department-wide requirements are supplemented by issuances from Interior's individual land management agencies.

National Park Service

Director's Order # 18 (DO-18), **effective 1998**, outlines NPS Wildland Fire Management policy and endorses the principles, policies, and recommendations of the 1995 Policy, calling for the integration of fire management with all other aspects of park management and requiring that fire management programs be designed to meet resource management objectives.

Reference Manual 18 (RM-18), **revised in 2001**, contains specific direction for fire management programs. Chapter 4, Fire Management Plans, and Chapter 10 Fuels Management, include revisions to incorporate both the 1995 Policy and the 2001 Review and Update.

Bureau of Land Management

Standards for Fire and Aviation Operations 2002 (BLM Handbook 9213-1, the "Red Book") provides BLM policy and guidance to perform fire and aviation management operations. It references the 2001 Federal Wildland Fire Management Policy. Started as a BLM-only document, the 2002 edition now applies to BLM, the Forest Service, and the Fish and Wildlife Service.

Instruction Memorandum No. OF&A 2000-20, Subject Prescribed Fire "Interim Direction", July 12, 2000, contains guidance on the content of Fire Management Plans as well as the linkage of these plans to Resource Management Plans. It includes instructions for the identification of polygons within a land unit and identification of the appropriate fire management strategy for each polygon.

Instruction Memorandum No. 2002-34, Land Use Planning and Fire Management Planning, dated December 7, 2001, provides additional information and guidance regarding the 1995 Policy and the treatment of wildland fire management in land use, fire management, and other implementation-level plans and projects.

U.S. Fish and Wildlife Service

Fire Management Handbook, dated June 12, 2001, incorporates 1995 Policy requirements that each refuge or complex have a fire management plan, that fire use be addressed in the Comprehensive Conservation Plan, Habitat Management Plan, and that these plans comply with the NEPA process.

Bureau of Indian Affairs

BIA Instructional Memorandum "Fire Management Plan, June, 1998, provides requirements for how the Fire Management Plan documents the Wildland Fire Management Program as described in the approved land use plans. It also describes management response strategies based on values to be protected for fires requiring suppression and fire having resource benefits.

FMUs are a key element in a Fire Management Plan, and BLM's guidance on delineating the possible fire management strategies for each unit (called polygons by BLM) is fairly typical:

> **Category A:** Where wildland fire is not desired at all.
>
> **Category B:** Where unplanned wildland fire is likely to cause negative effects, but those effects may be mitigated or avoided through fuels management, prescribed fire or other strategies.
>
> **Category C:** Where fire is desired to manage ecosystems, but there are constraints because of the existing vegetation condition due to fire exclusion.
>
> **Category D:** Where fire is desired, and there are no constraints associated with resource condition, or social, economic, or political considerations.

The most current actions reflecting the desired interagency approach are (1) the January 2002 adoption of performance goals and measures, (2) the May 2002 10-Year Comprehensive Strategy, and (3) the May 2002 Draft Interagency Fire Management Plan Template.

Developing a Joint Fire Management Plan Template

The Interior department and the Forest Service chartered an interdepartmental work group in 2002 to (1) review fire management planning procedures used by federal agencies, and (2) develop a single, landscape-scale FMP template for use by all five agencies. This group had the advantage of starting with the results of a two-year joint Forest Service/NPS project to do the same thing for those two agencies. The Forest Service/NPS project resulted in uniform guidance on FMP's for use by those two agencies. The five agency template is to provide a seamless, cross-boundary approach to wildland fire management using standard:

- format and terminology
- guidance for consistent application of principles
- integration with land use planning efforts
- review process
- schedule for completing all new FMPs by the end of FY 2004

Both departments were reviewing the proposed template in June 2002. Its major features are summarized in Box 2-3.

Box 2-3. Interagency Fire Management Plan Template
May 10, 2002 Draft

Fire Management Plans identify and integrate all wildland fire management and related activities within the context of approved land management plans.

I. INTRODUCTION

II. RELATIONSHIP TO LAND MANAGEMENT PLANNING/FIRE POLICY

III. WILDLAND FIRE MANAGEMENT STRATEGIES
- A. General Management Considerations
- B. Wildland Fire Management Goals
- C. Wildland Fire Management Options
- D. Description of Wildland Fire Management Strategies by Fire Management Zone

IV. WILDLAND FIRE MANAGEMENT PROGRAM COMPONENTS
- A. Wildland Fire Suppression
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- C. Prescribed Fire
- D. Non-Fire Fuel Applications
- E. Emergency Rehabilitation and Restoration

V. ORGANIZATION AND BUDGET

VI. MONITORING AND EVALUATION

Glossary

Appendix

Revising Training to Reflect Federal Wildland Fire Management Policy

The Advance Fire Use Applications course, S-580, given by the National Advanced Resource Technology Center, was revised to include a unit entitled "Fire Use Management Team Organization and Management." This course describes how to use the interagency Fire Use Management Teams, which were developed to help implement the Policy provisions allowing accomplishment of beneficial objectives by managing natural wildfires in addition to using prescribed fire. The Advanced Incident Management course (S-520) has also been revised to reflect provisions of the Policy.

Implementation Accomplishments

While the agencies have moved expeditiously in issuing new policies in support of the Policy, implementation of the key fire management plan requirement lagged. Table 2-1 provides an overview of each agency's actions on these plans.

Table 2-1. Status of Agency Fire Management Plans, as of September 30, 2001

Agency	Units needing plan	Units with a plan	% Units with a plan	Units not compliant with 1995 policy	Per cent of plans not compliant
BIA	157	78	50	79	50
BLM	60	60	100	0	0
FWS	648	419	65	252	38
FS	242	219	90	137	57
NPS	277	147	53	227	82
TOTAL	**1,384**	**923**	**67**	**695**	**50**

Source: GAO- 02-158 Wildland Fire Management, March 2002

The table shows that, as of Sept. 30, 2001, 50 percent of all federal units did not have fire management plans consistent with the Policy requirement. In accordance with the Policy, therefore, all fires on about half of these agencies' units may have to be suppressed immediately, regardless of the circumstances. This elimination of the "fire use" option may increase suppression costs while decreasing benefits.

However, as the GAO reports, compliant fire management plans cover 82 percent of the almost 655 million acres of burnable federal land. This means that only a small percentage of federal wildlands are not covered by an FMP that satisfies the Fire Policy. While BLM has all its units and burnable acres in compliance, the other agencies have moved more slowly.

In the March 22, 2002 joint Interior/Agriculture response to GAO, the agencies made the following points:

- There is more work to be done to complete Fire Management Plans. Using a joint FMP template, which incorporates both the 1995 Policy and the 2001 Review, both departments will be 100 percent compliant by 2004, having completed the remaining FMPs.

- It is not correct to assume that updated FMPs will automatically result in implementing a "let burn" decision. Such a decision can be made only when the land use plan provides for it, and in many cases the land use plans have not been updated to reflect the 1995 Policy or the 2001 update.

- Due to the prolonged drought for the last three years, and the heavy build up of fuels in forests and rangelands, it may be unrealistic to expect large savings through "fire use" techniques, since full suppression may be the only viable option now in many cases.

Academy Field Work

In conducting the six large-fire case studies, the Academy team reviewed how the Policy was being implemented. Table 2-2 summarizes what the Academy found at each of the land unit sites by arraying key elements of the Policy against the findings on each of the six fires in a question and answer format. For example, Question 1 “Was there a fire management plan on site?” shows that in each of the six cases, the answer is “Yes.” With one exception (Star), these plans were all less than 5 years old.

However, the case-study land units were much less successful in implementing two other aspects of the policy. Only Moose and Green Knoll had attempted to establish landscape-scale FMPs or LMPs. Only the Moose fire had an FMP that allowed for fire use, and only Yellowstone National Park (site of the Arthur fire) had a history of fire-use fires. The absence of landscape-scale efforts at the remaining four sites reflects the difficulty encountered in developing joint FMPs involving federal agencies having differing land management goals. The use of the joint FMP template described above should help to overcome this difficulty.

It is interesting to note that Question 6(a) dealing with “fire use” did not yield any “Yes” answers (with the exception of the Moose fire, which had both suppression and “fire use” techniques). This reinforces the point made in the agencies’ response to GAO that even when land units have current FMPs properly tied to the land management plans, full suppression may well be the only practical option when large-scale wildland fires occur because of community interfaces, drought, or fuels build-up.

Table 2-2. Policy Implementation at Six Fires

Wildland Fire Policy Requirement	Arthur	Sheep	Virginia Lake	Moose	Star	Green Knoll
1. Was there a fire management plan on site?	Y	Y	Y	Y	Y	Y
2. Was the plan tied to land and resource management plans?	Y	Y	Y	Y	Y	Y
3. Did the plan show fire management units within the land unit, and show different fire options for the different units?	Y	Y	Y	Y	Y	Y
4. Was there any evidence of landscape scale efforts in either the fire management plan and/or the land and resource management plans?	N	N	N	Y	N	Y
5. Were actions on the particular fire being studied consistent with the fire management plan?	Y	Y	Y	Y	Y	Y
6 a. Was there any effort to use the fire being studied as a "fire use" type fire?	N	N	N	N&Y[3]	N	N
6 b. Was there a history of the land unit allowing previous wildland fires to be used as a "fire use" type fire?	Y	N	N	N	N	N
7. What conclusions (i.e., (a) adequate or (b) inadequate) regarding planning, staffing, training, and equipment were reached on the land unit's preparedness efforts prior to the fire?	A	A	A	A	A	A
8. Were the fires suppressed at minimum cost[4]?						
9. Were fire prevention programs established at the land unit?	Y	Y	Y	Y	Y	Y
10. Were the actions of the land unit and IMT consistent with the given operational role for Federal agencies in WUI type fires?	Y	Y	Y	Y	N/A	Y

PERFORMANCE MEASURES FOR IMPLEMENTING THE FEDERAL WILDLAND FIRE MANAGEMENT POLICY

The land management agencies have used a variety of performance measures related to fire management in their Government Performance and Results Act (GPRA) plans. These measures have focused on initial attack success rates, urban-interface areas with completed fuels treatments, prevention and education programs, and firefighting production capability. Box 2-4 provides a more complete list of these measures.

[3] Full suppression while the fire was on Flathead NF but fire use when it entered Glacier NP.
[4] The Academy study team was not able to answer this in the short time allowed.

Box 2-4. Some Fire-Related Performance Measures Used in Federal Agency GPRA Plans

INTERIOR

- Percent of wildland fires contained by initial attack
- Percent of rural fire districts receiving assistance for improved safety, training, and equipment standards
- Percent of communities' at-risk priority projects to restore natural ecological process through fire use implemented
- Number of fire facilities upgraded
- Total acreage with natural ecological process restored through increased use of fire

FOREST SERVICE

- Percent of wildland-urban interface areas with completed fuel treatments.
- Percent of all acres with fuel levels meeting condition class 1
- Percent of affected communities with prevention and education programs in place, and where fire-wise treatments are being applied on the ground
- Firefighting production capability rating for initial attack of wildfires is maximized
- Percent of needed support resources available for deployment in support of large wildfire incidents
- Percent of affected communities with increased firefighting capability and readiness
- Proportion of acres in short-interval, fire-adapted ecosystems (fire regimes I & II) in condition classes 2 & 3 compared to condition class 1

These performance measures illustrate two points: first, Interior and the Forest Service have not been using the same measures, and second, none of the agencies has a performance indicator for the percent of burnable acres covered in their FMPs.

In May 2002, the secretaries of Agriculture and the Interior, the Western Governors' Association, the National Association of State Foresters, the National Association of Counties, the Intertribal Timber Council, and several non-governmental organizations reached agreement on a common set of performance measures (see Table 2-3). These goals and measures respond to many of the Policy issues—such as measuring the percentage of burnable acres covered in fire management plans, the restoration of fire-adapted ecosystems, and the reduction of hazardous fuels both in and outside the wildland-urban interface. These measures were part of the 10-Year Comprehensive Strategy, which is an effort to work collaboratively in managing wildland fire, reducing hazardous fuels, restoring habitats, and rehabilitating public land. Implementation of the joint performance measures will commence by January 2003, by which time, the departments of the Interior and Agriculture (and the state, tribal, and local officials) are to have established the baselines within their respective jurisdictions from which future performance will be measured.

Table 2-3. The 10 Year Comprehensive Strategy Implementation Plan, May 2002

Goals and Performance Measures

Goal One--Improve Fire Prevention and Suppression: *Losses of life are eliminated, and firefighter injuries and damage to communities and the environment from severe, unplanned and unwanted wildland fire are reduced.*

1. Amount of time lost from firefighter injury in proportion to number of days worked across all agencies.
2. Number of acres burned by unplanned and unwanted wildland fire.
3. Percent of unplanned and unwanted wildland fires controlled during initial attack.
4. Number of homes and significant structures lost as a result of wildland fire.
5. Average gross costs per acre for suppression and emergency stabilization and rehabilitation by size class and fire regime for fires (i) contained within initial attack, (ii) escaping initial attack, (iii) within wildland-urban interface areas, (iv) outside wildland-urban interface areas, (v) in areas with compliant fire management plans, and (vi) in areas without compliant fire management plans.
6. Percent of burnable acres covered in federal fire management plans in compliance with Federal Wildland Fire Policy.
7. Percent of burnable acres covered by state fire management plans in compliance with state policy.

Goal Two—Reduce Hazardous Fuels *Hazardous fuels are treated, using appropriate tools, to reduce the risk of unplanned and unwanted wildland fire to communities and to the environment.*

1. Number of acres treated that are (1) in the Wildland-Urban Interface or (2) in condition classes 2 or 3 in fire regimes 1, 2, or 3 outside the wildland-urban interface, and are identified as high priority through collaboration consistent with the Implementation Plan, in total, and as a percent of all acres treated.
2. Number of acres treated per million dollars gross investment in Measures a. (1) and a. (2) respectively.
3. Percent of prescribed fires conducted consistent with all Federal, State, Tribal and local smoke management requirements.

Goal Three--Restore Fire-adapted Ecosystems *Fire-adapted ecosystems are restored, rehabilitated and maintained, using appropriate tools, in a manner that will provide sustainable environmental, social, and economic benefits.*

1. Number of acres in fire regimes 1, 2, or 3 moved to a better condition class, that were identified as high priority through collaboration consistent with the Implementation Plan, in total, and as a percent of total acres treated.
2. Percent of acres degraded by wildland fire with post-fire rehabilitation treatments underway, completed, and monitored.
3. Number of acres moved to a better condition class per million dollars of gross investment.

Goal Four—Promote Community Assistance *Communities at risk have increased capacity to prevent losses from wildland fire and the potential to seek economic opportunities resulting from treatments and services.*

1. Percent of states with a prioritized list of at-risk wildland-urban interface communities.
2. Percent of communities at risk with completed and current fire management plans or risk assessments.
3. Percent of communities at risk with fire prevention programs in place and being implemented.
4. Percent of communities at risk that initiate volunteer and community funded efforts to reduce hazardous fuels resulting in removal of the community from the at-risk list.
5. Percent of acres treated to reduce hazardous fuels by mechanical means with by-products utilized.

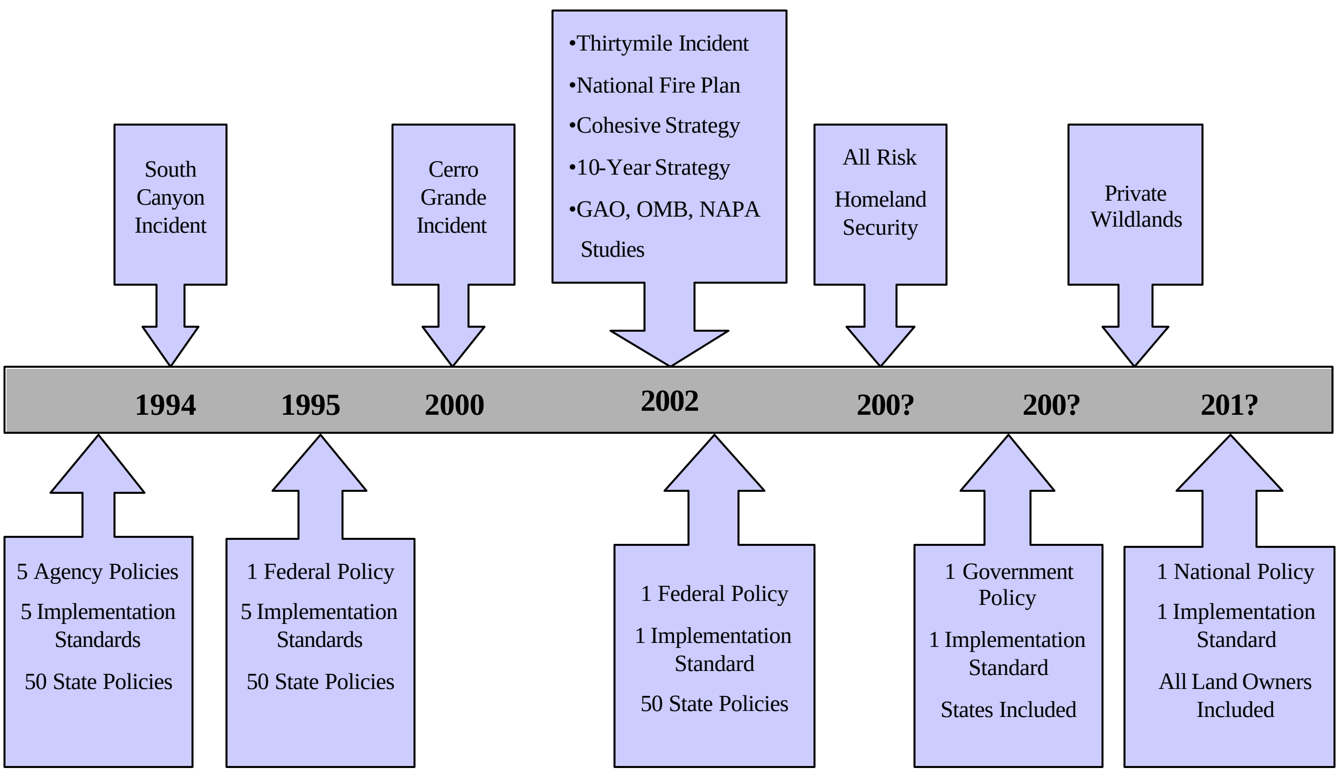
NEXT STEPS IN THE POLICY'S EVOLUTION

The federal Fire Policy provides consistent direction, but relies on each of the federal land management agencies to implement it independently. It neither prescribes uniform implementation standards nor applies to state and private land managers.

Recognizing these limitations, the NWCG chartered a Task Group to develop an implementation plan for the Fire Policy. The Group includes representatives from the land management agencies and the National Association of State Foresters. Complementing the 10-Year Comprehensive Strategy, the long-term goal of the project is to deliver a national (not just federal) fire management policy that will be adopted consistently by federal agencies and the states. The project will further refine the wildland fire policy to offer differentiated guidance for wilderness, general wildlands, and wildland-urban interface. But it is only the next step; ahead lies the ultimate need to develop a single national policy to include all landowners under the same implementation standards.

A timeline tracing the developments from 1994 to 2002 and beyond might appear as follows:[5]

Figure 2-1. National Policy Timeline



[5] Federal Wildland Fire Management Policy, Evolutionary Context and Current State, a working paper for NWCG's Task Group on Implementing the Federal Wildland Fire Policy, p. 4.

CHAPTER 3
HOW LARGE WILDFIRES ARE FOUGHT AND FINANCED

All wildland fires start small and initial or extended attack operations usually put them out. When it becomes apparent that initial or extended attack will not stop the fire, another level of firefighting response is activated—the Incident Management Team (IMT). Headed by an experienced Incident Commander (IC), an IMT may manage over 2,000 people and hundreds of pieces of equipment on a large wildland fire. The costs for these fires can run millions of dollars.

There are several stages of wildland fire suppression operations:

- predispositions, which set parameters for how large the fire may become
- pre-attack efforts, which prepare the land unit to undertake suppression actions
- initial and extended attack
- transition to an IMT
- IMT suppression actions
- mop-up activities to prevent the fire from spreading beyond control lines
- emergency stabilization and rehabilitation to mitigate the adverse effects of the fire and suppression actions on soil, water, and critically threatened natural and cultural resources
- long-term restoration to mitigate adverse fire affects

This chapter discusses how large wildland fires are fought and how suppression costs are financed.

INCIDENT COMMAND SYSTEM

Federal land management agencies must quickly mobilize resources when wildland fires ignite on their land units. To do this, they have adopted the Incident Command System (ICS), which is a national emergency management process specifically designed to allow users to adopt an integrated organizational structure that meets the complexity and demands of an incident, without compromising agency authorities. ICS brings a consistent approach to managing wildland fires using combinations of federal, state, local, tribal, and other resources that the IMT orders through central dispatching systems.

ICS consists of five activities including command, operations, planning, logistics, and finance/administration. The primary responsibilities for these units are shown in Box 3-1 below.

Box 3-1. Incident Command System Functions [1]

Command and General Staff: Establish priorities and implementation strategies, monitor safety, and perform liaison and information functions.

Operations: Manage the suppression and rescue elements of the Incident Action Plan.

Planning: Collect, evaluate, and distribute data about the incident.

Logistics: Provide services and support needs related to the incident.

Finance/Administration: Track all incident-related materials and costs, provide timekeeping payroll services.

This management/organizational structure evolves in complexity or increases in size commensurate with the fire. As the size and complexity of a fire increases, staff and equipment are added to each of these areas based on workload needs.

First efforts to suppress a wildland fire occur during initial and extended attack. A key feature of initial/extended attack is that incident command is still provided by the local land unit. On small fires, the IC may perform all of the command and general staff functions. As the fire grows, additional positions will be added to the ICS structure. If extended attack efforts fail to contain the fire, the fire is declared uncontrolled and an IMT may be ordered to manage the fire.

Many factors determine the complexity of a fire, such as location, topography, size, fuel type, weather, threats to life and property, values at risk, political sensitivity, and jurisdictional boundaries. Fire complexity is defined by type. A Type 5 fire is the least complex and typically requires two to six firefighters. A Type 1 fire is the most complex, requiring the full complement of the nation's most experienced command and general staff experts.

A fire's type dictates the level of ICS qualifications needed. Through training and experience, firefighters become qualified to hold positions with increased responsibility and authority on increasingly complex incidents. A Type 3 incident requires that the IC be Type 3-qualified. Likewise, a Type 1 Incident requires a Type 1-qualified IMT.

The land unit and its chief administrator (referred to as the agency administrator or AA) are responsible for determining the complexity of a fire, and therefore the type of IMT needed to manage the incident. For smaller fires, the land unit uses its judgment regarding the management structure needed. Once a fire escapes extended attack, however, the land unit prepares an Incident Complexity Analysis, which is part of the Wildland Fire Situation Analysis (WFSA) (described later in this chapter and in Chapter 5) to determine the incident complexity and type of team needed. The analysis consists of selecting "yes" or "no" to a series of

[1] Westbrook, Garner, *Wildland Fire Suppression and the Incident Command System*, http://www.pfmt.org/fire/wildland_fire.htm

statements for eight factors. The number of "yes" responses determines whether a factor is positive or negative, which determines the complexity of the fire and, thus, the type of team needed. Box 3-2 shows the eight factors used in the analysis and examples of conditions used to assess each factor. Table 3-1 shows how the analysis of these factors translates into the designation of incident and IMT types.

Box 3-2. Eight Incident Complexity Analysis Factors and Sample Evaluation Statements

A. Fire Behavior
- Burning index predicted to be above the 90 % level
- Potential exists for "blowup" conditions (fuel moisture, winds, etc.)
- Crowning, profuse or long-range spotting
- Weather forecast indicating no significant relief or worsening conditions

B. Resources Committed
- 200 or more personnel assigned
- Three or more divisions
- Wide variety of special support personnel
- Substantial air operation
- Majority of initial attack resources committed

C. Resources Threatened
- Urban interface
- Developments and facilities
- Restricted, threatened or endangered species habitat
- Cultural sites
- Unique natural resources, special designated zones or wilderness
- Other special resources

D. Safety
- Unusually hazardous fire line conditions
- Serious accidents or fatalities
- Threat to visitor safety from fire and related operations
- Restrictions/closures in effect or being considered
- No night operations in place for safety reasons

E. Ownership
- Fire burning or threatening more than one jurisdiction
- Potential for claims (damages)
- Different or conflicting management objectives
- Disputes over suppression responsibility
- Potential need for unified command

F. External Influences
- Controversial wildland fire management policy
- Pre-existing controversies/relationships
- Sensitive media relationships
- Smoke management problems
- Sensitive political interests
- Other external influences

G. Change in Strategy
- Change to a more aggressive suppression strategy
- Large amounts of unburned fuel within planned perimeter
- WFSA invalid or requires updating

H. Existing Command Team
- Worked two operational periods without achieving initial objectives
- Ineffective organization
- Overextended mentally and/or physically
- Incident action plans, briefings, etc. missing or poorly prepared

Table 3-1. Fire Complexity and IMT Relationships*

Fire Complexity		IMT Required	
Incident Type	**Relationship to Eight Analysis Factors****	**IMT Type**	**Description**
1	3 factors are rated positive	**1**	Up to 44 Command and General Staff support and subordinate positions. Nationally mobilized.
2	Fewer than 3 factors are rated positive	**2**	Up to 27 Command and General Staff, support and subordinate positions. Regionally or nationally mobilized.
3	Informal assessment	**3**	Up to 10 staff working with the IC for an extended attack. Up to 100 firefighters. Locally mobilized.
4	Informal assessment	**4**	An IC with a limited management support structure. Up to 20—probably not over 50—firefighters. Locally mobilized.
5	Informal assessment	**5**	An IC without a management support structure. Up to 10 firefighters. Locally mobilized.

* This is a simplification of the process. The eighth factor, Existing Command Team, is considered separately from the others. For example, for a Type 2 team designation, there must be fewer than three factors rated positive, but the Existing Command Team factor must be negative.

** The eight analysis factors are described in Box 3-2.

INITIAL AND EXTENDED ATTACK

When a wildland fire is reported, the local land unit is responsible for mounting an initial attack effort. The number and type of resources dispatched to the fire depend on several factors, including access, fuel type, limitations on equipment use, and fire danger. Another critical factor is the availability of resources to respond. If multiple fires have ignited, initial attack resources may be stretched too thin to effectively suppress all of the fires. This occurred on the Moose Fire and Virginia Lake Complex.

Many wildland fires occur on or near jurisdictional boundaries. For example, a National Forest can have another Forest, a National Park, or BLM land adjacent to it. Or, state, local and private lands can surround or be contained within a federal land unit. All six fires the Academy field teams examined involved multiple jurisdictions, and five of the six involved private lands.

Where multiple jurisdictions are involved, local cooperators are often the first ones to respond. Throughout the country, land management agencies enter into mutual-aid agreements with state and local cooperators to coordinate response efforts. These agreements establish each party's roles and responsibilities within a designated geographic area and who pays for those efforts. In some places, they specify that federal agencies have initial attack responsibility on state or private land, and vice versa, based on the juxtaposition of initial attack resources. For example, the western portion of the Colville Indian Reservation, where the Virginia Lake Complex occurred, is a significant distance from the principal Bureau of Indian Affairs (BIA) fire suppression stations. BIA has a mutual-aid agreement with the Okanogan Fire Protection District 8, which has fire protection responsibility for private property in that part of the reservation, to also protect Indian-owned properties. In exchange, BIA provides equipment to the District.

Initial Attack

The first person to arrive at a fire serves as the IC until someone more qualified arrives. The initial attack IC is responsible for performing all command and general staff functions until incident complexity dictates the need to delegate these responsibilities.

The IC develops an Incident Action Plan (IAP) to determine how best to suppress the fire. In the early phases, the IAP is usually not written. Plans and decisions are communicated orally in crew briefings. The IC is guided by his/her knowledge of the land unit's land management plan (LMP), fire management plan (FMP), and local restrictions in effect, such as where retardant should not be dropped because of threatened and endangered (T&E) species habitat. Ultimately, the IC documents the initial attack actions.

For any wildland fire, providing for firefighter and public safety is the most important objective the IC considers when determining appropriate initial attack strategies. Other factors include such things as current and predicted weather and fire behavior, values at risk, and the resources available. "Prompt, decisive action during the early stages of a fire often determines the success or failure of the initial attack."[2]

There are two primary fire control strategies: direct attack and indirect attack:

- Direct attack is where efforts to control the fire, including line construction, are conducted at the fire's perimeter. This strategy is used when the fire perimeter is burning at low intensity and fuels are light, which permit safe operation at the fire edge. It is often used when high value resources or improvements are threatened.
- Indirect attack is used on fast spreading or high intensity fires and uses natural or constructed fire lines or fuel breaks and favorable topography. The control line in this case may be located a considerable distance from the fire's edge. Intervening fuel is usually backfired.

[2] *Fireline Handbook*, NWCG Handbook 3, PMS 410-1, NFES 0065, January 1998, p.6.

Table 3-2 lists the advantages and disadvantages of each strategy.[3]

Table 3-2. Advantages and Disadvantages of Primary Fire Control Strategies

Strategy	Advantages	Disadvantages
Direct Attack	• Burned area is kept to a minimum. • It is the safest place to work. Firefighters can usually escape into the burn area. • Full advantage is taken of burned areas. • It may reduce the possibility of the fire moving into the crowns of trees or brush. • It eliminates the uncertain elements of burning out or backfiring.	• Heat, smoke, and flames may hamper firefighters • Control lines can be very long and irregular because they follow the edge of the fire. • Firefighters may accidentally spread burning material across the control line. • It does not take advantage of natural or existing barriers. • There usually is more mop-up and patrol required.
Indirect Attack	• Firefighters can locate the control line along favorable topography. • It takes advantage of natural or existing barriers. • Firefighters work away from smoke and heat. • There is more time to construct line. • It allows firefighters to construct line in lighter fuels. • There may be less danger of slopovers.	• More acreage will be burned. • It may be dangerous to firefighters because they are some distance from the fire and cannot observe it. • The fire may cross the control line before the area between the fire and the line is burned out. • Burning out may leave unburned islands. • The dangers of burning out or backfiring come into play. • It fails to take advantage of line that has already burned out.

Extended Attack

ICs can order resources as necessary. When an IC orders additional resources above those dispatched on initial attack, the incident goes into extended attack. Extended attack incidents are generally less than 100 acres, except in the case of rangeland fires, which generally burn faster.

Extended attack fires are usually Type 3 incidents. Some land units have a local Type 3 IMT to handle these incidents. Other units put together a local Type 3 organization as the need arises. Local cooperators are often members of these teams. The IC must build an ICS organization commensurate with the incident's complexity. Usually, the first staff positions to be assigned are

[3] *Standards for Fire and Aviation Operations 2001*, Department of the Interior Bureau of Land Management, April 2001, pp. 139-140.

an operations position, a plans position, one or two logistics positions, a finance officer, a safety officer, and division[4] supervisors.

The land unit's fire management officer (FMO) monitors initial and extended attack either on site or by radio. The land unit's agency administrator would probably be aware that an initial attack effort was underway only if there was a problem. Standard operating procedures are in place that indicate when the agency administrator and FMO are notified of a fire. Extended attack usually lasts for two to four operational periods, during which time the fire is contained, controlled and mopped up. (Management of a fire is usually organized around two 12-hour operational periods—for example, 6 a.m. to 6 p.m. and 6 p.m. to 6 a.m. the next day.)

The Need for a Wildland Fire Situation Analysis

If extended attack is unsuccessful, the agency administrator is required to complete a WFSA. "The WFSA is a decisionmaking process in which the agency administrator or representative describes the situation, establishes objectives and constraints for the management of the fire, compares multiple strategic wildland fire management alternatives, evaluates the expected effects of the alternatives, selects the preferred alternative, and documents the decision."[5]

Several individuals participate in developing the WFSA because it requires knowledge of many facets of the land unit's operations. In particular, good understanding of the goals and objectives in the agency's LMP and FMP is necessary. Expertise in fire behavior and fire suppression also is required. The WFSA, which can be prepared manually or in automated format, contains several major sections, described in Box 3-3 below.

[4] The perimeter of a fire is divided into divisions, geographic areas of operation under the supervision of a division supervisor. Divisions are established when the number of resources exceeds the span of control of the Operations Chief. The size of a division is determined by the terrain, fuels, fire behavior, and access.
[5] Bunnell, David and Zimmerman, Thomas, *Wildland and Prescribed Fire Management Policy Implementation Procedures Reference Guide*, August 1998, p. 71.

Box 3-3. Major Sections of the Wildland Fire Situation Analysis

Fire Situation describes the fire size; fuel condition; current and forecasted fire behavior; current and forecasted weather; and suppression resource availability.

Objectives defines the priorities and assigns weights to four key factors—safety, economic, environmental, and social.

Alternatives lists the alternative strategies for fighting the fire. It also describes the desired and worst-case outcomes, including the probability of success, final fire size, and the time to contain/control.

Suppression Costs lists the estimated resources and corresponding costs for undertaking each alternative.

Impact on Resource Values identifies the resources that will be affected using each alternative and an estimated dollar loss for those resources.

Comparison of Alternatives/Decision Tree compares the compliance with objectives and financial impact of each alternative and computes a score for each.

Decision Summary describes the strategy selected and the rationale for the decision.

Perhaps the most important aspect of the WFSA is that agency administrators can develop and consider more than one suppression strategy. This is important because the WFSA process is designed specifically for comparing and weighing significantly different alternatives, including a least-cost one. The process allows agency administrators (and ICs who are so inclined) to go beyond their experiences and examine a full set of reasonable or plausible strategies.

Some of the alternatives included in the WFSAs for the six case study fires included:

- full suppression (or minimize fire size)
- minimize fire size while providing minimum suppression damage
- protect high value areas (concentrate efforts on protecting specific high-value areas, improvements, trails, and corridors)
- modified suppression (use fewer resources and natural boundaries to keep suppression costs moderate and produce “fire use” benefits)
- indirect attack
- direct/indirect attack

The WFSA provides the overall strategy and parameters for managing the incident. Also, as part of the WFSA process, the agency prepares an Incident Complexity Analysis that determines the level of qualifications needed for the IMT.[6]

Type 1 teams are mobilized according to national procedures, which are managed by the National Interagency Fire Center (NIFC) located in Boise, Idaho. Type 2-teams are managed by the Geographic Area Coordinating Centers (GACC).[7] Both Type 1 and 2 teams are ordered through the appropriate GACC.

Of the six fires the Academy staff examined, five required Type 1 teams. The Arthur, Green Knoll and Star Fires ordered Type 1 teams during initial attack operations. The Moose Fire and Virginia Lake Complex first ordered Type 2 teams and subsequently ordered Type 1 teams. Only the Sheep Fire was contained using a Type 2 team. Before discussing the IMT phase of a wildland fire, it is important to first understand what a Type 1 team is and the skills it brings to a fire suppression effort.

EVOLUTION OF THE TYPE I INCIDENT MANAGEMENT TEAM

Large wildland fire suppression is a complex operation that requires a highly specialized management organization. Type 1 teams have the capacity to manage the most complex wildland fire incidents, sometimes involving over 2,000 people and hundreds of pieces of equipment. At the beginning of the 2002 fire season, there were 16 Type 1 IMTs throughout the country. The size and composition of these teams have changed dramatically over the last 30 years. Larger, more complex fires of longer duration, coupled with a diminished capacity within local land units to support large fire operations have resulted in the development of larger teams with more specialized capabilities.

In the mid-1970s, before the implementation of ICS, "short" teams consisting of a Fire Boss, Line Boss, and Safety, Service, Plans and Finance Chiefs were used. When sent to a fire, the "short" teams would absorb the existing fire organization and order additional capability as needed. An agency administrator could choose between ordering a "short" or "long" team. At that time, "long" teams consisted of about 20 individuals.

During this period, most fires were single jurisdiction; wildland fires that affected communities were rare outside California, and most fires were contained in 7-10 days. Teams were not usually dispatched out of their geographic area or outside of the sponsoring department.

By the early 1980s, due in part to the implementation of ICS, team size and configuration began to standardize, and by 1985 most GACCs had formed interagency teams. Many included state

[6] Sometimes an agency will order a Type 1 team immediately based on the initial assessment of the fire because it recognizes that the fire will become a Type 1 incident. In the Arthur Fire, the Park did not mount an initial attack but instead ordered a Type 1 team.

[7] There are 11 GACCs located throughout the country. The federal land management, state and local government agencies established the GACCs to coordinate and facilitate the movement of wildland firefighting resources within identified geographic areas.

and other governmental personnel. By the end of the decade, long duration fires and community-interface fires were common; fires were becoming more complex in general and were often multi-jurisdictional. At the same time, federal agencies were experiencing major workforce reductions. Consequently, local land units were losing their ability to provide fire suppression support. As a result, team size began to grow to better manage these fires and reduce the impact on the local units. Box 3-4 shows examples of complexities in fire management operations that have driven the evolution of the Type 1 team.

Box 3-4. Examples of Fire Management Complexities that Evolved Since the 1970s

- Wildfires affecting communities
- Fuels build-up
- Long duration fires
- Multi-jurisdictional fires
- Large-scale mobilization and demobilization
- Complex aviation operations, often over populated areas
- Extensive use of data and technology (information technology, remote sensing, global positioning system (GPS), geographic information systems (GIS), fire behavior forecasting, general use of computers for many applications on incidents)
- Human resource and labor union issues
- Heavy media interest (a large fire can require up to 25 Information Officers)
- Hazardous materials regulations, Occupational Safety and Health regulations, and health and safety issues
- Environmental concerns
- Protection of threatened and endangered (T&E) species, cultural and historical resources
- Major use of contract resources
- Security (a large fire may require 20 Security Officers—although not a team member)

In 1999, the National Wildfire Coordinating Group (NWCG)[8] began to examine team composition. Review participants included IMT members from Type 1 and 2 teams, agency fire managers, and agency administrators. At its May 2002 general meeting, NWCG approved new national standards for Type 1 and 2 teams. Type 1 teams can now have up to 44 positions and Type 2 teams can have up to 27 positions.

INCIDENT MANAGEMENT TEAM PHASE

Transition to an Incident Management Team

Once an IMT is assembled, the local agency administrator, accompanied by the land unit FMO and the initial attack/extended attack IC, briefs the incoming team, preferably at a location away

[8] In 1976, the secretaries of the Interior and Agriculture created NWCG to serve as a forum for developing recommended policies, guidelines, and standards to benefit the participating agencies. Each agency determines whether and in what manner it will adopt NWCG proposals.

from the fire. During the briefing, the agency provides, at a minimum, the following written information:

- fire situation information, including size, cause, fuels, weather, topography, and fire behavior
- the role of local cooperators
- the land unit's FMP
- concerns about resource values, improvements, wilderness or roadless areas, cultural resources, T&E species, mop-up and rehabilitation requirements
- priorities for control
- media procedures
- political concerns and considerations
- agreements in effect for mutual aid and cost sharing
- date and time for the team to assume command
- safety issues
- operations and planning information
- logistics information
- finance/administration information

The agency administrator gives the IC a Delegation of Authority, which is the official document that gives the IC the authority to manage the fire. On a multiple jurisdiction fire, each agency administrator provides the IC with a delegation, or all agency administrators may sign a combined delegation. In the delegation, the selected suppression strategy and agency objectives are identified. Political, social, environmental and cost issues also may be addressed.

The IC may negotiate with the agency administrator on the alternative selected and the terms of the Delegation of Authority. For example, if the IC believes that the selected strategy is not attainable, or if the restrictions in the delegation are such that the IC believes they will impair the IMT from meeting the primary objectives, those items are discussed.

The delegation specifies when command is transferred to the incoming IMT. After the agency briefing, the IMT members start phasing into their areas of responsibility by meeting with their counterparts on the local team and shadowing the current operations for one or two operational periods. Local team members may continue to work in various capacities for the incoming team or they may be released.

The success of the transition depends on how well the extended attack organization briefs the team and how well the incoming IMT handles the transition. The briefings by the agency administrator and the outgoing IC and staff are critical to this process.[9]

Operational Management

Once the incoming team takes command, it is responsible for developing firefighting strategies and tactics consistent with the selected alternative and agency objectives contained in the WFSA

[9] *Fireline Handbook*, NWGC Handbook 3, PMS 410-1, NFES 0065, January 1998, page 34.

and Delegation of Authority. The IMT reviews the WFSA each operational period to ensure that the fire is still within the WFSA's parameters. It also continually reassesses the fire situation and responds to that assessment. A number of activities are key components of this process.

The Planning Session

The IMT conducts a planning session to develop an IAP for each operational period. The IAP provides operational direction for managing the fire.

The planning session includes the Command and General Staff and other specified team members. The Planning Section Chief heads the meeting and starts by providing a situation and resource status. The IC reviews incident objectives. The Operations Section identifies geographical or functional boundaries on the fire and specifies tactics and suppression resources needed for each. The Logistic Section Chief provides information on communications, transportation, and medical support information. The Safety Officer ensures that safety considerations for the incident are recognized. The agency administrator (or his/her representative) is present to keep current on the incident, provide information, or share concerns.

After the meeting, the Planning Section is responsible for assembling the component parts of the IAP. These include the incident objectives; organization; assignments for operational resources; fire weather and behavior forecasts; the human resource message and communication plans; safety information and medical plans; and aviation plans. Specific assignments are stated as measurable objectives that can be used as accountability mechanisms for operational personnel on the incident. When completed, the IC reviews and approves the IAP.

Operational Period Briefings

Briefings are conducted for all operational and support personnel prior to each operational period. During these sessions, the IMT ensures that required information and direction is provided to all concerned to implement the IAP. For example, the Incident Meteorologist (IMET) briefs the group on the expected weather and the Fire Behavior Analyst provides information on the current and expected fire behavior. The Safety Officer may discuss issues of concern and special precautions that should be taken by operational personnel. The Operations Section Chief provides an update of control actions and specific assignments to the crews and other personnel assigned to operational activities. The IC may discuss emphasis items and provide general comments.

Operational supervisors also have briefings with assigned personnel on a division-by-division basis. These briefings provide specific information that outlines expected accomplishments, safety concerns, assigned personnel, transportation arrangements, and communications for each division. Following these briefings, crew leaders brief their crews individually.

The Situation Unit of the Planning Section debriefs operations supervisors following each operational period. Planning and operational projections are updated and verified as a result of this activity. Debriefing is primarily the responsibility of the Planning Section, but operational supervisors also may obtain information for planning. Accomplishments and recommendations from the previous operational period are used as a starting point for projections of needed suppression resources for the following operational period.

Incident Status Summary

The IMT prepares an Incident Status Summary daily and forwards it through the GACC to NIFC. The summary contains such information as fire size, percent containment, resources committed, estimated cost, and resources/improvements lost or threatened. The GACC uses the summaries and WFSAs to establish priorities for resource allocations between fires. NIFC uses the summaries to compile the National Situation Report. This report is posted daily on the NIFC website by 5:30 a.m. Mountain Time. It is the primary means by which agency staff, media, and other interested parties are kept informed on the national fire situation.

Agency Administrator Meetings

The IC must maintain open communication with the local agency administrator to ensure that the land unit's objectives are met. To accomplish this, the IC meets with the agency administrator as often as dictated by the fire situation. The mechanism for this communication is the daily WFSA review by the agency administrator and IC. It ensures that the selected alternative is still appropriate or provides an opportunity to modify it.

Other Management Organizations

Some variations on the typical single command organization warrant brief explanation.

Unified Command

Unified command should be used when a fire includes more than one jurisdiction. Under a unified command, representatives from each of the involved jurisdictions (federal, state, and local) share command of the incident. Collectively, they direct the management of the incident to meet a common set of objectives and contribute to the process of:

- determining overall strategies
- selecting alternatives
- ensuring that joint planning for tactical activities is accomplished
- maximizing the use of all assigned resources[10]

For example, the Green Knoll Fire used a unified command that included the Bridger-Teton National Forest and the Jackson/Teton County Fire Departments.

[10] *Standards for Fire and Aviation Operations 2001*, Department of the Interior Bureau of Land Management, page 168.

Complex

A complex consists of two or more fires assigned to one IMT or unified command to facilitate the overall management of the incidents. One IMT, under an Area Command, managed the six fires that comprised the Virginia Lake Complex.

Area Command

An Area Command is an organization established to oversee the management of multiple incidents in a single jurisdiction or fires burning on different jurisdictions within a local dispatch area. An Area Command also can oversee the management of a very large incident that has multiple IMTs. Primary functions of an Area Command include coordinating the incidents under its authority and prioritizing and allocating resources between the various incidents. There are four national Area Command teams. Due to the magnitude of fire activity in the surrounding region, the Virginia Lake Complex was placed under the direction and supervision of an Area Command team. Virginia Lake was one of six complexes that the Area Command was managing.

Factors Affecting Strategic Decisionmaking

As noted earlier, goals and objectives in the agency's LMP and guidance in the FMP, which are reflected in the Delegation of Authority and WFSA, are major determining factors in strategy selection. Resource availability, firefighter safety, access, fire behavior, terrain, and values at risk are other key factors. There also are a number of pre-existing conditions that affect strategic decision-making, and resulting costs. These conditions often have a more profound effect on the cost of a fire than the decisions made by the agency or IMT during the fire. Examples of these pre-existing conditions follow.

Fuel Build-Up

Heavy fuel concentrations limit the strategic alternatives for fighting a fire. In areas with heavy fuel concentrations, concern for firefighter safety often precludes direct attack and limits the effectiveness of air attack because of the high fire intensity. Heavy fuels also require more resources to control the fire. When combined with drought conditions, they are the primary reason for long duration fires that can burn uncontrolled for weeks.

Community Interface and Infrastructure on Federal Land

Thirty years ago, it was relatively rare, except in Southern California, for a large federal wildland fire to threaten communities. With the explosive growth of communities in and near wildlands, it is now difficult to have one that does not threaten structures. There also has been an increase in the amount and value of federal and non-federal infrastructure on federal lands such as utility corridors, cell phone and microwave towers, campgrounds, resorts, mining facilities, municipal watersheds, and hydropower facilities. Destruction of this infrastructure can produce major disruptions and economic impacts, particularly on surrounding communities. Trying to protect these community and infrastructure elements from wildland fire requires strategies and tactics that might not otherwise be needed. Such tactics could involve removing fuel around the structures/infrastructure, installing protection systems, constructing additional control lines around structures/infrastructures to prevent the fire from reaching them, and fighting the fire when it gets to the structures/infrastructures. These activities often involve the use of additional suppression resources, including heavy reliance on expensive aircraft, well beyond what would be used in their absence. The presence of community or infrastructure elements also can restrict a strategic option, such as the use of a backfire to clear an area between a natural control line and the fire.

Firefighter Safety

Heavy fuels, steep terrain, high fire intensity and adverse weather often affect strategic decisionmaking due to concerns for firefighter safety. In much the same way as air power was used in lieu of ground forces to limit casualties in the Gulf War and Afghanistan, ICs are opting to use expensive air tankers and Type 1 helicopters in order to limit firefighter exposure in steep terrain or under extreme burning conditions.

Concern for firefighter safety often limits the opportunity for aggressive strategies such as making a stand, supported by backfiring, in front of a fire. Less aggressive strategies such as anchoring the rear, flanking the fire and eventually pinching off the head, while providing less immediate firefighter exposure, may result in chasing the fire and fighting it on terrain and conditions dictated by the fire. These less aggressive strategies often rely on more favorable weather conditions to eventually pinch off the head of the fire. The net result from using less aggressive strategies is that fires often burn longer and become larger.

Extensive tree mortality throughout the West has created vast areas of dead trees, called snags. Snag patches may contain up to 200 dead trees per acre and stretch for miles. Under windy conditions or when burned through by a fire, snags can fall without warning. They kill or injure several firefighters each year. Rather than expose firefighters to the dangers of falling snags, IMTs usually route fire lines around snag patches, which results in larger fires. Additionally, when it is necessary to fight fires in snag areas, night firefighting operations are curtailed, which further extends the time to control the fire.

Resource Protection

Natural resources on federal land are steadily increasing in value, and an IC's discretion is sometimes limited by the need to provide higher levels of protection for those resources—both from the fire itself and from damage caused by fire suppression efforts. Table 3-3 provides examples of the resources to be protected and the options that may be restricted during a suppression effort.

Table 3-3. Natural Resources to be Protected and Related Restrictions

Some Natural Resources to be Protected	Some Firefighting Decisions that may be Affected
• Threatened and endangered species • Wilderness and scenic values • Streams and rivers • Water quality • Fisheries • Nesting sites • Soil	• Use of mechanical equipment • Use of fire retardant • Helicopter/air tanker use • Fireline construction • Locations of incident command posts, camps, and other facilities • Fuel storage • Noxious weed control, including decontamination of mobile equipment

Land Designations

Designation of land by presidential proclamations, congressional acts or land management planning may also limit strategic options for fire suppression, which may elevate suppression costs. Some of these designations are:

- national parks
- national recreation areas
- national monuments
- wilderness areas
- roadless areas
- scenic byways
- wild and scenic rivers

The Need for Successive Incident Management Teams

The need for successive IMTs on a fire is not necessarily related to the success or failure of a team's efforts to contain a fire. Current guidelines require firefighters to rest after working 14 days on a fire. Under this rule, if a fire is not contained and the IMT is nearing 14 days on the fire, the agency will request a new team.[11] Some of the long-duration fires that start in July and burn until the weather brings precipitation may require four or five IMTs.

In other cases, containment of the fire will initiate a team transition. For example, if a Type 2 team successfully contains the fire, it will transition the management of the fire back to the local

[11] If the nation is in Preparedness Level 5, which means national resources are in very short supply, there is some latitude to keep an IMT longer than 14 days on an incident.

land unit. If it is unsuccessful, a decision will be made, normally by the agency administrator, to transition to a Type 1 IMT. In most cases, a new WFSA and fire complexity analysis will trigger the need for the Type 1 team.

If the Type 1 team is successful in containing the fire, it may complete mop-up and demobilization activities and turn the management of the incident back to the local unit. If the Type 1 team is close to its 14-day limit, or if Type 1 teams are in critical supply, it may turn the incident back to a Type 2 team in order to be available for assignment to a more critical incident.

If the Type 1 team is unsuccessful, the agency may order a new Type 1 team. If the fire gets really large, a decision may be made to bring in a second team to manage part of the fire. This occurred in June 2002 on the Hayman Fire in Colorado. Three IMTs were assigned to that fire simultaneously. The ICs of those teams reported to an Area Command.

Obtaining and Allocating Resources to Large Wildland Fires

A vast array of people and equipment are required for direct and support activities needed for fighting wildland fires. The land management agencies use a tiered approach to obtaining and providing these resources. Local land units, GACCs, regional organizations, and the National Interagency Coordination Center (NICC)[12] all play a vital role in the process.

Obtaining Resources

Local land units provide the first level of "supply" for fire incidents. These units maintain a cadre of qualified personnel and inventories of equipment at sufficient levels for initial and extended attack and basic support operations. The fire management analysis process used to determine preparedness budgets, together with the fire activity level, determines the staffing and supply levels needed. Some locations stock significant volumes of frequently used products (such as tools, hose, and fire shelters) and have local contracts for heavy equipment and reconnaissance aircraft.

The land management agencies' regional offices are the next link in the supply chain. Most activity there involves contracting for crews and aircraft.

Supplies also are acquired on an interagency basis through the National Fire Equipment System (NFES) cache system. This system is comprised of 11 separate facilities throughout the country. The caches are managed and operated by the 11 GACCs, which the federal land management agencies established to coordinate and facilitate the movement of wildland firefighting supplies throughout the country. Approximately 3,500 items are available through the cache system, including items such as tools, sleeping bags, personal protective equipment and portable pumps. About 550 items are national items designed for all areas of the country and the remaining items are tailored to meet local needs. Each GACC has significant autonomy in its operations and

[12] NIFC houses NICC, a highly automated facility that quickly locates and mobilizes emergency personnel, equipment, supplies and aircraft. The 11 GACCs support NICC nationwide. When multiple incidents or competition for resources prevent a GACC from meeting the requests within its region, it refers requests for resources to NICC.

determines the items it will carry based on suggestions from the fire management community and NFES committee members.

The Forest Service Director of Fire and Aviation is responsible for establishing contracts for national suppression resources. This office coordinates the needs for national suppression resources on behalf of all land management agencies. The NIFC contracting staff has established the following national contracts, shown with current annual dollar figures expressed in millions:

- air tankers ($33m)[13]
- air transport ($1m)
- aircraft maintenance ($1.3m)
- helicopters ($117.5m)
- fire retardant ($15m)
- mobile food and shower services ($28m)
- smokejumper aircraft ($.7m)

The fire program also contracts for some engines and hand crews.

In state fire management operations, some states have opted to provide some of these resources themselves rather than contract for them. The most notable example of state-furnished services is food services, where California maintains a fire incident food service staffed by state prison inmates.

Allocating Resources to Fires

Allocating resources to fires also is managed in a tiered approach using a system of dispatch centers. Local land units maintain initial and expanded dispatch operations for initial and extended attack operations. In some cases, these local dispatch centers are interagency and/or intergovernmental in nature, with several agencies contributing to the centers' operations. They control all firefighting resources within their dispatch areas and coordinated with adjacent centers to obtain additional resources.

The local dispatch centers work under the umbrella of one of the 11 GACCs. A GACC establishes guidelines (a mobilization guide) for the dispatch centers in its area to use when filling orders. As the fire season intensifies and the number of concurrent incidents increases, local dispatch centers are faced with many competing requests for resources. The following statement from the North Dakota Dispatch Center is an example of how such orders are filled:

> "(the center) and local dispatch centers will fill orders from the best, most logical source available. This choice will be made on the basis of urgency, availability, delivery time, cost effectiveness, operational impact on local units, and safety."

[13] There are 44 air tankers under contract for the 2002 fire season. In 2001, there were 41. In addition to contract air tankers, the National Guard and Air Force Reserve maintain a total of eight C-130 aircraft that are available for air tanker use when all contract aircraft are committed or are not readily available.

When a local dispatch center cannot fill an order, it sends the order to its GACC. When a GACC receives a request for resources from a local dispatch office, it will look to the following sources:

1. other local dispatch centers within its geographic area
2. the GACC's own resources or, in some cases, resources from adjacent GACCs
3. NICC for resources from other GACCs or for some national resources, such as air transports

GACCs also play a pivotal role in coordinating the assignment of hand crews. Nationally, there are 72 federal Type 1 and 413 Type 2 crews available.[14] Type 1 crews must meet the minimum standards in the Interagency Hotshot Crew Operations Guide. Type 2 crews do not have the same level of experience, financing, training, and travel requirements of Type 1 crews. A local land unit hosts each crew, and it can dispatch its crew to a fire on the home unit. If another land unit needs a crew, it submits its request to its GACC.

In addition to federal crews, the GACCs also dispatch state, local, and contractor crews through their local dispatch centers. These crews, when sent out of the GACG area, are held to the same qualification standards as the federal crews and they are used as federal crews become scarce. If a GACC does not have any crews available, it passes the order to NICC, which contacts another GACC with available crews. Generally, a GACC will use most of its local, state, and contract crews before making a request to NICC.

Military crews also are available under agreement between the Department of Defense (DOD), the Department of Agriculture, and DOI. DOD can provide emergency assistance to federal agencies in the form of personnel, equipment, supplies, or helicopter support when requested by NIFC or when a forest or grassland fire on state or private land is declared a major disaster.[15] In all cases, requests for military assistance are sent to NICC. Recent cases of military support include the use of active duty, military battalions during the 2000, 2001 and 2002 fire seasons. The Area Command for the Virginia Lake Complex ordered one battalion of military personnel.

The National Guard also may be used for fire support. Typically, the National Guard is used for transportation, security, traffic control, and shower and kitchen services. A state governor may mobilize the National Guard. The most common use of the National Guard is not under mobilization procedures, but by use under agreement with individual states in which Guard personnel are hired under the Administratively Determined (AD) Pay Plan for Emergency Firefighters.

Unable-to-Fill Orders

During periods of heavy mobilization, there are times when the system cannot fill requests for resources. Unable-to-fill (UTF) orders mean that IMTs must adjust their suppression tactics to compensate for resource shortages. These types of adjustments can affect the overall cost of the suppression efforts. Table 3-4 shows the UTF orders for the 2000 and 2001 fire seasons.

[14] Source: National Interagency Mobilization Guide

[15] Generally, the firefighting community must be at Preparedness Level V, the most severe, before it can activate military forces.

Table 3-4. Unable-to-Fill Orders for the 2000 and 2001 Fire Seasons

RESOURCE	2000	2001
IMTs	2,568	580
Type 1 Crew	159	24
Type 2 Crew	206	2
Engines	82	1
Mobile Food Service	37	24
Showers	18	7
Air Attack Aircraft	23	2
Infrared Aircraft	562	33
Lead Planes	21	20
Type 1 Helicopter	6	1
Type 2 Helicopter	27	3
Air Tanker	39	15

Firefighting Equipment Loss

At the close of each incident, all property and equipment ordered from the cache system is to be returned. Under the fire loss program, the IMT is required to prepare a fire loss report within 60 days of the close of a fire, showing the consumable and durable items used on the fire. If property or equipment has been destroyed or lost, the IMT must provide documentation to the cache so that equipment can be replaced and the caches restocked. The national target, expressed as a percentage of items not returned, is 15 percent. The actual figure for 2001 was 18 percent.

The land unit delegates responsibility for equipment accountability to the IMT, and evaluates it on the amount of fire loss as part of the overall evaluation of the team's performance. Several GACCs offer informal awards to the IMTs within their GACC that have the lowest loss rate. If an IMT experiences an unacceptable return rate, the cache manager sends a letter to the host land unit for follow-up.

Upgrading the Dispatch System

The land management agencies have a major effort underway to upgrade the dispatch software system through a project called the Resource Ordering and Status System (ROSS). This initiative is discussed in Chapter 8.

Decision Support Tools and Information Technology

The use of electronic data and information technology is playing an increasingly important role in fire suppression. For example, use of the automated decision-support tool, WFSA, is required on all incidents that escape initial attack. In addition, several other computer models such as those described in Table 3-5 are available to assist fire managers with large-fire decision-making.

In the hands of a trained fire behavior analyst, these tools become key components for developing and assessing suppression strategies and tactics.

Table 3-5. Selected Decision-Support Systems[16]

NAME	DESCRIPTION
BehavePlus	BehavePlus can predict fire behavior at a given point on the ground, under different conditions such as fuel type, fuel moisture, wind, and slope.
FARSITE	FARSITE is a fire growth simulation model that uses spatial information on topography and fuels along with weather and wind data. FARSITE incorporates the existing models for surface fire, crown fire, spotting, and fire acceleration into a two-dimensional fire growth model.
Consume	Consume is a PC-based, interactive fuel consumption model that predicts total and smoldering fuel/biomass consumption during prescribed fires and wildland fires. Predictions are based on weather data, fuel moisture levels, and a number of other factors.
FireLib	FireLib is a system for predicting the spread rate and intensity of free-burning wildfires. FireLib is a direct descendant of the BEHAVE fire behavior algorithms for predicting fire spread, but more advanced.
SIAM	The Structure Ignition Assessment Model assesses potential residential ignitions during COMMUNITY-INTERFACE fires, given a structure's materials and design and its exposure to flames, to produce an ignition risk index.
RERAP	The Rare Event Risk Assessment Process is a Windows-based program that helps calculate the information needed to manage prescribed fire and wildfires.
FOFEM	The First Order Fire Effects Model is an easy-to-use computer program for predicting effects of prescribed fire and wildfire. It predicts fuel consumption, smoke production and tree mortality. Area of applicability is nationwide on forest and non-forest vegetation types. FOFEM also contains a planning mode for planning prescribed fires..

On the six case study fires, the most often used models were BEHAVE (an older version of BehavePlus) and FARSITE.

In addition to these models, the fire management community relies extensively on mapping capabilities to provide intelligence for large wildland fires. For these fires, the IMT needs information on the surrounding physical area, such as topography, water sources, and fuels, plus the location of key features, such as roads, buildings and sensitive habitat areas. Federal agency use of infrared photography, GPS receivers, remote sensing, and GIS is widespread. All of the six case study fires used this technology, but they had varying levels of equipment and expertise with which to use it. Current, accurate data are necessary to use decision support models and

[16] Source: Forest Service Fire & Aviation website http://fire.org/perf/tools.cgi

prepare maps of the fire. However, the extent to which the data on the case study fires were current and precise varied.

Current and predicted weather forecasts are critical during any wildland fire suppression effort. An incident meteorologist, whose specialty is forecasting fire weather, is dispatched to support IMTs. The meteorologists have several data sources:

- Direct downloads from the National Oceanic and Atmospheric Administration (NOAA) and others satellites provide data every one-half hour to their computers.
- The Internet is a source for weather data.
- National Weather Service offices provide additional data that are not available at the fire location.
- Microrems is a remote weather monitoring system.
- Remote Automated Weather Stations are ground-based weather monitoring units that provide real-time, on-site data. Meteorologists and others can gather the weather station data over the Internet or by radio.
- Field observers on the fire line can be used to send in weather observations every few hours.

Federal and state agencies also use a remote automated lightning detection system supplied by private contract. This system provides real-time lightning strike and location reports. Alerts can be given via e-mail or pager, and data are acquired through an online service. Many federal land units subscribe to this service. Because the system is only provided to agencies under contract, these data are not easily shared among cooperators in a given area.

Technology and the Business Management of Large Wildland Fire Incidents

Keeping track of resource utilization and related costs is a major undertaking on a large wildland fire, and technology is starting to make this task easier. Over the past several years, the Forest Service has been developing a system to automate the process of tracking the resources used on a fire and their costs in order to more efficiently manage incident operations. I-SUITE is an integration of three software applications running from one database:

- Incident Time System (ITS) for tracking personnel time
- Incident Resource Status System (IRSS) for tracking equipment usage
- Incident Cost Accounting and Reporting System (ICARS) for tracking and reporting costs

Much of the data needed for each application is redundant. I-SUITE provides one database that can be used simultaneously by multiple users on networked computers in the Incident Command

Post (ICP) and the dispatch system. The three applications also can be used as stand-alone programs for local units and dispatch offices for determining the status of resources and for time keeping.

The complete I-SUITE package was first available nationally during the 2001 fire season, although individual applications had been available in some places for several years. All Forest Service regions and a number of federal and state IMTs used at least some of the system's applications. Some local Forest Service units also used the system to perform time keeping for initial attack. The State of Florida uses ICARS routinely for cost analysis on its fires.

There are two other automation packages also being used by IMTs to track resources used and their costs. An NWCG Incident Business Practices Working Team has developed three alternative courses of action with respect to these systems: 1) make no change; 2) combine the existing applications into one program; and 3) perform an evaluation of IncNet. NWCG is reviewing these recommendations.

Chapter 8 provides additional information on the use of science and technology on large wildland fires.

MOP-UP, EMERGENCY STABILIZATION, AND REHABILITATION

When the general public thinks about firefighting operations, it often imagines firefighters constructing a control line near a wall of flames. However, there are three other activities that consume a lot of time, effort, and money during and after a suppression effort—mop-up, emergency stabilization and rehabilitation (ESR) to repair damage done by the fire, and long-term restoration. The costs of the first two activities are billed to the fire; third is paid for separately. Long-term restoration activities include fuels management activities designed to return an ecosystem to healthy condition.

Mop-Up

As soon as control lines are established, mop-up activities begin to prevent the fire from crossing the control lines. Mop-up includes such tasks as arranging burning fuels so they cannot roll across the control line; spreading smoldering fuels and applying water; extinguishing burning and smoldering material such as logs, snags, stumps, and ground litter; felling snags, lining unburned islands of fuel within the fire perimeter, widening and improving the fire line; and checking for spot fires. In heavy fuels, mop-up may account for over half the work hours on the fire.

The land unit sets the mop-up standards required before control of the fire can be returned to its control. One hundred percent mop-up is not uncommon on small fires. On large fires, the perimeter is usually mopped up for a specified distance in from the fire line. This means that all hot spots are extinguished and no smoke is showing within this distance. This distance depends on such things as present and predicted weather, time of year, size of the fire, fuels and values at risk. The Colville Indian Agency required that the Virginia Lake Complex be mopped up 100 percent before releasing the Type 2 team that was delegated that responsibility. Although it was a large fire, over 74,000 acres, the Agency did not believe it could effectively manage the mop-up operation because of the other fire activity in the region.

Emergency Stabilization and Rehabilitation

The damage from wildland fires takes two forms—damage to resources caused by the fire itself (discussed below) and damage caused by the actions taken to suppress the fire. ESR includes short-term actions to mitigate the adverse affects of suppression actions on soil, water, and critically threatened natural and cultural resources. Areas affected by such things as line construction (hand lines and dozer lines), equipment staging activities, base and camps, and the ICP are rehabilitated and sometimes reseeded. If firefighters damage a fence in order to construct a control line, the fence is repaired or replaced.

Emergency stabilization activities are often performed in conjunction with mop-up. The crews performing this work are under the supervision of the IMT.

Following the fire, an interdisciplinary Burned Area Emergency Rehabilitation (BAER) team, which reports to the agency administrator, assesses the affects of large fires. The BAER team surveys the fire area, maps the fire intensity, and develops a BAER plan for mitigating damage from the fire and reducing the adverse impacts of future weather events on the burned area. For instance, erosion control measures, such as seeding, mulching, and construction of erosion control structures, may be recommended to reduce soil erosion and/or mudslides from future storm systems.

The BAER plan is reviewed and approved at the agencies' regional or national level, depending on the cost to implement it. If approved, the costs of actions taken are charged to the fire.

FINANCING LARGE WILDLAND FIRE SUPPRESSION

Fighting wildland fires is a costly business. Funds for these operations are provided through two major sources. Each federal land management agency receives a direct budget appropriation to support the preparedness part of its fire management program. Funds allocated for this purpose enable the federal land management agencies to develop the capability to prevent, detect, and perform initial and extended attack on wildland fires. The activities funded include planning, prevention, detection, training, equipment and supply, and purchase or replacement of equipment (including engines). The land management agencies have developed budget planning models to determine annually the level of preparedness funds each land unit should receive. The Forest Service BLM and BIA use the National Fire Management Analysis System (NFMAS), which was first developed in the 1980s by the Forest Service. NPS has developed its own system—FIREPRO—and the Fish and Wildlife Service uses FIREBASE. Recently, the five agencies embarked on a project to develop a single improved budget model to be used by all.

The current models are complex. They use several variables, such as fire workload on a unit and program complexity, to determine the optimum number of permanent and seasonal staff and budget support requirements, given an average fire year, for each land unit within the agency. This figure is the Most Efficient Level, or MEL. [17] Congressional appropriations can be translated to a MEL level for any given year. For example, annual appropriations may fund an agency at 90 percent of MEL, which means the agency has 90 percent of the budget it estimates is needed to provide the most cost effective level of fire preparedness.

Other fire management activities for which the agencies receive direct budget allocations include suppression, hazardous fuels treatment, rehabilitation and restoration, rural fire assistance (DOI), and state and volunteer fire assistance (Forest Service). Like other appropriated funds, the land management agencies are accountable to Congress for how they are spent.

Once a fire occurs, it is assigned a project code and all fire costs are charged to that code. In addition, indirect expenses related to a fire, such as the time a dispatch office or cache in another region spends locating and supplying requested resources, also are charged to the fire. The agencies' budgets to pay for these suppression actions are developed primarily using historical data. Particularly in recent years, the agencies' budget allocations have not been sufficient to cover the costs of fighting wildland fires.

To cover the costs of fire suppression, Congress established a separate emergency suppression contingency account. Once the agencies' suppression budget allocations are exhausted, additional suppression costs are paid out of this account. If the funds in this account are exhausted, the agencies have authority to borrow from various trust funds and appropriated accounts to finance wildland fire suppression activities. Congress can later replenish these accounts through supplemental appropriations. In essence, federal fire managers have an "open checkbook" to suppress wildland fires—they can spend what they need to suppress a fire.

After the severe 2000 fire season, President Clinton asked the secretaries of Agriculture and the Interior to develop recommendations for the best way respond to what had occurred, reduce the impact of wildland fires on rural communities, and ensure sufficient firefighting resources in the future. The secretaries' response, which has come to be known as the National Fire Plan (NFP), contained five key points:

- Firefighting—Maintain a cost-effective level of preparedness in firefighting and prevention.

- Rehabilitation and Restoration—Rehabilitate fire-damaged wildlands and restore high-risk ecosystems.

- Hazardous Fuel Reduction—Invest in projects to reduce fire risk with a focused effort in the wildland/urban interface.

- Community Assistance—Work with communities to reduce the risks of catastrophic fire.

[17] This is a very simplified explanation for very complex operations research models.

- Accountability—Establish and maintain a high level of accountability including oversight reviews, progress tracking and performance monitoring.

Congress responded to the agencies' proposals by enacting the 2001 Interior and Related Agencies Appropriation Act (PL 106-291), which appropriated almost $2.9 billion to implement the NFP.[18] The land management agencies received 100 percent of MEL to bolster preparedness budgets, plus significant increases in all of the other fire management program budget line items. Congress continued to support the NFP in fiscal year 2002, allocating almost $2.3 billion. Table 3-6 shows NFP allocations for Interior and the Forest Service during fiscal years 2001 and 2002 and, for comparison, the allocations for fiscal year 2000.

Table 3-6. National Fire Plan Allocations—Fiscal Years 2001 and 2002
(Dollars in thousands)

Program	Fiscal Year 2000	Fiscal Year 2001	Fiscal Year 2002
Preparedness	574,617	925,855	903,425
Operations			
Suppression	197,256	472,433	382,745
Hazardous Fuels	117,040	400,129	392,745
Rehabilitation and Restoration	20,000	246,457	102,688
Fire Facilities	0	43,903	20,376
Research and Development	0	15,965	27,265
Joint Fire Sciences Program	0	0	8,000
Forest Health Management	0	11,974	11,974
State Fire Assistance	23,929	77,828	81,693
Volunteer Fire Assistance/Rural Fire Assistance	3,240	23,229	23,315
Economic Action Program	0	12,472	12,472
Community and Private Assistance	0	34,923	0
Emergency Suppression Contingency*	590,000	624,623	300,000
TOTAL	**1,526,082**	**2,889,791**	**2,269,133**

*A portion of this appropriation is to reimburse trust funds that were used on a temporary basis under existing legal authorities to finance firefighting activities.

Cooperators' Share of Suppression Costs

As discussed earlier, many large wildland fires burn on federal and non-federal land where state and local cooperators play a major role in fire suppression efforts. The federal land management agencies and their cooperators have established two primary mechanisms for sharing the costs of these suppression efforts. Where federal land is adjacent to or intermixed with non-federal land, most federal land units have mutual-aid agreements with their neighbors that outline initial and extended attack responsibilities and payment procedures. Financial arrangements vary. For example, on the Arthur Fire, Yellowstone National Park used agreements with the Park County,

[18] Of that figure, more than $700 million went to replenish and enhance the departments' fire suppression accounts that were depleted by the 2000 fire season, and to repay FY 2000 emergency transfers from other appropriations accounts.

Montana and Park County, Wyoming Rural Fire Districts, the Gardiner Volunteer Fire Department, and the Town of West Yellowstone, which border the park. The agreements with these organizations specify that if a party to the agreement is asked to assist in an initial attack operation outside its jurisdiction, all expenses incurred after four hours on the fire may be submitted to the requesting department for reimbursement. The agreement with the Town of West Yellowstone says that each party "shall provide for its own financing and budget" to cover the requirements in the agreement. However, for extended duration responses, the parties may agree to reimburse one another.

Once a fire moves beyond the extended attack phase, the federal land management agency and the state normally prepare a cost-share agreement to formalize the parties' responsibility for the cost of the incident. The basis for splitting costs is usually determined by each party's percentage of acres protected or level of effort. The terms and conditions are negotiated by the IMT's Finance Section Chief, an agency representative, and a state representative (usually someone from the state's forestry organization). For particularly costly fires, these negotiations are often elevated to a higher level. For the June 2002 Hayman Fire in Colorado, which is estimated to cost over $50 million dollars, the Colorado State Forester and the Forest Service Regional Director negotiated the terms and conditions of the cost-share agreement.

Chapter 5 discusses some of the issues uncovered with respect to cost sharing on the six case study fires.

CHAPTER 4
THE SIX CASE STUDIES OF 2001 LARGE FIRES

For this project, the Academy agreed to conduct case studies of six large wildland fires. These case studies were to be the core of the Academy's research and a key basis for Panel's recommendations. The Panel selected the cases from a list of 21 of the largest fires in 2001 provided by DOI and the Forest Service. Selection was based on preliminary assessments of 10 fires nominated by the agencies, using criteria developed by the Academy staff in consultation with the agencies. Among the criteria given weight during the final selection process were:

- diverse lead agencies
- community interface
- a fire that ran into a pretreated area
- high local involvement

The complete list of selection criteria information for each of the six case study fires is shown in Table 4-1.

Table 4-1
Wildland Fire Suppression Cost Study: Six Large-Fire Cases

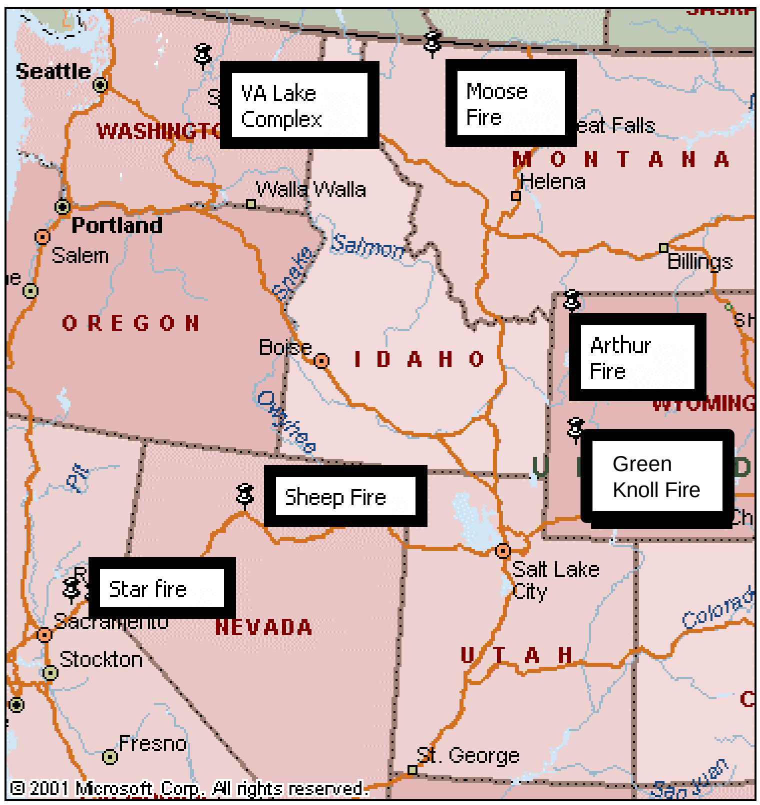
CHARACTERISTICS OF FIRES	FOREST SERVICE FIRES			DOI FIRES		
	Moose	**Star**	**Green Knoll**	**Virginia Lake**	**Arthur**	**Sheep**
Acres Burned	71,000	17,500	4,470	74,243	2,800	83,673
Selection Criteria						
1. Status of fire management plan	Current	Not Current	Current	Not Current	Current	Current
2. Fire managed to provide resource benefits	Partial	No	No	No	No	No
3. Wildland-urban-interface involvement	Limited	Limited	Heavy	Heavy	Moderate	Limited
4. Location	Montana	California	Wyoming	Washington	Wyoming	Nevada
5. Single vs. multiple ownership	NF/NPS/ST/PVT	2 NF/PVT	NF/PVT	Tribal/PVT	NPS/NF	BLM/PVT
6. Diverse lead agencies	NF/NPS/ST/CO	2 NF	NF/CO	BIA	NPS	BLM
7. Degree of local cooperation	Low	N/A	High	Low	High	Low
8. Tribal involvement	No	No	No	Yes	No	No
9. Diverse management.	Yes	Yes	No	Yes	Yes	Yes
10. Predominant fuel type	Timber	Timber	Timber	Diverse	Timber	Rangeland
11. Cost per acre	$274	$1,611	$2,975	$339	$2,142	$26
12. Political pressures	Moderate	None	High	High	High	Moderate
13. Environmental, cultural & similar issues	Moderate	Heavy	Moderate	Moderate	Low	Moderate
14. Type of Command	1 & 2	1 & 2	UC 1 & 2	1,2, & AC	1	2
15. Pre-treated areas	No	No	No	Some	No	Some
Total Costs (Millions)	$19.6	$28.2	$13.3	$25.2	$6.0	$2.2

Legend

NF=National Forest	BLM= Bureau of Land Management
CO-County	BIA= Bureau of Indian Affairs
ST=State	UC= Unified Command
PVT=Private	AC= Area Command
NPS=National Park Service	N/A= Not Applicable

During March and April 2002, Academy field teams spent one week on site at each of the case study locations. The fire locations are shown on the map in the Figure 4-1. The field teams received excellent cooperation at all six locations. The land units assembled extensive documentation on each fire, including the final fire package, which the field teams reviewed. Using interview guides, the field teams interviewed officials of the local land unit, the IMTs, state and local governments, and private landowners affected by the fire to learn how the fires evolved, how they were managed, and how costs were monitored.

Figure 4-1: Location of Six Case-Study Fires



As a result of the fieldwork, the teams identified 30 major factors that influenced the costs of the case study fires.[1] These factors are listed in Box 4-2. Available records in the final fire packages did not provide sufficient detail to estimate precisely the portion of the total costs attributable to any specific factor. Instead, the Academy field teams developed qualitative estimates for these factors based on their review of available records and on-site interviews. The land units where the fires occurred also were given an opportunity to comment on the field teams' assessment. The charts in Figure 4-2 show the factors and their estimated impact on the total costs for each of the case study fires. Most notable is that the number and strength of factors increasing the fires' costs far outweigh the number and strength of cost decreasing factors.

[1] Detailed descriptions of these cost factors are included in Appendix J.

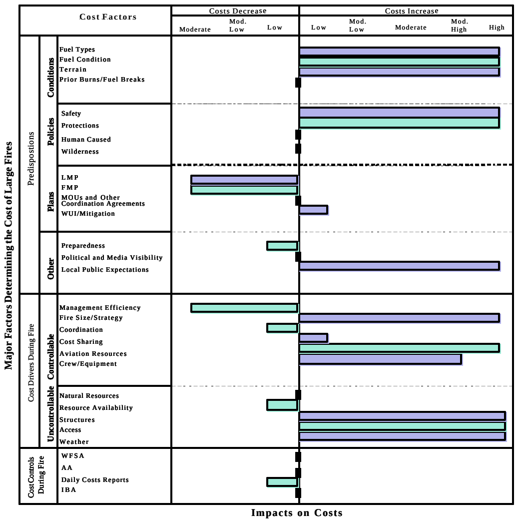
Box 4-1. Factors Influencing Costs of Case-Study Fires

Predispositions	Cost Drivers During Fire
• Conditions — Fuel Types — Fuel Condition — Terrain — Prior Burns/Fuel Breaks • Policies — Safety — Protections — Human Caused — Wilderness • Plans — LMP — FMP — MOUs and Other Coordination — Agreements — WUI Mitigation • Other — Preparedness — Political and Media Visibility — Local Public Expectations	• Controllable — Management Efficiency — Fire Size/Strategy — Coordination — Cost Sharing — Aviation Resources — Crew/Equipment • Uncontrollable — Natural Resources — Resource Availability — Structures — Access — Weather **Cost Controls During Fire** • Wildland Fire Situation Analysis • Agency Administrator Involvement • Daily Cost Reports • Incident Business Advisor

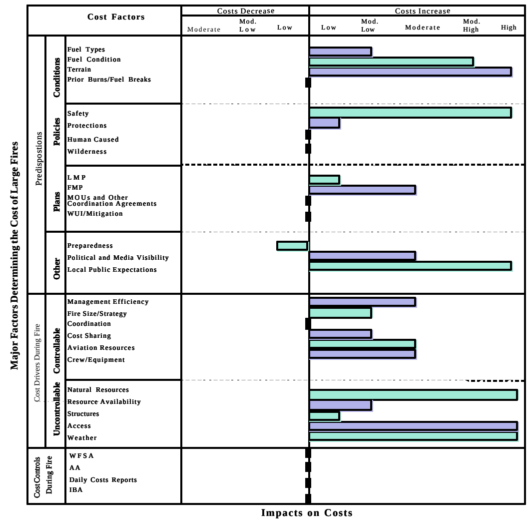
Figure 4-2: Cost Factors

DOI FIRES

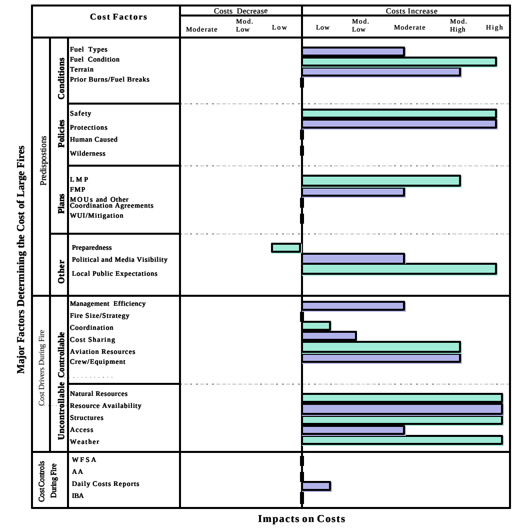
ARTHUR



SHEEP

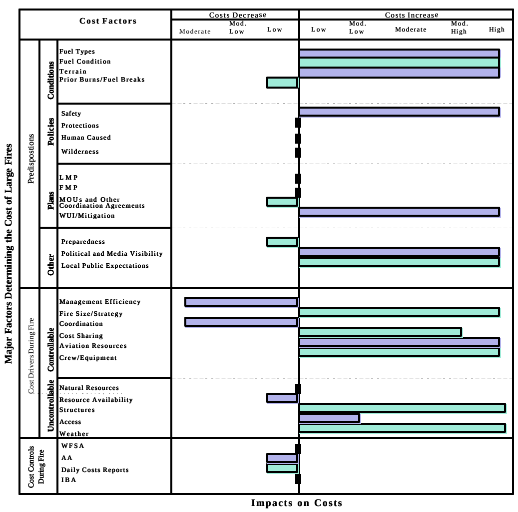


VIRGINIA LAKES

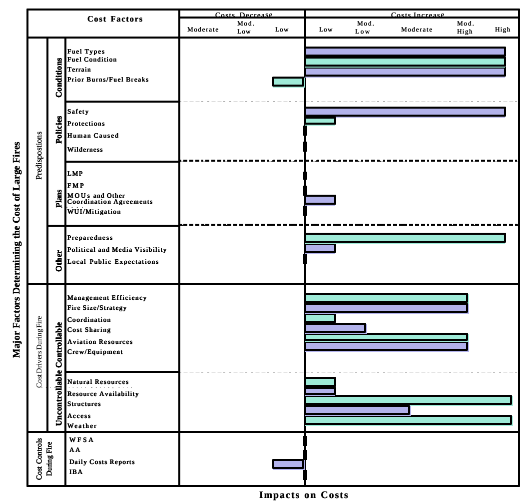


FS FIRES

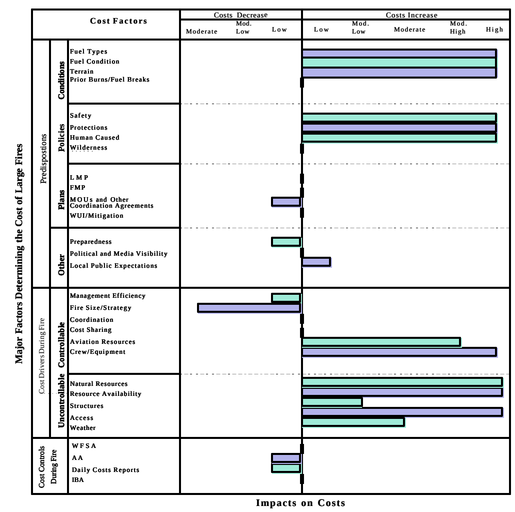
GREEN KNOLL



MOOSE



STAR



Case study reports, contained in Appendix F, provide a detailed description of the fires and how the cost factors impacted the overall cost of each fire. They assess whether agency policies were substantially followed in the decision making related to these incidents, and whether firefighting costs could have been reduced without reducing safety or firefighting effectiveness. They also identify lessons learned that can be used to improve the cost-effectiveness of firefighting in the future. Brief summaries of these cases are presented below in the order of the dates the fires started.

GREEN KNOLL FIRE—FOREST SERVICE

The Green Knoll Fire started on Sunday, July 22, 2001, when a campfire escaped just inside the Targhee National Forest in Wyoming. Because of its location and believing the fire was on the Bridger-Teton National Forest (BTF), BTF fire management personnel assumed responsibility for managing the suppression actions. The Green Knoll Fire was the first large fire of the 2001 season. It was declared controlled on August 8, 2001, 17 days after it started.

Green Knoll burned 4,470 acres of timber within the BTF and adjacent private lands. It also involved a community-interface and demonstrated how a maximum effort can be mounted to protect it. Although the fire burned into two subdivisions and threatened several others, causing the evacuation of 400 people, no structures were lost. The fire occurred early in the fire season when resources were abundantly available. Green Knoll firefighters were well organized and resources were also brought in from all over the nation. Ten of the nation's air tankers (about one-fourth of the national fleet[2]) were on the fire at one point. At the peak of the incident, 1,369 personnel were assigned. Initial cost estimates totaled $13.3 million. The Academy field team was advised in April 2002 that the cost had grown to over $17 million, which is more than $3,800 per acre. This made the Green Knoll Fire the most expensive per acre on Forest Service land in 2001.

The 3.4 million acre Bridger-Teton National Forest is one of the largest forests in the continental United States. More than 1.2 million acres of it are designated as wilderness. It borders the Grand Teton National Park on three sides, has mountain ranges that reach from 5,900 to over 13,000 feet, and is part of the Greater Yellowstone Ecosystem. Recreation (camping, mountain biking, fishing and hunting), wildlife habitat, beautiful vistas, and tourism are its primary attractions. Jackson is the largest city near the Forest.

Fire management for nearly 5 million acres in this area has become an interagency, multi-jurisdictional partnership. Because many public and private buildings are surrounded by or adjacent to large tracts of public land, firefighters from BTF, Grand Teton National Park, the National Elk Range, and the Jackson/Teton County Fire Departments ignore established boundaries to jointly manage wildland fires. Interagency and community-based firefighters train

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[2] In 2001, there were 41 air tankers under contract. There also were 8 Modular Airborne Fire Fighting Systems (MAFFS) units (owned by the National Guard and Air Force Reserve), which could only be activated by a governor with approval from the Forest Service's Office of Fire and Aviation Management after all commercial contract tankers were committed.

together each spring and early summer and work together to develop joint annual operating plans. An emergency operations/mutual-aid plan drafted jointly in early 2001 should be credited with improving the management of the Green Knoll Fire and preventing the suppression costs from being even higher. The Academy field team was told repeatedly that this partnership performed almost seamlessly during the incident.

Fast action by BTF management to call in a Type 1 IMT, the strategy and tactics utilized by both the Type 1 and Type 2 IMTs, and the heavy reliance on costly aircraft resources were factors that helped contain the fire. Had these actions not been taken in such a timely, efficient and effective manner, total costs most likely would have been much higher. Certainly, some of the values at risk—residences in the threatened subdivisions—would have been destroyed.

BTF's administrative operations plan lays out budget and finance requirements in advance for IMTs. The plan helped guide the business conduct during the fire and was credited with reducing costs, although savings were relatively small compared to the total cost of the fire. Both IMTs assigned to the fire used daily cost reports to determine when to release resources during the demobilization process. The team was sensitive to releasing more costly resources first whenever possible.

The most controversial issue from the Green Knoll Fire concerns the cost-share agreement. Generally, participants' shares of the costs are based on either the ownership of acres burned or the level of firefighting effort. An early version of the agreement set the Forest Service portion at 85 percent and the State of Wyoming at 15 percent of total costs. The final agreement split the costs between the Forest Service and the state at 88 and 12 percent, respectively, based on the ownership of total acres burned and using a total cost estimate of $13.3 million. In addition, the state paid one-half the daily aviation costs during an agreed upon five days. In total, the state paid $2.7 million, however, FEMA later reimbursed the state for its share of the costs.

While little of the Forest Service expenditures on the Green Knoll Fire was for "structural protection," a significant amount was spent to suppress the fire before it reached the structures in the path of the fire. The state paid for "structural protection," that is, the costs associated with direct preventive treatment (such as sprinkler systems, foam, gel, and wrapping buildings) for individual homeowners and for part of the aviation costs. The Forest Service paid for everything else.

This case study illustrates the following key points:

- The fire epitomized the actions that firefighters must take to protect people and property, and the cost of doing so. Wildland fire suppression costs will continue to rise as long as more homes are located in or near the forests.
- Once a fire escapes in this environment, few opportunities exist to significantly reduce suppression costs.
- The ability to obtain needed national resources can be critical to containing a fire in a timely fashion.
- Cooperative working relationships among federal, state and local agencies can contribute significantly to effective and efficient fire suppression operations. Especially significant

in this case were the joint emergency action plans developed in advance by local firefighters and the federal agencies, and the joint training exercises based on them.

- Complete, expeditious, and responsive communications and information to area residents had great value in maintaining public confidence and support.
- Releasing costly resources in a timely manner can be accomplished without endangering firefighter or public safety. This opportunity was facilitated by the well developed interagency firefighting capabilities available locally.
- Previously established written guidelines on administrative, budget, and finance practices provided useful guidance to local staff, as well as to IMTs.
- Agency personnel need better guidance for negotiating and preparing cost-share agreements.

ARTHUR FIRE—NATIONAL PARK SERVICE

The Arthur Fire was reported on July 29, 2001, in Yellowstone National Park about three miles west of the Park's east gate entrance in Wyoming. Lightning apparently started the fire on July 28 near the top of a ridge at 9,000 feet. This area was in an old-growth forest where there were heavy accumulations of dead and down woody fuels that were dry due to continued drought conditions. The winds were high, pushing the fire into the tree crowns where it spread rapidly. The area within the fire perimeter was steep, remote and rugged, requiring significant use of aerial resources until the fire was contained two weeks later on August 11. The fire burned 2,800 acres and cost an estimated $6.3 million to suppress, about $2,142 an acre.

Approximately 95 percent of Yellowstone is a proposed wilderness area and is managed as such to maintain its wilderness characteristics. The Park has a performance goal of allowing over 90 percent of its lightning-caused fires to burn naturally, with monitoring and appropriate readiness but no active suppression. Under less severe burning conditions, Park policies would have encouraged the use of less aggressive and costly suppression strategies on the Arthur Fire.

Land ownership around Yellowstone is primarily under the jurisdiction of the Forest Service and NPS. The Shoshone National Forest borders Yellowstone in the area of the Arthur Fire, and some of the threatened residences and businesses were located in that forest. Just outside Yellowstone's east gate are about 70 residences, several lodges and other businesses, and a power grid that the Arthur Fire threatened. One of the lodges, the Pahaska Lodge, has historic significance as Buffalo Bill Cody's personal hunting lodge.

The costs of the Arthur Fire were driven largely by conditions outside of management control. Factors such as weather, topography, the presence of structures, and the threat of the fire escaping Park boundaries predisposed the fire to be costly regardless of fire managers' efforts. In those areas where managers had more control—such as planning, preparedness, and the application of management tools—Park and IMT managers acted in ways that moderated costs. However, fuels treatment projects recommended in 1998, which included thinning and/or prescribed burning in the area affected by the Arthur Fire and nine other areas identified as high fire risks, were never authorized by the Park's superintendent and were not undertaken because of objections by Park resource managers.

The Arthur Fire occurred when fire activity was low in the Park and nationwide. The availability of resources helped firefighters contain the fire within the Park's boundaries and, therefore, avoid additional suppression costs.

The relationships between the Park and the Shoshone National Forest and Park County Volunteer Fire Department contributed to the efficient management of suppression operations. Senior Park management involvement was substantial and supportive, leading to thorough preparation for the Type 1 IMT's arrival. Moreover, the Park's FMO and assistant FMO are very experienced with large wildland fires; both are qualified for positions on the Type 1 IMT that was assigned to the Arthur Fire. The IMT IC also had worked at the Park. The previous working relationships between the Park staff and the IC, and their knowledge of each others' operational practices and the unique characteristics of the Park's terrain and fuel types made transitions from the Park to the IMT and back essentially seamless and less costly than would normally have been expected.

In addition to unique knowledge of Yellowstone and its fire management practices, the IMT brought considerable expertise with it to assist in decision making. The team included a fire behavior analyst, an incident meteorologist, computer specialist, and a GIS specialist. As a result, the team had a full range of decision-making tools and practitioners readily available to use as required. The team also included additional safety officers to help minimize the risks associated with steep terrain and grizzly bear habitat, and a fully staffed aviation function to manage the substantial aircraft operation.

Cost issues were not at the forefront of decision making by the IMT. Nevertheless, operational efficiency seemed to be part of the corporate culture and a point of pride. The WFSA process forced a daily reevaluation of likely costs, and was one vehicle that brought the IC, agency administrator, and Finance Section Chief together each day to consider costs in relation to strategy. The IC considered the WFSA important for this reason, and also because its stipulated objectives drove fire suppression strategy and thus costs. Costs also factored prominently (though not exclusively) into demobilization decisions and, all things being equal, attempts were made to demobilize the most expensive equipment, such as aircraft, first.

The use of an IBA on the Arthur Fire also enhanced the IMT's attention to costs and adherence to policies, procedures, and internal controls. Although the IBA reported directly to the Park's acting superintendent, the IBA believed that it was equally important to coordinate with the IC. His emphasis was on helping ensure that appropriate attention was given to good business management practices on the incident.

This case study illustrates the following key points:

- Regardless of its level of preparedness, a land unit may not be capable of containing a fire when it is small. Arthur Fire conditions prohibited an initial attack effort and predisposed it to be a costly fire from the outset.
- Obtaining national firefighting resources when needed can be critical to containing fires in a timely fashion.

- Land unit management's understanding of fire suppression requirements supported critical decisions—closing the road and air space—even though they adversely affected local businesses.
- Land units undertaking ambitious fire use programs must take aggressive suppression actions under certain conditions.
- Having the capability to assemble a Type 3 IMT on the land unit can avoid the additional expense of bringing in an outside team, thereby reducing suppression costs.
- Yellowstone fire management staff's extensive experience with large wildland fires, and its ability to concentrate on this fire without being called away to other fires greatly enhanced its ability to manage the fire.
- Different values and priorities between resource program managers and fire management staff can create obstacles to needed fuels treatments, in addition to those created by external parties.

SHEEP FIRE—BUREAU OF LAND MANAGEMENT

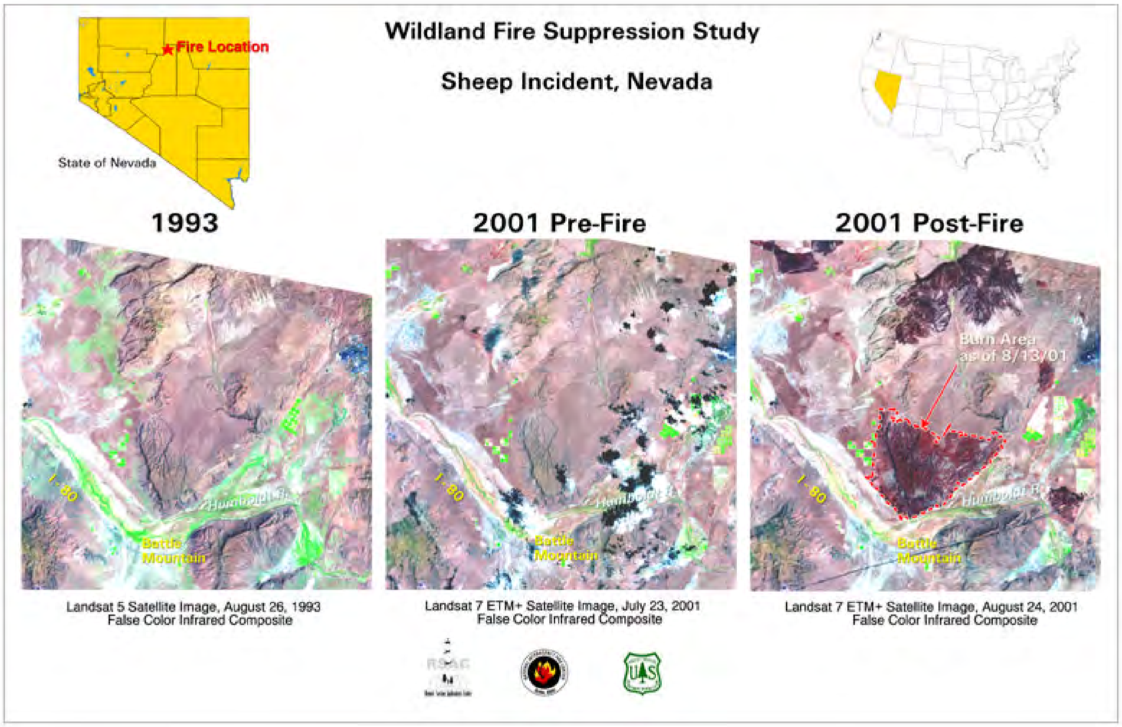
The Sheep Fire started August 9, 2001, 20 miles north of Battle Mountain, Nevada. The fire was declared controlled six days later on August 14. It burned 83,673 acres and cost approximately $2.2 million to suppress, about $26 an acre.

The Sheep Fire occurred within the boundaries of the lands managed by BLM's Elko, NV Field Office. Typical of much BLM land, the area affected by the fire is a checkerboard of ownerships, with approximately equal distribution between BLM and private lands. The land (both public and private) has been predominantly used for cattle and sheep grazing since the mid-1800s. However, ranching now accounts for only about three percent of the economy in this area, as outdoor recreation and mining uses are sharing land. Within this BLM district, there are 220 grazing allotments held by 180 permittees.

Based on the Elko Field Office's FMP, developed in 1998, the Sheep Fire occurred in a fire management zone designated for moderate suppression. However, the fire seasons since 1998 have been radically more severe than historic norms for the area in the number of fires and acres burned. In 21 years of fire history (1980 - 2001), 61 percent of the acreage burned occurred from 1999 to 2001. Fifteen of the 20 largest fires also occurred during this same time period. Of the 7.3 million acres managed by the Elko Field Office, 1.3 million acres had burned in the prior 3 years. Seventy-five of the 180 permittees had experienced partial or full closure of their allotments because of fire damage. As such, the fire management staff was following a much more aggressive suppression strategy than the FMP specified.

Four years of drought conditions in the northern Nevada desert created rapid burning conditions at the time of the Sheep Fire. The primary fuels in the fire-affected area included sagebrush and cheat grass. Fire in these fuel types spread rapidly, however, it is comparatively easy to construct fire line and perform mop-up activities there. The moisture content of the fuels in the area was very low at the time of the fire. High temperatures, gusty winds, and low humidity with little humidity recovery at night cause major fire runs in these fuel types. The graphic below shows the fire's location and pre- and post-fire images and the fire perimeter.

Figure 4-5: Sheep Incident, Nevada



During initial attack, there were problems with dispatch and follow-up orders caused by radio communication difficulties at the dispatch center. Orders for additional resources and support personnel did not get placed or filled during the first 12 to 16 hours of the fire.

This fire posed minimal risks to structures, with only a few isolated ranches and some industrial plants in the fire-affected area. The IMT proposed to backfire somewhere between 10,000 to 12,000 acres to contain the fire quickly. Nothing in the delegation of authority from the agency administrator would have prohibited this indirect strategy. However, the local ranchers were more concerned with the loss of grazing lands than they were with the potential loss of their homes and other structures. The Field Office also had concerns about the fire's potential negative affect on sage grouse habitat and cultural resources, such as the historic California Trail that prospectors followed during the Gold Rush. These concerns influenced the IMT to use direct attack instead. However, this strategy was not successful. The area eventually burned was essentially the same as it would have been had the backfire strategy been used, but the suppression and rehabilitation costs were higher.

About half of the acreage burned on the Sheep Fire was on private land in Lander County. The county had elected not to enter into an agreement with the State of Nevada for fire protection; therefore, it shared responsibility for suppression costs with BLM. BLM had an agreement with Lander County for initial action on fires, but the agreement had no mechanism for recovering costs from the county once the fire escaped initial attack. The Lander County Battle Mountain

VFD was used for a brief period (four hours) for structural protection, but provided no additional physical or financial support. BLM officials did not negotiate a cost-share agreement with the county because they did not believe that the county could pay for suppression costs. Therefore, the federal government paid the full cost of suppressing this fire.

This case study illustrates the following key points:

- The inability to obtain resources in a timely fashion can be a major factor in determining whether a fire can be contained during initial attack.
- A land unit's decision not to pursue a cost-share agreement with local cooperators can place a disproportionate burden on the federal government to pay for fire costs.
- Local landowners' ability to create pressures that significantly influence strategy and tactics—and, therefore, costs of a fire—illustrate the need for a cooperative approach to fire management planning and suppression operations.
- Due to more severe fire seasons in recent years, land management agencies, particularly those with multiple-purpose missions, are taking more aggressive suppression actions to minimize the size of wildland fires and their impact on the land.
- Concern for firefighter safety and the value placed on protecting natural resources can increase fire costs.

VIRGINIA LAKE COMPLEX—BUREAU OF INDIAN AFFAIRS

In the early morning hours of August 13, 2001, a storm system moved through the Pacific Northwest. By the time it passed through Oregon and Washington, lightning had ignited 140 fires. Eighteen fires were ignited on the Colville Indian Reservation, which is home to the Colville Confederated Tribes. Although BIA's Colville Indian Agency, which has a cooperative agreement with the Tribe for natural resource management of the reservation's land, was at 100 percent MEL, the high number of concurrent fire starts quickly drew resources down. Two of the fires—Virginia Lake and Goose Lake—escaped initial attack by the afternoon of the 13th and became the Virginia Lake Complex (the Complex). Over the next several days, four other fires would be added to the Complex. When it was over, the Virginia Lake Complex burned over 74,000 acres and nine houses were lost. Suppression costs were estimated at $25.2 million, about $339 an acre.

Maintaining good communications was a challenge throughout the incident because of the communications network dictated by the geographic scope of the fire. The area where the Virginia Lake Fire occurred contains many 'dead areas'—areas with steep canyon walls and minerals in the soil—where radios and cell phones cannot operate. In addition, the local cooperators and the national teams often used different radio frequencies and were unaware of the other's activities.

Managing the fire in a cost-efficient manner was a goal in the delegations of authority for the Complex. The IMTs, BIA Colville Indian Agency and tribal personnel reviewed costs daily. However, firefighter safety and protection of structures and tribal resources were the overriding considerations in strategy selection. There was more focus on risk and gains from various actions than on costs.

The primary local cooperator fighting the fire was Fire Protection District (FPD) 8, and its relationship with the national teams was problematic. The atmosphere on the fire was tense from the outset as the FPD 8 firefighters were desperately fighting to protect their homes and livelihoods. District personnel repeatedly reported to the fire without the proper equipment and were asked to leave. There were conflicts on the fire line between the teams, whose priority was to keep the fire away from structures, and some of the FPD firefighters who valued the land, which was their livelihood, above homes and objected to the teams driving the fire onto rangeland to protect homes. Many FPD 8 members refused to leave the fire lines long after they exceeded the work-rest guidelines. A number of district people were threatened with arrest if they did not leave a given area.

Approximately 200 structures, including the St. Mary's Mission which is considered a cultural treasure by the Tribe, were threatened during the course of the fire, and keeping the fire away from them was a primary driver for the suppression strategies selected. A large number of resources, including expensive air resources, were used to prevent the loss of additional structures, beyond the nine lost early in the fire, during the later IMT phase of the fire. Many of the engines, provided as a result of the Washington State mobilization, were large structural protection engines that are more expensive than wildland fire engines. As the wildland fire severity increased throughout the nation and the fire management community moved into national mobilization of resources, resources were drawn from great distances.

The number of resources assigned to the Complex was greater than any of the other case study fires. At its peak, the Complex was assigned 2,614 people (61 crews, including 550 Army soldiers), 15 helicopters, 131 engines, 25 bulldozers, and 44 water tenders. The Type 1 IMT could not keep pace with the record keeping for this vast amount of resources. As a result, the demobilization process was delayed, causing unneeded resources to be charged to the fire and preventing them from being reassigned to other fires.

The cost-share agreement between BIA, the Washington State Department of Natural Resource, and the Washington State Military Department was for the period August 13-31, 2001. The terms of the agreement required the Washington State Military Department to pay for all resources ordered through the Washington State Fire Resources Mobilization Plan during the period August 14-23, 2001. For the remaining resources, costs were shared on the basis of "Negotiated Percentage of Effort," based on daily activity, by jurisdiction. BIA's negotiated percentage was 95 percent, and Washington State DNR's was 5 percent.

This case study illustrates the following key points:

- Agency missions and land use goals have a large impact on firefighting objectives, as outlined in the delegation of authority, and on suppression strategies and costs.
- Difficult relationships between IMTs and local cooperators can divert the IMT's time and energy away from the primary task of suppressing the fire and cause them to underutilize local knowledge and experience.

- The business management functions of fire suppression activities must keep pace with the size and complexity of the fire to ensure timely mobilization and demobilization of resources.
- Agency personnel need better guidance for negotiating and preparing cost-share agreements.

MOOSE FIRE—FOREST SERVICE

On August 14, 2001, a lightning storm crossed the mountains of northwestern Montana and ignited more than two dozen fires on the Flathead National Forest and adjacent lands. One of these fires was the Moose Fire. The fire migrated into Glacier National Park, which adjoins the Flathead on its eastern boundary, about two weeks after it ignited. Over the seven week period, the fire consumed more than 71,000 acres, demanded the attention of local and national media, and cost about $20 million to suppress. It was the largest wildland fire on Forest Service lands in 2001, and it took the longest to contain and control. However, the Moose Fire was not the costliest fire. The cost per acre was only about $275, among the lowest of the 2001 Forest Service large fires.

The land affected by the Moose Fire included those managed by two federal agencies (Forest Service and NPS), a state forest managed by the Montana Department of Natural Resources and Conservation, and private lands. The fire occurred on lands with little community interface, although there were isolated structures that were defended by both federal firefighting forces and local county volunteer fire staff. Small communities, such as Home Ranch Bottoms and Apgar, and private in-holdings along the north shore of Lake McDonald were at times perceived as threatened by the fire, but no structures were lost.

For the first time in many years, the Flathead's fire preparedness was fully funded, staffed and equipped. At the time of the fire, however, many of these resources had been diverted to other fires either locally or regionally. Three days into the fire, Flathead's FMO was assigned to an IMT out of the state, somewhat disrupting local management continuity, even though other experienced staff outside of fire management filled in on his behalf. Over the seven-week duration of the Moose Fire, IMT continuity was tested as five IMTs transitioned in and out.

Until the fire entered the Park, the strategy was to minimize fire size while acknowledging public and firefighter safety first, protection of property second, and resource objectives third. The Park staff, however, wanted to allow the fire to burn naturally as much as possible because of its location in a remote area with minimum resources at risk. The Park had direct responsibility for structural protection of buildings on private land near Lake McDonald within the Park boundaries. Structural protection of these buildings increased fire costs by about $400,000, but use of minimal suppression tactics in the Park lowered suppression costs by an undetermined amount.

Flathead County's fire and emergency services provided structural fire protection on private lands on the west side of the North Fork of the Flathead River. However, the county refused to participate in delegations of authority to the various ICs or to participate in a formal unified command.[3] Instead, the county established and maintained a separate incident management plan, incident command post, and organizational structure; conducted a separate planning process; and managed a separate process for ordering resources and implementing tactics.

On several occasions, the second IC incorporated the county into his command structure, assigned the county responsibility for structure protection, and identified county resources as part of the tactical plan to protect private property. However, the third IC did not establish a similar relationship with the county. Moreover, his IMT opposed some of the actions planned or carried out by the county, believing that they were unnecessary and unsafe. Conversely, a county official believed that the Forest Service "demonstrated a total disregard for the public's safety and well being" by abandoning the North Fork Community and relocating the fire base camp from in front of the fire to behind the fire (from North Fork to Columbia Falls).

The lack of cooperation between the county and the Forest Service is not new. The county believes that, while it can work with a unified command, it cannot legally delegate its responsibilities to the Forest Service. The Forest believes, however, that a delegation of authority is necessary to provide overall management and accountability for public safety and private property protection.

The single most important factor that affected the fire's total cost was the escape of the fire from initial attack and the inability of the IMTs to contain the fire in its early stages. While the fire would have been difficult to suppress fully under the best of circumstances, there was some evidence that opportunities existed to improve the chances of containing the fire early in its development:

- Initial attack reinforcements from off-Forest were not ordered following the lightning storm of August 14. With multiple fires and serious drawdowns of regional and national resources for other fires, reinforcement orders and other steps, such as placing dozers or local fire engines on standby, might have improved resource availability for the Moose Fire.
- Expanded dispatch was not implemented. As a result, dispatching of ground and air resources, media and public inquiries, and ordering for the Moose and nearby fires became the responsibility of an already busy existing dispatch organization.
- There was a period of about two hours between the initial report of the Moose Fire and the time the first air tanker was diverted to it from a nearby fire. By then, the fire had grown to 20 acres and airdrops made thereafter were reported to be ineffective. Also, smoke and terrain were a safety hazard. Had air tankers been diverted to the Moose Fire sooner, there is a possibility that the fire could have been contained during initial attack.
- After the first few days, the fire spread so fast at times that none of the teams could keep up. Emphasis on suppressing another nearby fire occupied management's attention

[3] The county contends that a formal unified command was never established while the Forest Service believes that the delegations of authority constituted such a command.

during this critical period. After that, indirect attack and marginal containment was the best anyone could hope for.

- In the early stages, no one in charge seemed to be thinking a few days ahead and deploying forces where there might be an opportunity to slow or stop the fire's forward progress. Assigning a Type 1 IMT earlier in the incident could have improved the chances of keeping the fire small.

This case study illustrates the following key points:

- Opportunities to contain the fire during the initial attack and its early development may have been lost due to delays in air support and use of inexperienced personnel.
- Management continuity could have been improved had the IMTs been allowed to remain on the fire longer than the 14 days allowed under current policy.
- Difficult and complex interactions among the National Forest land unit, the state, IMTs, and Flathead County officials illustrate the challenges of making full use of local resources in fire suppression efforts and conducting the landscape-scale planning called for by national fire management policies and plans.
- Greater management experience and availability of air support during the early stage of this fire may have improved the chances to suppress it during initial attack.

STAR FIRE—FOREST SERVICE

On the morning of Saturday, August 25, 2001, a fixed-wing reconnaissance aircraft reported a wildland fire on the Eldorado National Forest, about an hour's drive west of Sacramento, California. Although it was never confirmed, the Star Fire was assumed to be human-caused. By the time it was brought under control 19 days later, this fire had consumed about 17,500 acres on two national forests—the Eldorado and the Tahoe. It cost about $28.2 million to suppress, making it the most costly wildland fire in 2001. However, its per-acre cost of $1,611 was mid-range.

On the day that the Star Fire ignited, extremely dry, heavy fuels, low relative humidity, warm temperatures, and steep slopes (greater than 80 percent) combined to establish conditions conducive to a large wildland fire. The fire never posed a threat to a community-interface area. However, several factors left the Forests with no option other than to aggressively suppress it:

- The Forest Service's policy requires that all human-caused fires be suppressed.
- During the first few days, the fire burned over 3,600 acres of private commercial timberlands within the Forest's boundary. According to the Eldorado's FMP, "suppressing fire aggressively is the highest priority on private lands and public lands adjoining private lands."
- The January 2001 Sierra Nevada Forest Plan Amendment—which amended the land and resource management plans of 10 National Forests including those of the Eldorado and Tahoe—limits the use of fire-use fires in these areas.

- Protecting highly valued natural resources at Tahoe, including the northern-most native population of Giant Sequoia trees, old-growth sugar pine trees, rust-resistant sugar pine populations, and threatened and endangered species' habitats became a primary concern.
- Local and media expectations were that the fire would be suppressed in the shortest time possible.

The lack of the right resource (a Type 1 helicopter) at the right time prevented a successful initial attack. A Type 1 helicopter to assist in the initial attack did not arrive until more than 10 hours after the Forest initially requested it, and 5 hours after the fire began making a significant run.

Concern for firefighter safety shaped suppression strategies and the eventual size and cost of the fire. Direct line construction along the fire's northeast perimeter was halted as a safety precaution after a falling tree injured a Hotshot crewmember. The method of suppression then shifted from primarily direct attack to indirect attack. For instance, a decision was made to locate the control line some distance away from the fire's active edge and to use a burnout to consume the fuel between the edge of the fire and the control line.

Once the fire overwhelmed initial and extended attack and became large, there were few, if any, opportunities to significantly reduce costs. Very steep and unsafe terrain often made the placement of ground crews at critical sites impossible, and the IMT relied on the extensive use of Type 1 helicopters to successfully stall the fire's advance on two occasions. Almost 25 percent of the fire's cost was for aircraft, primarily Type 1 helicopters.

The three WFSAs prepared for this fire seemed to have no influence on controlling costs. The first significantly underestimated the final fire size, the second significantly overestimated the final fire size, and the third, prepared two days before the fire was contained, was not needed. In addition, the strategy to suppress the fire was developed by the Type 1 IC independent of the applicable WFSA. The ineffectiveness of the WFSAs as decision-making tools could be traced, at least in part, to the inexperience of the agency staff tasked with preparing them.

This case study illustrates the following key points:

- No matter how well prepared a federal land unit may be, a few unwanted fires—such as Star—will escape initial and extended attack, especially where extremely hazardous fuels exist.
- Availability of key resources is critical to a successful initial attack.
- The WFSA, which is designed primarily to justify ordering an IMT and help select appropriate firefighting strategies, has limited value in setting meaningful cost goals or limits for fires as large as Star.
- Although a large fire may not threaten the human interface, it can be costly to suppress if other conditions, such as protection of natural resources, exist.
- Appropriate concerns for firefighter safety can increase fire suppression costs.
- Once a fire overwhelms initial and extended attack and becomes large, there are few opportunities to significantly reduce management costs.

THE 2002 FIRE SEASON—THE HAYMAN FIRE

The Hayman Fire ignited on June 8, 2002 on the Pike National Forest, about 40 miles south of Denver. It became the largest fire in Colorado history, burning over 137,000 acres. The fire burned 133 residences, one commercial building, and 466 outbuildings. In addition to numerous communities, it threatened significant infrastructure, including a major watershed for Denver, and recreation areas. On June 21, Academy staff visited the southern ICP of the Hayman Fire while suppression operations were still underway.[4] Academy staff attended briefings throughout the day and had discussions and interviews with several members of the Type 1 IMT managing the fire, including the IC.[5] This was the second Type 1 team assigned to the fire.

The Hayman Fire faced several of the same issues found on the six case study fires. Privately-owned property within the boundaries of National Forests in the Colorado Front Range are extensive. The IC indicated that this was probably the most complex fire he had ever fought, partly because of the extensive community interface. During the course of the fire, thousands of residents were evacuated. The large community interface presence limited the team's decision space for developing alternative strategies on this fire. At the time of the Academy's visit, firefighters had some defensible control lines, but houses were both inside and outside those lines. The IMT's discussions included the option of sacrificing houses to save houses. Another complicating factor in the development of suppression strategies was the large number of local cooperators. When the IMT arrived at the fire, there still was a lot of suppression activity that was not tied into the IMT. The IMT had to bring the other cooperators into its fire organization and planning.

There were some problems with GIS support during the IMT transition. The first IMT had three GIS specialists, but the second IMT had none. When the first IMT left, so too did all the GIS support. As a result, the incoming team was "hustling" to obtain the necessary GIS support during the first couple of days after it took over the fire. Even after its GIS support was operational, the second IMT did not have the same capability as the first team. Agency management became frustrated when it could not obtain from the second IMT the same type of information that the first team provided.

This is the third fire season that I-Suite has been available for use on large fire incidents. Both IMTs assigned to the Hayman Fire used I-Suite. Although the Finance Section officials that the Academy staff interviewed had some problems with the system during the fire, it was able to make the necessary corrections. People, rather than system, problems appeared to be of greater concern to the Finance Section at the time of the Academy staff's visit. A large number of VFD resources had not checked in with Finance to provide the proper documentation to get paid. In addition to creating future problems for the state, which pays the VFDs, Finance was not able to capture those costs.

[4] Due to the size of the fire, three IMTs were assigned to the fire at the same time, reporting to an Area Command.
[5] The IMT in command at the time of the Academy staff's visit was the same team that was assigned to the Arthur Fire.

Firefighters contained the fire on July 2, 2002. As of August 8, the fire has cost an estimated $39.1 million. BAER activities continue on fire-affected areas. This fire was considerably larger, more expensive, and more complex than any of the six 2001 case study fires studied by the Academy. Yet, it illustrated similar points regarding difficulties of controlling costs during a fire and providing smooth transitions between IMTs.

PRINCIPAL COST THEMES

From the case studies and other research, the Academy field teams identified 16 principal themes that are driving up the cost of wildland fire suppression. The themes were reviewed and refined by the Panel at its second meeting in May 2002 and are summarized below.

- **Fuels Build-Up.** The build-up of fuels, particularly in the western states, is the primary factor driving fire costs. Heavy fuel concentrations result in large fires that are more difficult to control, not only because of their size and intensity, but also due to the difficulty of building fire lines through large fuel accumulations. Heavy fuels also increase firefighter risk and limit strategic alternatives.

- **Community Interface.** Because of the significant rise in the number of areas where human habitation intermixes with forested areas, federal agencies are increasingly employing suppression strategies intended to avoid loss of homes and other structures on private lands, as well as infrastructure vital to interface communities, such as power lines and communication towers. Local public expectations typically are that these resources will be protected regardless of cost or whether the local community or individual landowners have exercised due diligence to implement wildland fire mitigation programs. The strategies, tactics and firefighting resources used to protect these resources from wildland fire are generally much more costly than those for protecting the federal land unit's natural resources.

- **Natural Resource Protection.** Public values and concerns coupled with increased scientific understanding of the functioning of natural ecosystems and their components have placed a high priority on the protection of natural resources. As a result, agency administrators and/or IMTs must identify, locate, and incorporate natural resource concerns—such as wilderness and roadless areas, sites where cultural heritages are to be preserved, and threatened and endangered species—into their suppression responses. Protecting these resources can significantly increase the cost of suppressing a wildland fire.

- **Cost Sharing.** In general, cost sharing between state/local governments and the federal government was inconsistent and generally favored state and local governments. Sometimes costs were shared and sometimes they were not, even though a significant amount of federal effort and resources had been expended to protect private lands and structures. Some local governments are not part of cost-sharing agreements because there is a perception that they are unable to pay for the services rendered.

- **Cost-Saving Incentives and Accountability.** There are few incentives for land units to achieve cost savings in wildland fire management or in land management practices in general. Although the WFSA provides managers with a tool for assessing a broad range of wildland fire suppression strategies to accomplish their goals, other factors, such as protecting the human interface, often mean that only aggressive, more costly strategies are analyzed without formal consideration of less costly alternatives. Moreover, while land unit and fire managers interviewed expressed an ethic of cost consciousness, it was unclear as to who was accountable for managing the costs of wildland fires.

- **Land and Fire Management Plans.** LMPs and FMPs for many land units have not been revised to allow for the use of wildland fire for natural resources purposes. However, in some cases, even land units with fire use options in their plans are taking more aggressive suppression action because of the fuels build-up, increased fire intensity, community interface, and natural resources at risk.

- **Pre-Attack Planning.** Using current technology, there is room to improve pre-attack planning by mapping infrastructures, pre-selecting incident facility locations, and planning to ensure reliable incident telecommunications.

- **Land Unit Preparedness.** Land unit preparedness, even at the highest levels, cannot prevent some fires from escaping initial attack. However, having a Type 3 team at the local land unit can (1) improve the overall success rate of catching fires during initial attack because there is an increased capacity to effectively manage fires; (2) expedite and increase the efficiency of IMT transitions; and (3) return the responsibility for managing a fire back to the local land unit more quickly.

- **Firefighting Resources.** When a land unit experiences multiple fires in a short time period, local forces may not be able to effectively initial attack all fires. Under these conditions, some fires may escape initial attack and become large. Similarly, during periods of heavy mobilization nationally, firefighting resources may be depleted to the point that initial attack is delayed on new fires and large fires are understaffed.

- **Risk Assessment and Management.** The increased emphasis on public and firefighter safety and protection of structures threatened by fire increased costs on most of the fires reviewed. The availability of sophisticated decision support tools and their use in assessing risks varied from fire to fire. In the interest of safety, some land unit and IMT officials said they took less aggressive and more costly approaches to suppression than they might have in prior years. The Academy supports the increased emphasis on safety, but policy makers need to acknowledge and accept that such emphasis, as well as aggressive strategies for structural protection, contribute to higher fire suppression costs overall.

- **IMT Transitions.** Transitions between IMTs should be well managed to help make the best use of IMTs and to shorten the time they are required on the fire. However, even smooth transitions between IMTs may not provide optimal continuity and efficient use of resources. Greater flexibility in applying the 14-day rule for IMT rotations could improve management continuity and avoid unnecessary and potentially disruptive transitions. In addition, improvements in WFSA, ICARS, and other management support systems may be needed to facilitate IMT transitions.

- **WFSA.** The WFSA—as the primary decision support tool used to evaluate alternative suppression strategies in terms of their goals and objectives, costs, and impacts on the land management base—is not producing the desired results and improvements are needed. Except for the Arthur Fire and the Moose Fire (once the latter entered National Park land), the WFSAs for the case study fires had only one strategy or the strategies were very similar and were generally for aggressive suppression. Selected alternatives sometimes missed the final size and cost of the fire by a factor of four to five. Moreover, improvements and resources on nonfederal lands are not given a monetary value in the current WFSA process.

- **National and Regional Contracts.** The current system used to establish national and regional contracts, as well as the rationale used to determine whether to use contractor-owned instead of government-owned goods and services, are episodic and could benefit from a systematic reevaluation. Options for using state contracts may be desirable in some cases. The reimbursement protocols for California crews—24/7 portal to portal[6]—is spreading to other states and is becoming a morale and equity issue with federal firefighters.

- **Business Management.** In many cases, IMTs' business management functions are performed manually, which limits their ability to analyze and use cost and resource data in the complex tasks associated with day-to-day management of the fire. Manual records impose burdens on the agencies that have to reenter data in various systems to record costs and reimbursements. Moreover, they limit opportunities across agencies to compile uniform cost data for oversight and accountability purposes. Timely adoption of a standard business software approach (across agencies) for use on large fires could substantially enhance agencies' abilities to monitor and control costs.

- **Performance and Productivity.** The on-site performance and productivity of wildland fire teams and crews in general is commendable. However, the performance and productivity of some crews on certain fires was identified as a concern. Currently, there is no consistent approach to assess the performance and productivity of contract or agency crews. Consistently developed and applied performance expectations and productivity measures are needed to effectively address unevenness of crew performance and productivity.

- **Workforce.** The availability of federal staff with fire expertise has dwindled as agency employee participation in fire-related programs has declined. As well as limiting the size of the pool for firefighting positions, shortages are now also occurring in fire support

[6] Nonfederal California firefighters are paid 24/7—from the time that they are dispatched until they return. This generates not just more hours, but also more overtime hours and pay (at time and a half rates).

functions such as timekeepers and status check-in recorders. The result, increasingly, is to have to draw these staff from national sources resulting in the additional costs and delays associated with obtaining out-of-area resources.

These cost themes will be addressed throughout the rest of this report.

CHAPTER 5
INCIDENT MANAGEMENT CHALLENGES

Large wildland fires are anomalies that occur in significant measure because weather (drought, wind, and lightning), fuel conditions, and topography work against suppression efforts. To varying degrees, one or more of these factors contributed to the escape and rapid growth of the six case study fires.

Drought conditions were the common thread in each fire—fuels were unusually dry due to three years of lower-than-normal rainfall, and little or no rain fell in the weeks preceding the fires. Moreover, at critical points in each fire, high winds caused the fires to spread rapidly and uncontrollably. On two fires, the Virginia Lake Complex and Moose Fire, widespread lightning was a major factor, starting over a dozen fires in each location during the first evening and more over the next several days. This overwhelmed initial attack resources and allowed multiple fires to escape.

Topography also was a critical factor. The widely dispersed Virginia Lake Complex involved remote areas with limited access. Likewise, the Arthur, Green Knoll, Moose, Sheep, and Star Fires occurred in remote locations and either started in or quickly spread to steep and rugged terrain, limiting opportunities for aggressive initial attack and complicating extended attack. In addition, the lay of the land coupled with the steep terrain and its drainages often coincided with the direction of the prevailing winds, which tended to concentrate and intensify wind effects and fire behavior. The Virginia Lake, Arthur, Moose, Star, and Green Knoll Fires all experienced periods of rapid-fire growth because of this phenomenon.

High fuel loads and the general absence of fire breaks—nearby roads, areas treated by thinning or prescribed burning, or natural breaks such as meadows—were the other conditions favorable to large fires that were present in each of the case study fires. In the four predominantly timber fires—Arthur, Green Knoll, Moose, and Star—successful suppression activities over past decades had allowed fuels to accumulate instead of burn off. The forests had abundant dead and down timbers. The heavy fuel loads, combined with dense undergrowth and a large volume of ladder fuels allowed the fires to reach the tree crowns, increase in intensity, and spread rapidly. The Arthur Fire occurred in old-growth forest that had not burned in over 200 years and a beetle infestation had killed many trees. On the Moose and Green Knoll Fires, timber had not been harvested, thinned, or burned in the fire-affected areas for at least the prior two decades. The Star Fire burned in an area where some thinning had occurred, but overall fuel loads were above historic levels.

On the Sheep Fire, the dominant fuels were cheat grass and sagebrush on open range lands. The fuels were abundant, light, and quick burning. Where the fire ignited, the cheat grass was several feet high. In combination with weather conditions, these fuels caused the fire to outrun efforts to contain it until it reached a road that served as a barrier. The Virginia Lake Complex started in grassland but the six fires that constituted the complex included 9 of the 13 fuel types, and firefighters faced fuel build-up problems similar to those on the other fires.

Just as natural conditions played a major role in determining whether and how the fires developed, they likewise were a significant factor in determining when the fires were ultimately contained. In all six case study fires, firefighters were able to make significant progress and begin holding ground only after weather conditions, terrain and/or fuel conditions became more favorable. On the Arthur Fire, for example, the winds died down, temperatures cooled, and the humidity increased. These conditions did not stop the fire, but they allowed firefighters to make headway in surrounding it, creating fire lines, and taking other actions to prevent its growth if conditions again became adverse.

While natural factors are an important and often dominant influence, many other factors influence wildland fire suppression actions and their costs—including agency policies and budgets, local land unit plans and fire management policies, and strategic and tactical decisionmaking by agency administrators and IMTs. The 16 cost themes from the case studies, presented in Chapter 4, illustrate the broad range encompassed by these factors. Chapter 6 discusses the cost themes related to fuels management and Chapter 7 discusses the cost themes related to community interface issues. This chapter takes the remaining cost themes and discusses them in terms of six major challenges for more effective and efficient incident management operations. Table 5-1 summarizes these challenges.

Table 5-1
Challenges to Incident Management Operations Derived from the Case Studies

1. **Planning for Influencing Fire Management Strategies and Costs**. Federal LMPs and FMPs offer opportunities to land units for flexible management of wildland fires by specifying fire management zones where minimum, moderate, or maximum suppression strategies can be used when conditions permit. Values to be protected, as identified in those plans, help determine appropriate fire suppression strategies. The plans also form the foundation for fuels treatment efforts and can provide the means for agencies to use wildland fire, whenever possible, to meet land management objectives.

2. **Incentives for Cost Effective Behavior.** Along with LMP goals, policies to minimize risk to firefighters and the public and protect structures and natural and cultural resources often drive the selection of more aggressive and costly suppression strategies. There are few incentives for adopting less costly strategies, and oversight and accountability mechanisms to measure cost containment performance are rarely used. There is already significant reliance on contractor crews and equipment, and this is likely to grow. The fire management program could benefit from a systematic reevaluation of contract cost-effectiveness and an examination of performance standards for all firefighting resources. Funding mechanisms for wildland fire suppression costs could include incentives for agency administrators to make costs a more prominent consideration in the planning and management of their fire suppression programs. Post-incident reviews offer an opportunity to assess how costs are managed on large wildland fires.

3. **Community Involvement and Cost Sharing.** Federal efforts to promote effective working relationships with state and local leaders and develop arrangements to share costs for protecting nonfederal structures and infrastructure offer potential to enhance community participation in mitigating wildland fire risks and more equitably distribute fire suppression costs among those who primarily benefit.

4. **Preparedness.** The availability of firefighting resources for initial/extended attack can often determine whether a fire will escape, and the greatest savings will occur when escape can be prevented. The availability of current pre-attack data on a land unit and reliable communications also can improve agency efforts to contain a fire during initial and extended attack.

5. **Incident Management Operations.** Once a fire escapes, the selection and implementation of suppression strategies help drive costs. Public safety and the proximity of residences head a long list of factors that impact strategy selection. On long-duration fires, fewer and smoother transitions between IMTs could improve the continuity of suppression operations. Enhanced data and decision tools to assist in selecting and costing out strategies and business management tools to assist in implementing them offer opportunities to improve wildland fire suppression activities and help contain costs.

6. **Resource Issues:** The aging of agencies' employees who participate in fire-related programs, and the agencies' de-emphasis of the importance of participation by younger employees foretells continued firefighter shortages in the future. Local community resources play an increasingly active role in wildland fire suppression actions, however, they do not always have the same level of training and experience with wildfires as federal firefighters. Agencies could benefit by exploring options to encourage greater employee participation in their firefighting programs and to improve capacity within local communities.

PLANNING IS CRITICAL FOR INFLUENCING FIRE SUPPRESSION STRATEGIES AND COSTS

The Academy field teams found that the land units' land and fire management plans significantly influenced how agencies fight wildland fires and address the excess fuel build-up that feeds large fires. LMPs and FMPs drive the menu of strategies that agency administrators and ICs select from to suppress a fire. The firefighting strategy selected is one of the major cost determinants they may be able to control. The LMP and FMP also are critical in designing strategies for fuels treatment programs and identifying areas suitable for such treatments. This section discusses how these plans affected fire suppression strategies on the six case study fires. The relationship of planning and fuel treatment efforts is discussed in Chapter 6.

Planning and Fire Suppression Strategies

Until the early 1970s, national policy required aggressive suppression to keep fires to the smallest possible size. As discussed in Chapter 2, the 1995 *Federal Wildland Fire Management Policy* (updated in 2001) changed that direction. The policy affirmed the valuable role fire plays in maintaining ecosystem health and reducing the risk of catastrophic fires, and required the land management agencies to assess whether fires should be allowed to burn for resource benefit purposes. It required all land units with burnable vegetation to develop FMPs that identify how fires should be managed in each area within the land unit. Each area within the land unit is referred to as a fire management unit (FMU) or fire management zone (FMZ). The FMPs are to be closely linked to the land unit's LMP. In part, because the five land management agencies have different missions, ranging from preservation to multiple use,[1] LMPs have a wide variety of goals, objectives, and desired future conditions of the land. Collectively, agency mission and land management goals and objectives significantly influence how land managers view fires' role on their land units.

The LMP also identifies resource values throughout the land unit. Values to be protected play a major role in determining wildland fire suppression strategies for each FMU/FMZ. The greater the need to contain a fire to minimize its impact on resource values, the more costly suppression efforts will be, all other things being equal. For example, on the Star Fire, suppression strategies were selected to keep the fire away from the area of the Forest that contained the northern-most native population of Giant Sequoia trees. On the Virginia Lake Complex, a primary objective that influenced suppression strategies was to minimize the fire's impact on the Tribe's timber and cultural resources.

On the other end of the spectrum, land use and fire management plans that encourage the use of little or no suppression action—as is often called for in congressionally-designated Wilderness areas or areas managed like a Wilderness area—allow nature to take its course with only monitoring and selective interventions to keep the fire within specified parameters. These fires tend to be relatively inexpensive, though sometimes large, and are intended to allow fire to play its natural role in the ecosystem. Agency administrators seek to keep the costs of these fires low, and positive environmental effects are expected.

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[1] See the Academy report *Managing Wildland Fire: Enhancing Capacity to Implement the Federal Interagency Policy*, December 2001, pp. 20-23 for more information on agency missions and their impact on fire management.

Not all FMPs reflect the current policy. Although all five agencies have communicated the need for updated FMPs, actual implementation by local land units is still incomplete. Without a current FMP in place, managers are precluded from taking advantage of the fire management options; they can only suppress wildland fires. Recently, the agencies developed an interagency template for all FMPs, which builds on a two-year project to integrate the Forest Service's and NPS' FMP guidelines. Updates are scheduled for most FMPs to reflect the template's format by 2004. This revision process offers an opportunity for land units to reassess the use of wildland fire on public lands.

At present, practically all federal LMPs and FMPs are for single land units. Although the 2001 policy calls for greater coordination and collaboration between the federal land management agencies and their state, local, tribal, and private neighbors, there is very little of this so called "landscape-scale" planning, which involves multiple adjacent landowners in jointly establishing resource and fire management goals throughout an area. Thus, a federal land unit's LMP and FMP, which help drive suppression strategy, do not consider the uses, values-at risk, and costs of suppressing wildland fires on adjoining federal, state, private and tribal lands. Four prior studies that Academy staff reviewed have recommended that the costs associated with protecting nonfederal lands from fires originating on federal land units be incorporated into the agencies' FMP.[2]

Case Study Fire Management Plans

In the six case study fires, the land units' FMPs covered the full spectrum—some approximated the 1970s policies of full suppression everywhere, while others were flexible, designating significant portions of their land area as open to minimum suppression strategies when conditions permitted. As Table 5-3 illustrates, most plans were fairly restrictive. Even where plans call for less than full suppression, they sometimes were difficult to implement. For example, on the Sheep Fire, the FMU where the fire occurred called for moderate suppression. However, more aggressive suppression actions were being used on all fires in this BLM district because of the increased fire intensity and severity in the years since the FMP was adopted.

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[2] National Association of State Foresters, *Cost Containment on Large Fires: Efficient Utilization of Wildland Fire Suppression Resources*, July 1, 2000; State and Private Forestry, USDA Forest Service, *Policy Implication of Large Fire Management: A Strategic Assessment of Factors Influencing Costs* A Report by the Strategic Overview of Large Fire Costs Team, January 21, 2000; Fire and Aviation Management, USDA Forest Service, *Fire Economics Assessment Report*, September 1 1995; Pacific Southwest Research Station, USDA Forest Service, *Analysis of USDA Forest Service Fire-Related Expenditures 1970-1995*, Research Paper PSW-RP-230, March 1997.

Table 5-3
Fire Management Plans' Key Provisions Affecting Strategies

Fire	Land Unit		Latest Revision		Key FMP Provisions
	Name	Size (millions/acres)	LMP	FMP	
Arthur	Yellowstone NP	2.2	1986	1992 updated annually	Most of the Park is managed as a Wilderness area. Wildland fires are not suppressed, but monitored when fire conditions permit. Principal exceptions include: border areas where fire may leave Park, where private residences/businesses are at risk, or developed Park areas, historic sites, and unique habitat.
Green Knoll	Bridger-Teton NF	3.4	1989	1995, updated annually	Provides for fire use in three Wilderness areas; in the remainder of the Forest, fires are managed using the full range of wildland and prescribed fire options to protect, enhance and restore resources and developments in and near the Forest.
Moose	Flathead NF	2.3	1985, amended periodically; major revision underway	1996; redrafted after fire in 2001	Provides for fire use in three Wilderness areas; the remainder of the Forest maintains aggressive fire suppression capability to support land management objectives and allows prescribed fire, both planned and unplanned, to achieve land management objectives. LMP revisions, underway, have as an objective to return the Forest to its natural fire cycle. This should ultimately translate into a more flexible FMP, if successful.
Sheep	BLM Elko Field Office	5.9	1986	1998; being redrafted as of 4/02	Provides for moderate suppression strategies on a large segment of rangeland, but the provision has not been followed because of extraordinarily high fire activity since the FMP was adopted. Aggressive suppression taken as a matter of practice.
Star	Eldorado NF	.79	1987, amended 2001	1999; being redrafted as of 3/02	Most wildland fires require a suppression action. Fire-use fire requires development of procedures not yet completed (as of 4/02).
Virginia Lake	Colville Indian Reservation	1.4	2001	2001	During fire season, aggressive suppression of all fires. Provisions for less aggressive actions off-season will not be implemented until the Tribe develops and approves governing criteria; less aggressive actions are permitted in two areas managed as Wilderness.

The Yellowstone National Park and Colville Indian Reservation LMPs and FMPs, which governed the Arthur Fire and Virginia Lake Complex respectively, illustrate the significant variations the Academy field teams found in the plans and the role of fire on those land units. The key reasons influencing the variations were the different missions and constituencies of the land units. These required that the respective agency administrators manage the lands for very different purposes.

About 95 percent of Yellowstone National Park is managed as a de facto Wilderness. Under its plans, lightning-caused fires are managed as other natural events—in the least invasive manner appropriate to the circumstances. They are allowed to burn naturally when conditions permit. The required conditions include favorable weather, the absence of nearby developed properties or Park boundaries where damage could occur, and availability of appropriate monitoring and standby resources to intervene if necessary. This practice began in 1972, when the Park designated two backcountry areas totaling 340,784 acres as natural fire zones. The success of the program led to its expansion to practically the entire Park. Even after the catastrophic 1988 fires, the policy remains embedded in the Park's fire management program. The Park has a performance goal to have over 90 percent of its naturally caused wildland fires burn naturally. [3]

In contrast to Yellowstone, BIA manages the Tribe's lands to enhance timber production and other natural resources that provide economic support for the Tribe. Wildland fire is viewed as disruptive and costly to tribal members and other residents on the Reservation. In order to protect its natural and cultural resources, residences, farms, and ranches, the Tribe's plans call for aggressive suppression of wildland fire on the vast majority of its land. The Tribe uses prescribed fires for land management purposes, and has done so for centuries. Prescribed fires are generally ignited during a brief period early in the year when fuel moisture levels are high and weather conditions are favorable to minimize chances for escape.

Different Approaches to Fire Management Affect Fire Strategies and Costs

Different approaches to fire management can impact suppression costs. Sometimes these different approaches occur on one fire; a fire can be managed using strategies from both ends of the spectrum—from aggressive suppression to fire-use strategies. This occurred on the Moose Fire.

The Moose Fire started on the Flathead National Forest and burned into Glacier National Park. In terms of habitat and resources, the adjacent National Forest and National Park lands were similar. Of greatest concern to both agencies were the potential impacts on wildlife—the area provided habitat to several threatened and endangered species—and the potential damage to private residences. Wildland-human interface issues were minimal. But based on their respective land and fire management plans, the Forest and the Park authorized different suppression strategies. On the Flathead National Forest, a full suppression strategy was used. The strategy was to fight the fire as aggressively as possible within safety constraints. On NPS' lands, the agency administrator had a full range of suppression strategies to consider, and the initial strategy was to use modified suppression tactics to minimize the impact of suppression actions within the Park. For the most part, there was no line construction, Park management had to approve the use of mechanized equipment, and aerial retardant was used only occasionally. Prior fires also provided a natural containment area for the fire, obviating the need for much in the way of constructed fire lines. The Park was able to adopt this strategy because the fire did

[3] Yellowstone's goal, as stated in 2001, was actually more ambitious than this—seeking to keep 91 percent of all wildfires natural, not just those meeting specified conditions. Some Park officials view this as impractical because many fires, as a matter of policy, must be suppressed. These include human-caused fires—which the Park always suppresses—and fires that occur near historic sites, unique environmental sites, developed areas, or others properties.

not immediately threaten residences in the Park and there had been some rain, which reduced burning conditions. The Park's use of modified suppression tactics had a positive effect on lowering the total cost of the Moose Fire.

INCENTIVES NEEDED FOR COST EFFECTIVE BEHAVIORS

The fire policy speaks to minimizing the cost of fire suppression, and on the case study fires, agency administrators in their Delegations of Authority made references to managing the fires in a cost efficient manner. Yet cost considerations were clearly secondary to other factors in the selection of suppression strategies, and incentives to contain costs were few. In addition, a number of other factors created disincentives to selecting less costly suppression strategies.

According to the 2002 NASF survey, 22 percent of the respondents said that the lack of incentives and accountability to reduce costs is one of the two most significant factors contributing to escalating large fire suppression costs. Fifty-one percent said that the lack of incentives and accountability, the "open checkbook attitude," and expensive tactics used is one of the two most significant barriers to reducing large wildland fire suppression costs. Twenty-three percent indicated that if they were in charge, the first step they would take to control suppression costs would be to monitor costs, scrutinize the use of high-cost resources, and hold people accountable for seeking to achieve these goals.

Factors That Can Work Against Cost Containment Efforts

Firefighter and public safety were major concerns on all six case study fires. For example, initial attacks were delayed (Sheep Fire) or not attempted (Arthur Fire) due to safety concerns. On the Star Fire, the eventual size and cost of the fire grew when direct line construction along the fire's northeast perimeter was halted as a safety precaution after a falling tree injured a Hotshot crewmember. In addition, some land unit and IMT officials said that, in the interest of safety, they took less aggressive and more costly approaches to suppression than they might have in prior years. Although not evident on the six cases, anecdotal information suggests that the increased emphasis on safety also may encourage over-ordering of resources to help ensure safe conditions, particularly when information about present and potential conditions is sketchy or communication devices are unreliable or otherwise compromised. Although warranted, safety concerns in recent years are contributing to higher fire suppression costs overall.

Adopting a strategy to use a wildland fire for resource purposes, and thereby reduce the cost of suppression actions, poses a different type of risk to land managers. One agency official indicated that if a fire-use fire exceeds its boundaries or worse, burns homes, it is usually a career-ending event. Despite all efforts to mitigate risks, a freak wind or weather event could cause the fire to escape and put the agency administrator's career at risk. Except for the land manager's conviction that fire needs to re-establish its rightful place in the ecosystem, there is no incentive for firefighters to select a fire-use strategy.

Public expectations also influence the selection of suppression strategies. Communities in the vicinity of large wildland fires typically expect firefighters to keep fires as small as possible.

They have little or no exposure to the cost of wildland fire suppression. For the most part, federal and state agencies pay these costs, making them largely irrelevant to affected communities. They fear for public safety and the potential damage to property, livelihoods and natural resources that surround them, and dislike the aesthetics of fire-scarred landscapes where lush forests once stood. Allowing a fire to burn naturally or using backfire options in an area, strategies that trade off more acres burned for lower suppression costs and/or environmental benefits, often are loudly objected to by the public. Even when a land unit's plans support such strategies, public outcry can be a strong disincentive to selecting such alternatives.

The Sheep Fire provides a good illustration of how community expectations can challenge fire managers' attempts to reduce suppression costs. The IMT on this fire was very familiar with wildland fires in the Elko area and recognized that attempts to use dozer lines to contain this fast-moving range fire were probably futile. The team considered using indirect attack, using backfires from identified barriers to contain the fire. But local ranchers objected to such a strategy. Due to fires in the previous couple of years, 75 of the 180 permittees had experienced part or all of their allotments being closed because of fire damage. To reduce tensions with the local residents, the IMT elected not to backfire 10,000-12,000 acres. But, the end result was the same—the acres ultimately burned when the control lines did not hold—and suppression and rehabilitation costs were higher. However, those responsible for suppressing the fire were not viewed as part of the problem because they did not intentionally burn additional acres.[4]

Funding mechanisms for wildland fire suppression provide few incentives for cost consciousness. As noted in Chapter 3, when suppression costs exceed the land management agencies' annual appropriations, Congress provides additional funds to pay those costs. Federal land managers and firefighters have "an open checkbook" when it comes to making strategy decisions that affect costs.

The Academy field teams found no centralized source of cost data across the land management agencies, no centralized data on the actual use of resources on the case study fires, or any way of measuring the performance or output of resources used. The current status of information is such that very little can be discerned about a fire after the fact without reviewing voluminous paper source documents and interviewing participants on a fire, and that does not allow for much meaningful oversight. Nor does it allow meaningful review of efficiency and effectiveness. While the Academy field teams observed an ethic of cost consciousness among the land managers and IMTs, ensuring cost efficiency requires some method for establishing cost expectations, collecting and analyzing the necessary data, and measuring outcomes against those expectations.

Current Incentives to Contain Costs

Current incentives strongly push agency administrators and IMTs to select more costly suppression strategies, while few incentives support reducing the cost of wildland fire suppression. Discussions on suppression costs are part of the closeout sessions between the land units and the IMT, and the cost effectiveness of suppression operations is part of the rating that an agency administrator prepares for the IMT. However, the ratings the Academy field teams

[4] See Appendix F for more information on the Sheep Fire.

obtained appeared to be superficial and offered little advice regarding areas for potential improvement. Ratings for crew performance were similar. Even when there were substantial complaints about specific crews' performance, which contributed to increased suppression costs on the Moose Fire, the ratings did not reflect any problems. In part, this results from the lack of performance standards for firefighting resources.

Post-fire cost reviews performed by the land management agencies provide an indirect incentive for containing costs. The Forest Service authorizes national cost reviews of selected large fires that meet the following criteria: (1) incident costs were projected to exceed $5 million; (2) a Type 1 IMT was assigned; (3) control objectives and predicted times to achieve control exceeded 5 days; and (4) there were significant natural resource concerns. Reviews of smaller Forest Service fires may be conducted at lower levels of the organization. NPS requires that fires be reviewed to determine firefighting strategy cost effectiveness. BLM mandates a state level review of fires costing $250,000 or more, and a national level review of fires exceeding $500,000.

The Academy field teams found that Forest Service performed cost reviews for two of its six case studies, and became aware of at least three reviews prepared for other fires in 2001. However, there is no systematic review of large wildland fire costs across the land management agencies, the results of these reviews are not widely shared, and recommendations are generally directed at an individual land unit rather than a larger audience. A more systematic use of these reviews is hampered by the lack of mechanisms to do it.

COST SHARING

The case studies revealed a range of cost sharing techniques used by the land management agencies to determine the appropriate amounts of suppression costs to be borne by federal and state entities. Two of the Forest Service fires—Moose and Green Knoll (no state lands were burned by the Star Fire; thus, cost sharing was not an issue)—illustrated differing approaches to cost sharing. Two of the Department of the Interior fires—Sheep and Virginia Lake (the Arthur Fire was on federal lands only)—also used different techniques.

The Moose Fire cost share agreement evolved from a previous understanding between Montana and the Forest Service covering federal lands and almost all of the counties in the state (unfortunately, Flathead County had refused to be included). The agreement was based on percentage of acres burned. This facilitated the final cost share agreement negotiated by state and Forest Service "cost-agreement" experts. This did not preclude a problem with determining shared costs. Tracking and apportioning resources and the cost of these resources became extremely difficult, in part because some resources were shifted from the Werner Peak Fire without adequate documentation, the length of the fire, and the jurisdictions involved. Also, because ICARS provides estimates, not actual costs, there were difficulties determining the appropriate amounts. The final total remained undetermined at the time of the Academy field team site visit.

The Green Knoll Fire cost share agreement was negotiated while the fire was still being fought. Several individuals, including an outside cost-share team and budget and finance personnel from the Bridger-Teton Forest and from the region, were involved. The negotiated agreement supposedly split costs based on total acres burned plus aviation costs for a specified time period. However, because of the difficulty in timely determining actual costs, it was finally agreed that the state would pay $2.7 million and the Forest Service paid the balance. The cost share agreement, therefore, was based more on estimates than on actual costs. It should be noted that FEMA reimbursed the state for the full amount because other fire losses in Wyoming had previously surpassed FEMA's minimum reimbursement requirements. The federal government, in short, paid the full cost of the Green Knoll Fire.

The federal government paid all the costs for the Sheep Fire even though some costs were incurred for structural protection on nonfederal land. Normally, the county where the fire occurred would be responsible for reimbursing the federal government for those costs.[5] The BLM Field Office did not attempt to obtain reimbursement, however, because it did not believe that the county could pay.

The cost share agreement for the Virginia Lake Complex required the state to pay for all resources ordered through the Washington State Fire Resources Mobilization Plan. The federal government paid 95 percent and the state 5 percent of the remaining costs. For a fire that assigned significant resources to protect private structures, the cost percentages appear heavily weighted toward federal payment. At the time of the Academy field team's site visit, BIA had not submitted a statement to the state for any reimbursement.

PREPAREDNESS

Preparedness for initial attack plays a significant role in determining whether or not a fire will escape. This is an important cost factor because the greatest savings occur when escapes can be prevented. According to the NASF survey, almost 26 percent of the respondents said that presuppression activities were among the top three activities that should be emphasized to reduce the costs of suppressing large wildland fires. Twenty-seven percent indicated that if they were in charge, the first step they would take to control suppression costs would be to mount an aggressive initial attack and use research and development innovations to keep fires small. However, land unit preparedness, even at the highest levels, cannot prevent some fires from becoming large wildland fires. The six case studies reflect this fact.

Except for the Eldorado National Forest (Star Fire), the land units where the case study fires occurred were at 100 percent preparedness at the time of the fires. And although the Eldorado was not at its full preparedness level (of the 206 fire positions needed and authorized, 60 were vacant on the day the Star Fire ignited), Forest officials said that adequate initial attack forces and local emergency equipment were available. The Colville Indian Agency and the Elko Field Office (where the Virginia Lake Complex and the Sheep Fire occurred) also had access to other initial attack resources in addition to their own. The Colville Indian Agency had access to

[5] As indicated in Chapter 4, Lander County, where the Sheep Fire occurred, had not entered into an agreement with the state for fire protection and was, therefore responsible for sharing the fire suppression costs with BLM.

prepositioned resources, which are additional forces moved into an area in anticipation of high fire activity. Extra crews were on standby at a nearby Forest Service base, and a crew from another fire was held because additional fire activity was anticipated in the area. In addition, BLM stationed a single engine aircraft nearby. The Elko Field Office had access to resources provided by "severity funding," which are funds used to increase initial attack resources in anticipation of worse-than-expected fire conditions. Yet, despite the land units' high preparedness levels, all six case study fires became large.

On three of the case study fires—the Virginia Lake Complex and the Moose and Sheep Fires—the extraordinarily high level of local fire activity caused by a series of lightening storms stretched resources to the limits of their high level of preparedness. Moreover, when out-of-area fire activity is high, local resources can be drawn down to assist on other fires. On the Moose Fire, many of the Forest's resources had been diverted to other fires, either locally or regionally. Also, three days into the Moose Fire, the Forest's FMO was dispatched with his Type 1 team to an out-of-state assignment.

On the Moose, Star, and Virginia Lake Complex fires, the initial attack personnel believed that they could have caught their fires if they had received timely aircraft support (the teams sought air tankers or large helicopters to help retard the fires' growth until firefighters could surround the fires). These aircraft, had they been available, may have had the desired effect. But particularly as the fire season progresses and national mobilization is underway, it is not reasonable to expect that the necessary resources will always be available under any practical set of budget constraints.

The Arthur Fire illustrates the potential for enhancing overall land unit preparedness without necessarily increasing preparedness funding. The Park was able to form a local Type 3 IMT for the fire. This required that the Park have appropriate levels of fire-qualified staff and the senior management commitment to support a local team and encourage employee participation in the program. Having this level of firefighting expertise on site can enhance a land unit's chances of preventing a fire from escaping. For this same reason, the Colville Indian Agency wants to develop a local Type 3 team.

Nevertheless, the Arthur Type 3 team was not able to prevent the fire from becoming large. Because of the weather conditions, steep terrain and heavy fuels, the fire management staff opted not to mount an initial attack for safety reasons, but instead ordered a Type 1 team immediately. The internal Type 3 team capability, however, enabled the Park to efficiently prepare for the Type 1 IMT's arrival by setting up structural protection, communications, and other necessary infrastructure, and ordering resources in consultation with the IC. The Type 3 team also was able to assume command of the incident from the Type 1 team earlier than usual when the fire was contained. Without this internal capability, a new external team would have been required. The availability of the internal team also avoided the learning curve, mobilization costs, and transition difficulties that are often associated with an outside team.

Maintaining a local Type 3 team offers opportunities for land units to more effectively manage wildland fires. However, unless non-fire employees or local fire departments and cooperators staff the team, it produces a "ghost effect." Similar to what happened on the Moose Fire, team members who are fire management employees—and have fire-related jobs that may put them on Type 1 or 2 teams—may not be available when the local Type 3 team is activated.

The Academy's field teams also identified other issues that, if addressed, could improve the land management agencies' ability to prepare for fighting wildland fires and containing fires during initial/extended attack.

- On the Virginia Lake Complex and Sheep Fire, the roads, structures, and potential hazards (mining areas) were not reliably mapped at the time the fires started. This slowed suppression operations. With a commitment of staff time and funding, these deficiencies in the land units' databases can be corrected.

- Incompatible radios and radio frequencies between local cooperators and the IMTs posed significant problems to suppression operations on the Virginia Lake Complex. The teams and local firefighters were not able to communicate with one another as needed, which contributed to strained relationships. The area where the Complex occurred also had several dead zones where radio communications were unreliable. Providing modern, compatible communications equipment to all firefighters on an incident and obtaining and positioning repeaters or other means to ensure communication coverage throughout the fire area is a safety imperative and an essential incident management requirement.

- Inadequate pre-attack planning prior to the Star Fire caused a problem with the placement of the incident base. At the time of the Star Fire, the Eldorado National Forest had not completed a plan for the quantity, location, and infrastructure needs of incident base locations to support large fires. Large fires occur so infrequently (typically once every 7 to 14 years) that Forest officials did not believe such a plan was warranted. As a result, the base had to be moved because of safety and archaeological concerns. Having high quality GIS data about conditions on the ground routinely available for multiple purposes would make this essential pre-attack planning more appropriate and cost-effective.

- The models used to allocate resources to federal land units for preparedness do not consider the costs of protecting nonfederal lands or the firefighting personnel and equipment that are available in adjacent state and local jurisdictions to help with such efforts. The four studies cited elsewhere in this report also recommended that the costs associated with protecting nonfederal lands from fires originating on federal land units be incorporated into the agencies' computer planning models in order to guarantee adequate resources for initial and extended attack and large-fire efficiencies. Three prior studies also recommended that the agencies' budget models be enhanced to consider the firefighting personnel and equipment that are available in adjacent state and local jurisdictions.[6] Finally, another study recommended that the agencies' analytical tools be

[6] *Developing an Interagency, Landscape-scale Fire Planning Analysis and Budget Tool,* Report to the National Fire Plan Coordinators: USDA Forest Service and U.S. Department of the Interior, November 30, 2001; Fire and Aviation Management, USDA Forest Service, *Fire Economics Assessment Report*, September 1 1995; Pacific Southwest Research Station, USDA Forest Service, *Analysis of USDA Forest Service Fire-Related Expenditures 1970-1995*, Research Paper PSW-RP-230, March 1997.

enhanced to consider non-economic factors, such as political, social, and media expectations, in order to be able to accurately guide large-fire management decisions.[7]

INCIDENT MANAGEMENT OPERATIONS

On the six case study fires, the Academy field teams found that uncontrollable factors (weather, fuel conditions, terrain, community interface) were the most significant factors affecting suppression costs. Once a fire escapes initial/extended attack, opportunities to contain costs become more limited. Nevertheless over 35 percent of respondents to the NASF survey said that suppression activities can play important roles in reducing suppression costs. This section discusses the aspects of incident management operations that have such potential.

The Wildland Fire Situation Analysis

The selection and implementation of suppression strategies is a critical factor influencing costs. As discussed in Chapter 3, the WFSA is an automated decision tool that helps agency administrators develop and assess alternative suppression strategies and select a cost-effective one. If done well, the WFSA provides the agency administrator with the information needed to understand the value, priorities, and tradeoffs associated with each strategy. It also is the only tool currently available to land and fire managers that attempts to determine the costs of suppression actions.

The WFSA process for the case study fires appeared to be useful primarily to communicate objectives, provide rough cost estimates, and establish the relative values of the various alternatives. These are important outcomes, but they are largely distinct and separable from the complicated methodology that the process uses to weight values, calculate outcome probabilities, and compute relative cost-plus-losses estimates for comparing two or more potential suppression strategies.

The Academy field teams found a number of problems associated with this important decisionmaking tool. The land management agencies need to address these issues if the WFSA is to be effective in helping contain wildland fire suppression costs.

Estimating Values-at-Risk

The WFSA has a section, Impact on Resource Values, which attempts to quantify the fire's potential damage to the land unit's resources for each alternative suppression strategy. These costs are factored into the total estimated cost for each strategy. The Forest Service, BLM, and BIA use NFMAS values to estimate these costs. The WFSA software also allows NPS and the Fish & Wildlife Service to input the monetary impact of fire effects from their FIREPRO and FIREBASE models or from other sources.

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[7] Fire and Aviation Management, USDA Forest Service, *Course to the Future: Positioning Fire and Aviation Management*, May 1995.

In some cases, however, it is not possible to calculate some values, such as the St. Mary's Mission on the Virginia Lake Complex or the Giant Sequoias on the Star Fire. These values to be protected are largely a matter of judgment, and the land and fire management plans are where those judgments should be reflected.

Significant federal firefighting resources also can be used to protect private property, structures, and infrastructure. The value of these resources to be protected is not valued monetarily, but intrinsically, in the current WFSA process. These resources are considered worth whatever monetary costs agencies incur to protect them, and the areas where they are located are aggressively protected from wildland fire as a matter of policy or accepted public expectation. In the current fire environment, this has a major impact on suppression costs. On three of the case study fires (Green Knoll, Virginia Lake and Arthur) wildland-human interface issues were a primary driver that influenced suppression strategies and their associated costs. On the other three fires, wildland-human interface issues played a more limited role in influencing strategy selection. The major constraint on costs in the case study fires appeared to be the availability of resources and/or the perceived upper limit of resource levels that managers felt capable of effectively directing.

The WFSA could accommodate the inclusion of these urban-type values-at-risk in its assessment, and methodologies are available that could be tailored to estimate potential losses from wildland fires to theses resources. HAZUS® is one. It is a software program originally developed by the National Institute of Building Sciences under agreements with FEMA to estimate potential losses from earthquakes in the U.S, and modifications are under development to enable estimation of losses from floods and hurricanes. HAZUS® is conceived to eventually become an all-hazards tool, including wildfire.

As part of this study, the Academy asked the Institute to illustrate how HAZUS® could be used to estimate populations and the values of buildings and lifeline infrastructures for four large and six small communities in the Academy's case study states of California, Montana, Nevada, Washington and Wyoming. Although the data are rough and the current model is not tailored to wildfire needs, this effort was intended to show how such a mechanism could be developed to generate potential loss information of value to fire suppression efforts. This type of modeling capability offers land management agencies an opportunity to better estimate the values-at-risk from wildland fires.

Complexity and Timing

The WFSA process is complex, and completing a WFSA takes staff from multiple disciplines several hours working under stressful conditions, usually late into the evening. The process often does not work well because during the critical time when a fire is escaping, many of the people with the knowledge to prepare the WFSA are working on other tasks necessary to suppress the fire. Because of the number of fires on the Colville Indian Reservation, the loss of houses, and two firefighter burnovers during initial/extended attack, BIA staff did not have time to complete a WFSA prior to the IMT's arrival. The IMT prepared it in consultation with BIA staff. Often, land units do not have staff experienced in WFSA preparation, including someone with tactical fire knowledge. And many land units do not have enough exposure to large wildland fires to be familiar with WFSA procedures. Formal training on completing the WFSA is limited, and even when available, the knowledge gained in the classroom is often forgotten by the time it is needed.

Ability to Estimate Costs

Most of the estimated costs for alternative suppression strategies in the case-study WFSAs were seriously inaccurate, and the cost estimation process did not appear to provide any meaningful cost ceiling for suppression operations. On the Green Knoll Fire, the estimated cost of the target outcome for the selected strategy was slightly over $2 million. The WFSA was amended twice and the final cost estimate was $13.3 million, which still underestimated the final cost, which, as of April 2002 was over $17 million. On the Moose Fire, the highest cost estimate for the worst-case scenario was $9 million versus a final fire cost of over $20 million. On the case study fires, the IMTs and agency administrators reviewed costs daily, and compared the cost estimates in the WFSA with the estimated accrued costs provided by the IMTs' Finance Sections. The Academy field teams found no evidence that suppression strategies were reconsidered when it was apparent that costs would exceed WFSA estimates. When fire costs approached the cost estimates, local managers simply prepared new WFSAs to reflect higher cost estimates. The revisions appeared to be viewed more as an administrative requirement than a significant strategy re-evaluation.

Developing Alternatives

The WFSA is supposed to give agency administrators the opportunity to develop and consider meaningful alternatives for suppressing a fire. However, except for the Arthur Fire and the Moose Fire (once the latter entered National Park land), the WFSAs for the case study fires had only one strategy or the strategies were very similar and were generally for aggressive suppression. The LMPs and fire management policies of the National Park lands where the case study fires occurred allowed those agency administrators to consider letting the fires burn for resource purposes. The other agencies' LMPs and fire management policies (such as the Forest Service's requirement to suppress all human-caused fires) did not permit less aggressive suppression options. In other instances, the fire dictated only one logical strategy. For example, on the Green Knoll Fire, the fire's location, which threatened a large number of structures, dictated an aggressive suppression effort. In those instances, the WFSA process becomes less of a decisionmaking tool and more of a communication and documentation tool.

For the WFSA on the Arthur Fire, the Yellowstone fire management staff followed NPS' national policy and prepared a full range of suppression options—full suppression, protection of high-value areas, and modified suppression (using fewer resources and natural boundaries to keep minimize suppression costs)—even though the staff recognized that full suppression was the only logical alternative on this fire. However, it is important to note that because of safety reasons, the Yellowstone staff did not mount an initial attack on the Arthur and, instead, used the time to prepare for the IMT's arrival, including preparing the WFSA. The luxury of time to fully prepare for an IMT is not common on most large fires, particularly as the fire season progresses. The short timeframe and late night hours that most land units face when preparing the WFSA are not conducive to developing a full range of options, particularly if only one seems logical given the fire situation. The result, however, is that agency administrators are not always provided with complete information on the options and their expected costs.

Other Issues

The Forest Service's January 2000 report, *Policy Implications of Large Fire Management: A Strategic Assessment of Factors Influencing Costs*, identified several other problems with the WFSA. It noted that:

- Few people use its full potential to display tradeoffs between costs and risks.
- The WFSA process is not well integrated with LMP and FMP planning processes on which it depends.
- Without doing pre-work before a fire ignites, the WFSA process cannot be adequately done prior to an IMT's arrival.
- Many users do not understand what the WFSA is actually doing, and expertise in the WFSA process is inconsistent across land units.
- The current WFSA process is too limited as a risk analysis and risk assessment tool; it does not integrate other uncertainty assessment techniques and fire behavior analysis tools, such as the Rare Event Risk Assessment Process and Fire Area Simulator. This would require better integration of the WFSA with information resources, such as GIS, to have thorough information about conditions on the ground (a geographic perspective), and modeling of the effectiveness of fire suppression resources.

Supply/Dispatch System Performance

As noted in Chapter 3, equipment and supplies for fighting wildland fires are procured at the local, regional and national levels. The Academy staff's research on the supply mechanisms revealed opportunities for reducing costs.

National Contracts

Forest Service Manual 5133 states that the Director of Fire and Aviation shall "annually determine and approve the number of national suppression resources and their period of availability, location, and funding to support preparedness and suppression activities." And although the techniques used to establish national contracts (options to renew, exclusive use) appear to be generating savings, there does not appear to be an ongoing system or process to analyze contracts at the regional and local levels to determine if incorporating them into new national contracts would reduce costs. Conversely, there also may be opportunities to procure some items regionally or locally at lower costs than are now available under national contracts.

Equipment and Supplies

Currently, there is no cross matching of items purchased locally against cache items to identify high volume local purchase items for possible inclusion in the cache system. Thus, in a decentralized system such as this, opportunities to generate savings through volume contracts for the cache are lost because there is no opportunity to review “top selling” local purchase items on a national basis. A Forest Service regional review team for the Star Fire recommended that an assessment be done to determine if it would be more cost effective to distribute “standard camp facility needs, such as tents, generators, and computers” as cache items rather than to continue the current practice of leasing them on each incident. Such a review might identify items that have a broad enough base of use to warrant inclusion in the cache system.

Developing Options for Contracting and Supply

The various supply and procurement methods used to meet firefighting needs amount to a large-scale, complex supply and procurement operation. However, there is no central management or approach that recognizes the advantages and related costs of the various components (NIFC contracts, cache, and crew support) as elements of a single system. Each of the procurement methods has cost advantages and extra costs. For example, the NIFC national contracts more than likely generate savings through the aggregation of government requirements and techniques to lessen contractor risk such as exclusive use. However, this acquisition approach incurs costs in the salaries and expenses needed to maintain the contract staff at NIFC. Likewise, the cache system offers price and item consistency advantages, but these come with the associated costs of stocking and distributing items in the depot system. Local purchase options at the unit level offer immediate availability and easy access, but have the disadvantage of higher prices and differing item characteristics from unit to unit.

Many supply and procurement organizations find it useful to make procurement decisions using a “method of supply” model to manage the full range of supply options. These options include local purchase, regional contracts, national contracts, and use of a depot stock program. These models identify plus and minus cost factors associated with the various methods of supply, using estimated use volumes. Based on this model, the optimum method is determined. The model also can be used to show the relative costs and benefits to the government of providing services directly versus using the private sector. For example, the Forest Service regional review team observed that, over a 15-day period, the Forest Service could have saved $667,000 by using mobile kitchen units operated by the California Department of Corrections in lieu of the national contract caterer. Given the current high degree of reliance on commercial services in the fire community, use of a data driven approach to making such decisions would provide better assurance that relying on the commercial sector was, in fact, economical.

Dispatch Operations

The effectiveness and efficiency of dispatch operations are critical to wildland fire suppression efforts. On the Moose and Sheep Fires, dispatch operations may have reduced the chances of containing the fires early in their development.

On the Moose Fire, the Forest Service did not implement a traditional expanded dispatch. As a result, dispatching of ground and air resources, flight following, media and public inquiries, and ordering for the Moose Fire and another major fire in the area were the responsibility of an already busy initial attack dispatch organization.

Problems with the dispatch center's communication system on the Sheep Fire delayed resource allocations to the fire. Dispatching for the Battle Mountain Field Office, which was responsible for initial attack, is handled by the Central Nevada Interagency Dispatch Center in Winnemucca, NV. Radio communication difficulties made direct dispatch with the Field Office impossible. To fill the void, a Battle Mountain Field Office staff member was trying to fill resource orders temporarily. Although first response resources were dispatched fairly quickly, orders for additional resources and support personnel did not get placed or filled during the initial 12 to 16 hours of the fire. Dispatching and resource ordering for the fire had to be transitioned from Central Nevada to the Elko Interagency Dispatch Center.

Dispatch operations on the case study fires varied from a mainly manual system (the Virginia Lake Complex) to a state-of-the-art Computer Aided Dispatching system used by the Eldorado National Forest (Star Fire) that determines the appropriate resource response—the number of resources necessary based on fire location, weather conditions, and resource availability. All responses are determined on the basis of the "closest resource concept." The Elko Interagency Dispatch Center also used a new software package developed by BLM—Wild Cad—for dispatch operations. The system tracks the availability of all local resources and identifies the closest available resources. It also provides detailed aviation mapping and street level information (roads, structures) important to the dispatch operation.

As noted in Chapter 3, the land management agencies are now developing an automated inventory control and dispatching system—ROSS. It does not have the same GIS capability as Wild Cad, and a dispatch official using Wild Cad indicated that his center would need to use both systems to maintain the mapping feature. Chapter 8 provides more information on ROSS.

Resource Availability

Resource availability during the IMT phase of suppression operations was a problem on two of the case study fires. Respondents to the NASF survey indicated that resource availability and their costs were one of the two most significant barriers to reducing suppression costs. On the Moose Fire, resources were supposed to be demobilized from another fire and reassigned to the Moose fire, but the process got bogged down; it was not clear just what crews or engines would be reassigned. The IC also requested additional Type 1 crews, but they were unavailable. According to documentation on the fire, the IC indicated that he could not meet his objectives without those crews, but the Moose Fire was not high enough on the regional and national priority lists to get them. On the Virginia Lake Complex, there were too few dozer bosses to staff the available equipment, and Type 1 crews, which were needed for the rugged terrain, were in short supply. These resource availability issues slowed fire suppression efforts.

During a severe fire season, it is not possible to have available all the requested resources to combat multiple, concurrent large wildfires. However, many key resources for large suppression efforts, such as Type 1 and 2 IMTs and crews, GIS units, and mobile food units, have not been subject to national analyses that examine the costs and relative benefits of their contribution to fire suppression effectiveness. The current levels of these critical components of the fire suppression program are largely a product of historic use and market factors. And while some analyses have been done on Type 1 and 2 helicopters (discussed below), they are very dated.

The case study fires all relied on aviation resources. The Star Fire suppression strategy relied on the extensive use of Type 1 helicopters to successfully stall the fire's advance on two occasions. Because of the steep, rugged terrain, narrow canyons, and the altitude of the Arthur Fire, the IMT needed Type 1 helicopters to support ground crews. On the Green Knoll Fire, aviation resources consumed approximately 41 percent of the estimated total cost of the fire. Because these expensive resources are critical to large wildland fire suppression operations, it is important that the land management agencies regularly assess their requirements.

The 1992 Forest Service study of Type 1 and 2 helicopters is an example of the type of analytic resource evaluation process that is periodically needed for key large wildland fire suppression resources.[8] The study's purpose was to determine the optimum mix of call-when-needed (CWN) and national exclusive use[9] Type 1 and 2 helicopters. Hourly rates for exclusive use helicopters are typically considerably cheaper than CWN hourly rates, but the tradeoff is that exclusive use helicopters are on-site 24 hours a day and CWN rates only apply for actual hours used, although there is a minimum number of hours guaranteed. The challenge was to determine the best mix to cover both initial attack and large wildland fire suppression requirements.

The study concluded that for the optimum mix of Type 1 helicopters, 3 exclusive use helicopters could fill national demand 25 percent of the time, and the remaining 75 percent could be filled from CWN. For Type 2 helicopters, the study concluded that 13 exclusive use helicopters could fill national demand 52 percent of the time, and the remaining 48 percent could be filled with CWN. Estimated annual savings from these two recommendations were $640,000 for Type 1 helicopters and $3,200,000 for Type 2 helicopters. Due to budget restraints, no Type 1 exclusive use helicopters were added, and seven Type 2 helicopters were added for exclusive use in support of large wildland fire suppression.

This same type of analytical technique can be used with other resource items. As an example, consider the current situation on Type 1 crews. There are now 72 interagency Hotshot crews used as a national resource in wildland fire suppression, distributed among the eleven GACCs. Each crew consists of 18-20 persons, and is "hosted" by a land unit. Crew productivity rates are shown in the Fireline Handbook (January 1998) with the caveat that "the productivity factors are an arbitrary figure arrived at from the 1979 Fire Lab Study data as a base." There is no connection between an annual estimate of the task to be performed (required chains of fire line) and estimated productivity to determine the number of crews needed. Current crew totals and distribution appear to be based on a fire directors conference held in the late 1980s; participants informally determined the total number and the distribution of crews. After the 2000 fire season,

[8] USDA Forest Service, *National Study of Type I and II Helicopters to Support Large Fire Suppression*, 1992.
[9] National exclusive use refers to helicopters held in reserve for use on large wildland fires, not for initial attack.

due to a high number of unable-to-fill orders for crews, it was decided to use National Fire Plan funds to bring the totals to the current figure of 72.

Using an analytical approach to this issue, the key questions of quantifying the task to be performed and the average crew production rates would be addressed using available historical data as well as actual observations of on-site work. Historical demand for crews can then be addressed to either confirm the current distribution or rearrange it as needed. Finally, the mix of contractor versus government crews can be addressed by developing costs and benefits of each, and then developing the optimum mix.

In addition to the issue of resource levels, several agency officials questioned whether current resources were always used where they were most needed. Academy field teams received anecdotal evidence that resources needed on the case study fires sat unused at other fires. The means for deciding on the best utilization of resources do not appear to be systematic or readily understandable. Given the magnitude of the potential consequences of not having needed resources on a large wildland fire, the fire management program should have a more analytic approach to determining suppression resource utilization.

Team Transitions

Long duration fires face the inherent problem of maintaining management continuity due to the current requirement to limit firefighters' assignments to 14 days, excluding travel, unless exceptions are granted. This requirement applies to IMTs as well as firefighters. Transitions, which usually last one or two operational periods, are inherently disruptive, and suppression operations may not proceed as efficiently as possible as the new team gears up its operations. On the Moose Fire, the longest of the case study fires (seven weeks) with five IMTs, one transition period took five days. The incoming team was on its first assignment to a major western fire and was unfamiliar with the territory and asked for a longer-than-usual transition period. The problem of management continuity is magnified when IMT transitions occur at critical time. This occurred on the Virginia Lake Complex; the incoming Type 1 team assumed command when the St. Mary's Fire was making a major run.

The 14-day rule also can affect a team's composition. On the Star Fire, the Type 1 team had difficulty filling key overhead positions because, in part, of the rule. While personnel from the California Department of Forestry and Fire Protection were able to fill many of these key overhead positions, it cost considerably more.

Data transfer between teams can be cumbersome and costly, and can take several days during which time suppression operations are affected. On the Moose Fire, the Type 1 IMT had its own decision support systems and expert staff. Transition to a Type 2 team was complicated by the use of different software and the need for data conversion by a private contractor. This increased costs and delayed some data products for a brief time. The Hayman Fire (near Denver in the summer of 2002) had similar problems. The first IMT assigned to that fire had three GIS specialists, but the second IMT had none. When the first IMT left, so too did all the GIS support. As a result, the incoming team was "hustling" to obtain the necessary GIS support during its first couple of days. Even after its GIS support was operational, the second IMT did not have the same capability as the first team. Agency management became frustrated when it could not obtain from the second IMT the same type of information that the first team provided.

Several agency officials indicated that limiting IMTs to 14-day assignments was too restrictive and often hindered smooth suppression operations. Multiple transitions also were difficult for local cooperators, as they had to build new relationships with each incoming team. Agency officials recognized that the purpose of the 14-day time limit was to protect the health and safety of personnel. But they argued that if assignments were for longer periods of time, they could provide team members with adequate time off on a rotational basis to ensure that everyone received adequate rest.

Incident Management Business Operations

The responsibility for managing large wildland fires goes beyond the strategic and tactical aspects of fire suppression. IMTs also must manage the business side of incident operations. The Academy field teams found two areas where enhancements to incident management business operations offer opportunities to contain suppression costs.

Use of Business Software

As mentioned in Chapter 3, over the past few years, IMTs have had access to three automated systems to automate the process of tracking the resources used during a fire and their costs in order to more efficiently manage incident operations. I-Suite appears to be the most commonly used system. However, at present, the land management agencies do not require IMTs to use any standard business software.

On the six case study fires, most of the IMTs attempted to use some components of I-Suite, but they often ran into difficulties due to staff inexperience, insufficient equipment, or system problems. For example, on the Star Fire, the Incident Time System (ITS), one of the I-Suite modules, crashed when the team tried to enter large quantities of data. On the Green Knoll Fire, the Finance Section did not have enough laptop computers or the networking capability to use the system as intended. They did not use the ITS application and only used the ICARS as a stand-alone system. The Finance Section on the Sheep Fire found the system too labor intensive to use because of staff inexperience. It opted to keep manual records and entered the necessary data into the ICARS portion of I-Suite after the incident. Despite the problems encountered, all of the IMTs interviewed during this study believe that I-Suite, or a similar system, is a valuable tool for efficient financial management of wildland fires. Perhaps the best evidence of the need and desire for such software comes from the Finance Section Chiefs who were willing to tolerate the poor software documentation, technical flaws, and a substantial learning curve to implement a developmental product in advance of national direction from their agencies.

On the Arthur Fire, the Finance Section was able to successfully use the entire I-Suite program, and its success provides a glimpse of the future potential for such software applications and what they can add to management and oversight of suppression costs. I-Suite allowed the IMT to automate time, resource, and cost information and to automatically share the data between its various databases to produce time sheets, equipment invoices, and management reports. This helped ensure that all sections of the command structure—finance, logistics, operations, planning, and safety—had the same data and could analyze it in ways that best suited their needs. For example, operations could get immediate, current reports on the numbers and particular types of equipment and crews on site; safety could be alerted to crews or individuals who may be exceeding work limits; and finance and logistics could begin early planning for demobilization to help ensure the most costly pieces of each category of equipment were released first when possible. The team's success in using I-Suite was credited, in large part, to having a staff member with exceptional computer skills who was able to work through the problems they encountered.

Refinement of the system continues, and the potential for such business software is significant. The software can forecast future costs for IMTs based on the resources on hand, readily allow tradeoff analyses that compare the costs of different tactical approaches to meet an objective, and produce a variety of management reports showing the mix and costs of resources.

Use of Incident Business Advisors

On large wildland fires, the agency administrator has the option of requesting an Incident Business Advisor (IBA) who is responsible for monitoring incident costs and advising the agency administrator and IC on methods to reduce them. Although IBAs report directly to agency administrators, they must work closely with the IMT. Absent an IBA, there is no single staff function solely responsible for monitoring all business management functions on large wildland fires.

Except for the Colville Indian Agency, the agency administrators on the case study fires requested IBAs. However, the general sense of the Academy field teams was that the agency administrators were not closely enough involved with the IBAs to provide essential support. Greater agency administrator involvement with an IBA would add weight to the IBA's role and emphasize the agency administrator's concerns about costs, efficiency, and effectiveness.

The critical role of the IBA requires a person with fire experience and general knowledge in a broad range of administrative, policy, and legal aspects of fire management business practices. Interpersonal skills also are essential to settle differences over a variety of issues regarding policies, reimbursement practices, contracting, and staffing. Optimally, these positions should be filled by agency staff familiar with these activities by virtue of their daily jobs and proven management skills. Some agency officials that Academy field staff interviewed believed that the land management agencies were devoting too little effort to recruit and train IBA candidates. The person who served as the IBA for both the Moose and Arthur fires was a retired federal employee. The dispatch centers servicing those fires did not have anyone else to fill those positions.

RESOURCE ISSUES

It has been repeatedly reported that the availability of federal staff with fire expertise has dwindled as agency employee participation in fire-related programs and activities declines. This shortage has been felt not only in firefighting positions, but also in purely support positions even though many of the latter only require a simple self-study course to qualify and have no or only limited physical fitness requirements. The result, increasingly, is to have to draw these staff from national sources even at relatively low mobilization levels, resulting in the additional costs and delays associated with obtaining out-of-area resources.

Academy field teams found this to be the case for record keepers on some of the fires reviewed. These support positions are critical for the timely in- and out-processing of resources and for avoiding confusion and delays at either end that can increase incident costs and reduce productivity. Some of the problems observed with demobilization at the Virginia Lake Complex were attributed to these support personnel not being able to keep up with the huge volume of paperwork involved in demobilizing resources.

At higher mobilization levels, orders for overhead and other critical positions often take several days to fill or go unfilled. On the Virginia Lake Complex, for example, the absence of safety officers and dozer bosses delayed deployment of heavy equipment for several operational periods. (See Chapter 3 for a discussion on unable-to-fill orders.)

Each fire season, agency heads send letters exhorting line officers to make people available for fire assignments. This kind of management support is essential, but it also should extend to encouraging non-fire employees to become trained and qualified to participate in the fire program. This involves considerable agency commitment because it means that while employees are training for or on fire assignments, someone else must do their work or it will not get done until they return. This can be a significant disincentive to line officers in other program areas who are being asked to encourage their employees to participate.

Academy field staff were told that relatively few line officers actively encourage employees to become involved, many are silent on the issue, and some actually discourage participation. A few tell employees that they cannot participate. This general theme prevailed across all sites. As the effects of this problem are becoming increasingly apparent in the bad fire years since 1999, some agencies are beginning to reinvigorate their local fire programs by encouraging new employees to participate and encouraging supervisors to support them. For example, the Elko Field Office, where the Sheep Fire occurred, is considering re-instituting a policy that requires new employees' participation in local wildland fire programs, and this may be a prelude to broader efforts.

In addition to increased federal employee participation, federal agencies need to look to greater state and local participation in wildland fire suppression. The support positions, discussed above, are good examples of where local people can help fill critical needs without disrupting their private lives significantly.

PERSPECTIVES ON COSTS VERSUS BENEFITS

The nation periodically faces natural events that cause severe damage to everything in their paths: droughts, floods, hurricanes, landslides, earthquakes, tornadoes, and wildland fires. When these events occur, emergency management systems spring into action to get people and property out of harm's way and to help deal with their aftermath. But the response to wildland fires is the only such event where the American public expects man to take on Mother Nature and stop her.

As the costs of suppressing large wildland fires rise, Congress and the public at large increasingly are concerned about finding ways to contain this trend. The Panel Report accompanying this Background and Research Report makes recommendations to do just that. At the same time, however, it is important to consider the cost of fighting wildland fires in comparison to the benefits they generate in terms of lands, lives, and other values saved from the fire's destructive path. Staff research did not identify any such studies, but did uncover some of the topics they might include.

One set of benefits comes form restoring the health of natural ecosystems by reintroducing the historic rhythms of natural fires, enabling native species to thrive, decreasing the ecosystem's flammability, and reducing the likelihood of high-intensity burns that savage the land, destroying not just the resources above ground but also the soil itself.

Other benefits come from preserving the many natural and cultural resources located on federal lands. It is often difficult to attach dollar values to them, but the LMPs for each land unit should identify them clearly. For example, on the Colville Indian Reservation, timber is a highly valued natural resource, historically contributing 80-90 percent to the tribal budget. Likewise, the St. Mary's Mission is considered a cultural treasure by the tribe. The firefighters' ability to redirect the path of this fire and contain it, helped reduce its impact on those resources.

Still other benefits come from protecting the rapidly growing wildland-human interface. Catastrophic fires in these areas endanger not only natural and cultural resources, they also threaten lives, destroy homes and other structures, and damage critical community infrastructure. Four of the six case study fires involved evacuations of local residents and major efforts to save homes, property, and infrastructure. The suppression efforts for these fires cost an estimated $70 million. But no data were gathered to estimate the value of the lives and property saved by those efforts, and no current models are used to estimate the value of additional structures and infrastructure that might have been lost to the fire if the suppression actions had not taken place.

In addition to these direct effects of fire, there are numerous indirect effects, such as:

- loss of industry or employment
- altered work and transportation patterns
- shifts in recreation activities, ranging from local parks to Wilderness areas
-
- altered sense of place

- changed subsistence activities[10]

It is important to remember that the effects of large wildland fires are not always negative. The Yellowstone fires in 1988 showed that large fires can benefit the ecology of a land unit. In addition to destroying cultural resources, fires often uncover them. And while large wildland fires can cause the loss of industry or employment, they also can be the source of employment and economic gain during a fire and post-fire rehabilitation activities. All these factors should be considered when evaluating the cost of large wildland fire suppression activities.

[10] *Burning Questions: A Social Science Research Plan for Federal Wildland Fire Management*, Report to the National Wildfire Coordinating Group, pp. 154-155.

CHAPTER 6
HAZARDOUS FUELS CHALLENGES

For most of the twentieth century, all wildland fires were considered to be harmful. They were seen as threats to human life, property, wildlife, and timber values. Consequently, fires were suppressed as soon as possible to reduce their negative effects, and advances in fire fighting capabilities made the suppression of fires highly effective.

The adverse effects of these efforts are now apparent. Aggressive fire suppression increased the frequency and intensity of wildfires significantly, and contributed to deteriorating health of many forests and grasslands that once benefited from frequent, low-intensity ground fires. The exclusion of fire caused the buildup of fuels such as dead logs and branches, promoted unnaturally dense growth of vegetation, allowed encroachment of woody species into shrublands and grasslands, altered wildlife diversity and populations through habitat modifications, and increased disease and insect infestations.[1] Apart from fire management practices, other human activities such as logging and grazing added to the current conditions. As a result, fire exclusion and these other factors have raised increasing concern about overall wildland conditions, and particularly the health of forests.

Compared to presettlement times, current forests appear denser, have many more small-diameter trees and fewer large trees, and are "littered" with greater quantities of surface, ladder, and canopy fuels. Figure 6-1 presents photos of the same place in the Bitterroot National Forest taken in 1895 and 1980. Changes over time are very clear. In 1895, the forest was open and dominated by groups of trees and open spaces. In contrast, the same forest in 1980 was highly overgrown and dense.

Dense vegetation and drought increase the risk of disastrous wildfires that burn longer, faster, and with higher intensity, destroying huge areas of forests and threatening human lives and property. It also makes forests prone to insect infestations, invasion of non-native species, and disease outbreaks.

Over vast expanses of shrublands and grasslands, the invasion of non-native species (such as cheatgrass and tamarisk) and the encroachment of woody species (such as pinyon pine and juniper) have important implications for wildland fire hazard because those species have greatly increased flammability or fire severity, and often both.

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[1] U.S. Department of the Interior and USDA Forest Service, *Restoring Fire-Adapted Ecosystems on Federal Lands. A Cohesive Fuel Treatment Strategy For Protecting People and Sustaining Natural Resources* (The Draft 2002 Joint Cohesive Strategy), draft, April 2002.

Figure 6-1. Changes in Forest Structure and Density[2]

BEFORE – BITTERROOT NATIONAL FOREST, 1895

AFTER – BITTERROOT NATIONAL FOREST, 1980

As a result of extensive studies, it has been realized that fire can play a positive role in sustaining ecological stability. Historically, many North American plant species were adapted to periodic fire recurrence, and reintroducing natural fire cycles to them can be beneficial. However, because of the degraded condition of many forests and grasslands, use of fire for forest management has now become much more complex and risky. It requires research and science support, as well as the newest technology to help plan, implement, and monitor appropriate fire management activities.

[2] *The Draft 2002 Joint Cohesive Strategy.*

Although fire can play a beneficial role for some species, it can harm others, depending on the ability of different plants to survive and regenerate after fire. For example, plants that have developed thick barks tend to be more fire resistant. In addition, fire management techniques are not all equally effective in different conditions, and a combination of techniques often is needed to achieve targeted land management goals. Each proposed treatment needs to be evaluated to show its impact on the overall area and its cost. This is best done as part of a systematic and integrated planning system, supported by sound science and experience. Land and fire managers need to be aware of how different vegetation types adapt to fire, current ecosystem conditions, the appropriateness of available fuel treatment methods, and the potential contributions of treatments to achieving management goals.

FIRE REGIMES AND CONDITION CLASSES

Drawing on a large body of research that has identified and quantified differences between ecosystems and their ecological health, Forest Service General Technical Report RMRS-87[3] identifies the five main natural fire regimes and three condition classes within those regimes.

These natural fire regimes combine:

- fire frequency (measured by fire return interval, such as every 20-35 years),
- intensity (measured by flame lengths or heat output); or severity (measured by the ecological impact of fire to soils, flora, fauna, etc.)
- seasonality (when a fire burns can be very important in determining its effects, e.g. burning in spring may result in weakening and even damaging sprouting shrubs) and
- size, patch arrangement and other spatial characteristics of fire in a particular vegetation type.[4]

Identification and classification of fire regimes across the nation is difficult and often contentious, because the spatial and temporal patterns of fires, and thus their effects, can be highly variable due to infinite variations of fuel, topography, and weather. For simplicity, five fire regime groups (identified in *Forest Service GTR RMRS -87*) are described in Table 6-1.

Fire intensity impacts the amount of vegetation being destroyed by fire and its relative ability to recover. It varies from low intensity surface fires, to more intense understory fires, to highly intense crown fires. Surface and understory fires generally burn grass, leaves, shrubs, lower branches of trees, small trees, and other vegetation close to the ground; they do not consume larger diameter, fire-adapted trees. Crown fires burn at high intensity, typically beginning as surface or understory fires but reaching the crowns of the dominant vegetation, consuming large trees, showering embers out and leaping ahead to burn ever larger areas. These fires can have very severe impact on those ecosystems that are not fire-adapted or that are adapted only to

[3] Schmidt, Kirsten M., Menakis, James P., Hardy, Collin, C., Hann, Wendall J., Bunell, David L., *Development of Coarse-Scale Spatial Data for Wildland Fire and Fuel Management*, USDA Forest Service Gen. Tech. Rep. RMRS-GTR-87 (Forest Service GTR RMRS –87), Rocky Mountain Research Station, April 2002.

[4] James K. Agee, *Fire Ecology of Pacific Northwest Forests* (Fire Ecology), Island Press, Washington, DC, 1993.

periodic ground fires. However, in some forest types and chaparral, crown fires are the natural fire occurrence and these ecosystems withstand these events well.

Table 6-1. Characteristics of Natural Fire Regime Groups[5]

Fire Regime Group (some typical vegetation types)	Frequency & Intensity	Fire Impact on Ecosystems (Severity)	Percent of Federal Lands
I Southeastern longleaf pine forests; ponderosa pine in interior west, oak woodlands in the west, most eastern hardwood forests	0-35 years Low intensity surface fires	- low severity - fires burn understory (small trees) and surface vegetation (branches, leaves, grass)	**31%**
II Tall grass prairie in Mid-West, some shrubland and brush types	0-35 years High intensity surface or crown fires	- stand replacement - fires kill aboveground parts of the dominant vegetation, changing the aboveground structure substantially	**13%**
III Sagebrush in the Great Basin, Rocky Mountain dry Douglas-fir, mixed conifer forests, some northeastern and Great Lakes hardwood forests	35-100+ years Low intensity surface (frequent) or higher intensity (long return-interval) crown fires	- mixed severity - causes selective mortality in dominant vegetation (depending on the tree species' adaptability to fire); highly variable effects both between fires and within a single fire	**36%**
IV Coniferous forests of southern California, some true fir forests, some lodgepole pine forests)	35-100+ years High intensity crown fires	- stand replacement - causes high mortality in dominant vegetation, some individuals or groups of trees may survive in protected locations (riparian areas and rocky areas)	**14%**
V Coastal rain forests of the Pacific Northwest, most spruce, fir and hemlock forests, Northern hardwood forests	>200 years severe surface and crown fires	- stand replacement - causes high mortality in dominant vegetation , some individuals or groups of trees may survive in protected locations (riparian areas and rocky areas)	**6%**

[5] Based on: *Protecting People and Sustaining Resources in Fire-Adapted Ecosystems. A Cohesive Strategy*. The Forest Service Management Response to the GAO Report GAO/RCED-99-65, October 13, 2000 (The Forest Service Cohesive Strategy), *The Draft 2002 Joint Cohesive Strategy*, and *Fire Ecology*.

Classifying fire regimes is an important step in developing forest and land management plans. Fire Regime Groups I and II are adapted to frequent, low-severity fires. Such fires have played an important role in sustaining their ecological health, helping to remove understory growth (trees and other plants growing close to the ground surrounding larger trees), invasive species, and enabling seeding. Excluding fire from these two ecosystem regimes—by past suppression activities—has had the most pronounced effects; the more natural burning intervals missed, the higher the risk of severely damaging fires in the future.

Fire Regime Groups III and IV are characterized by moderately frequent fire occurrence. Ecosystems in those fire regimes have been less dramatically affected by human intervention as compared to Fire Regimes I and II. The primary causes of departures from natural fire regimes in these groups are fire exclusion, establishment of exotic species, livestock grazing, and logging.

Lands in Fire Regime V are characterized by less frequent, higher-intensity fires, which burn large amounts of vegetation and drastically impact ecosystems in the short-term. Past fire suppression activities have resulted in only minimal or modest departures from their historical conditions.

The three fire condition classes identified in the Course-Scale Analysis categorize the current health of the Fire Regime Groups, as described in Figure 6-2. This assessment is based on the extent to which there is a departure from the historic pattern of each fire regime, as determined by the number of missed fire return intervals. These three condition classes help to identify these ecosystems that are at the greatest risk of losing key ecological components when struck by wildfire. The risk increases from low risk (Fire Condition Class 1) to highest risk (Fire Condition Class 3).

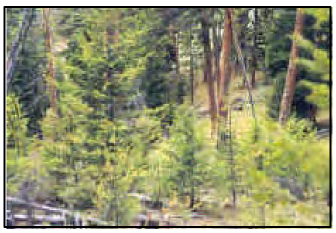
Figure 6-2. Fire Condition Classes[6]

Open ponderosa pine stand maintained by frequent, low-severity fire, is dominated by large trees. Stand is resilient to disturbances such as insects and disease outbreaks.

Fire Condition Class 1 – Low Risk

Ecosystems in this fire class are mainly within their historical fire regimes. Fires within those ecosystems generally pose little risk and have a positive impact on the biodiversity as well as soil and water quality. However, there is a need for maintenance management in order to prevent those lands from degradation. Such maintenance can be achieved by fire use methods.

Wyoming big sagebrush type with considerable diversity is generally more resilient to disturbance and provides habitat for a great number of species.

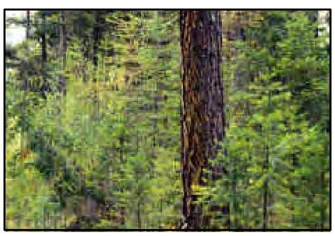


Selective logging in ponderosa pine stands progressively removed the larger trees. Without periodic fire, forest openings filled with thickets of smaller understory trees.

Fire Condition Class 2 – Moderate Risk

The risk of losing key ecological components due to occurrence of fire is moderate in this class. The fire regimes have been moderately altered from their historical range by decreased fire frequency, resulting in excessive accumulation of understory vegetation. If not treated, those fuel buildups might result in more intense fires that are more difficult and costly to suppress, and have negative impact on biodiversity as well as water and soil quality. Thus, fuel treatments, such as fire use or thinning, are needed to restore the original condition of these lands and reduce the risks of destructive wildland fires.

Wyoming big sagebrush type where fire has been excluded for an extended period has reduced diversity and provides habitat for fewer species. The site is also vulnerable to future cheatgrass invasion and to wildland



The dense thickets of understory trees eventually become sufficiently large to allow fire spread into the ponderosa pine crowns. These thickets are also highly drought-prone.

Fire Condition Class 3 – High Risk

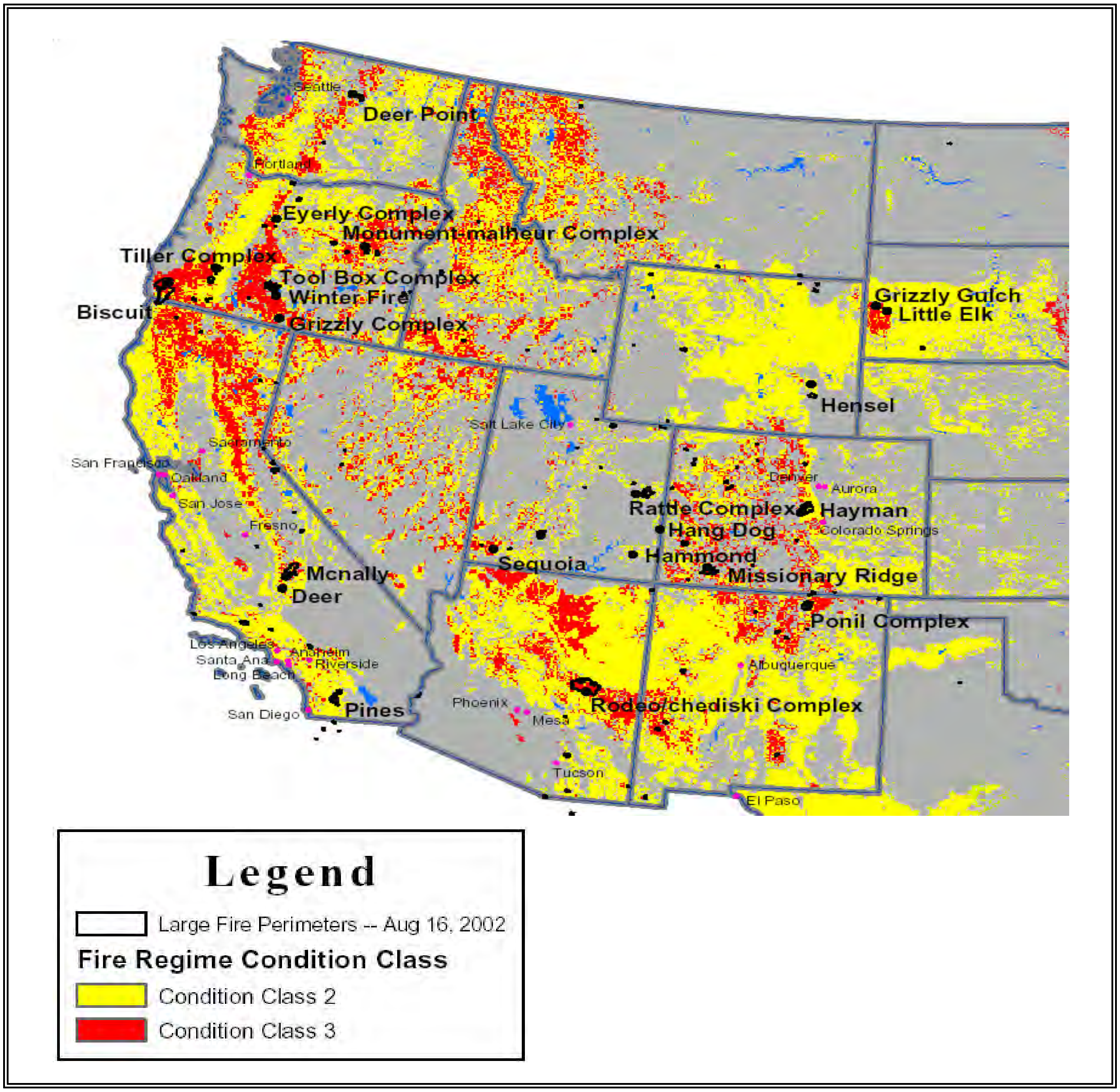
Fire regimes have been significantly altered from their historical range, resulting in high risk of losing key ecosystem components if fire occurs. Fire return intervals have been increased or decreased by multiples, leading to dramatic changes in landscape patterns. Excessive accumulation of dead vegetation and large quantities of small trees that grow densely among the larger ones can lead to severe, high-intensity wildland fires. Within this class, characteristic for short-interval fire-adapted ecosystems, wildland fires damage not only all trees but also can lead to serious soil erosion and water contamination. Fire use methods should be used cautiously in those areas; prescribed burning should be done after mechanical or hand treatments.

Rangeland sites entirely dominated by cheatgrass – unlike the native vegetation that formerly occupied this site – are highly vulnerable to fast-moving, higher-intensity wildfires.

As presented in the map below (Figure 6-3), lands that are in the Fire Condition Classes 2 and 3 are at a greater risk of disastrous wildfires. Most of the large wildfires in 2002 fire season were located in those areas.

[6] Based on the *Draft 2002 Joint Cohesive Strategy*.

Figure 6-3. Large Fire Locations in 2002 fire season (as of August 16, 2002) by Fire Condition Classes 2&3



Sources: Fire Perimeters: MODIS Satellite Imagery (Total number of fires from Jan 1 to August 16, 2002). Provided by RSAC, USDA Forest Service and Fire Regime Condition Classes: Fire Sciences Laboratory, RMRS, USDA Forest Service.

The amount of federal lands categorized by historical fire regimes and condition classes is presented in Table 6-2.

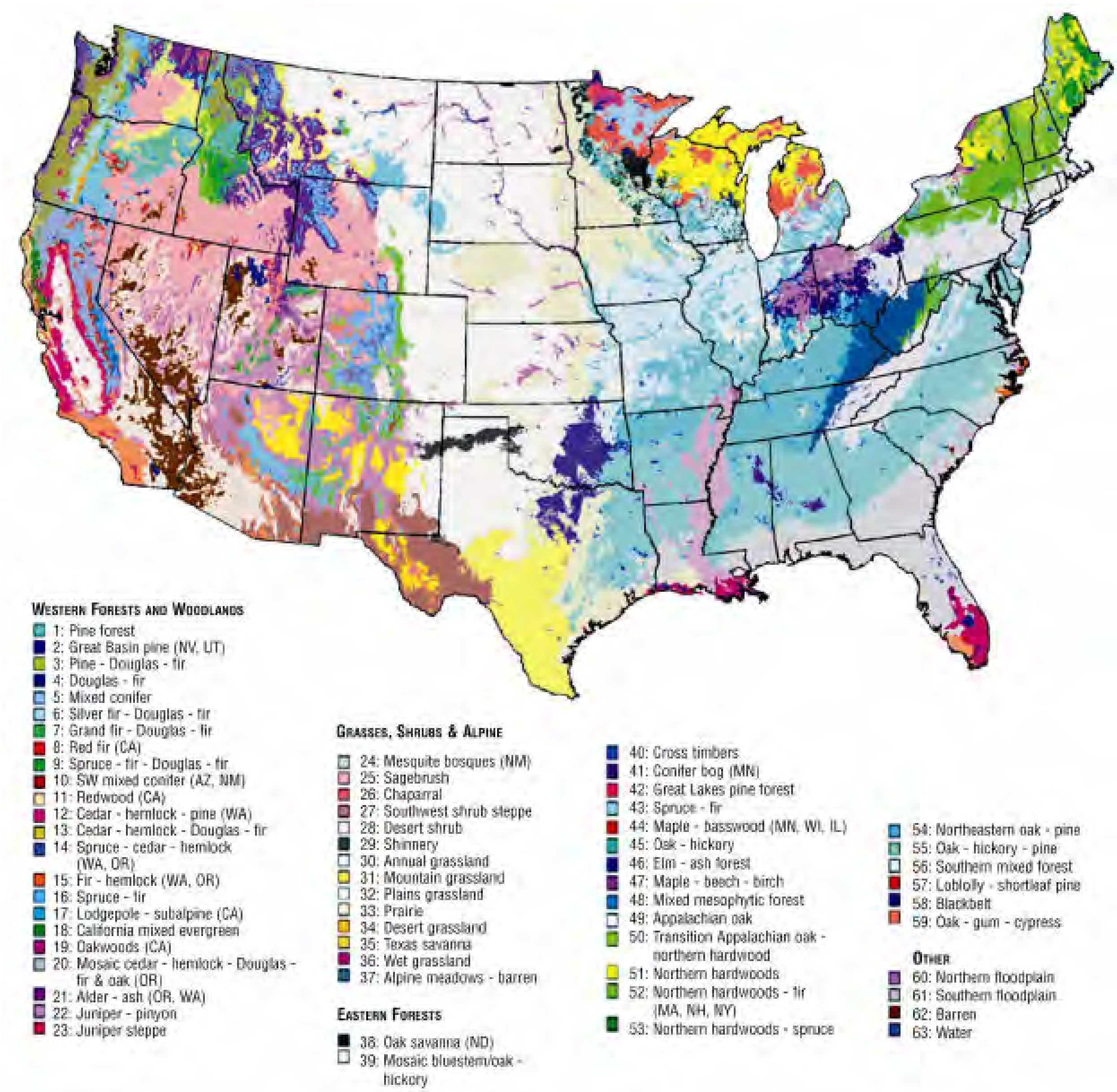
Table 6-2. Estimated Acres of Historical Fire Regimes by Condition Classes—All Federal Resource Agencies (in millions of acres)

HISTORICAL FIRE REGIME	Class 1 Low Risk	Class 2 Moderate Risk	Class 3 High Risk	TOTAL ACRES
	Acres/% of Total	Acres/% of Total	Acres/% of Total	
I	39 million **29%**	59 million **44%**	36 million **27%**	134 million
II	24 million **43%**	31 million **56%**	1 million **1%**	56 million
III	78 million **51%**	52 million **35%**	21 million **14%**	151 million
IV	29 million **52%**	10 million **18%**	17 million **30%**	57 million
V	24 million **87%**	3 million **12%**	< 1 million **1%**	27 million
TOTAL	193 million **46%**	156 million **37%**	75 million **18%**	423 million

Source: Historic Fire Regimes by Current Condition Classes, Version 2000
www.fs.fed.us/fire/fuelman/data_summary_tables.pdf

The five fire regimes and three condition classes included in the Course-Scale Analysis provide a comprehensive approach to understanding key characteristics of different ecosystems. However, because it is highly simplified and generalized, a more detailed analysis using finer-scale fire regime condition class data should be used by land and forest managers when planning for particular forests and grasslands. The map below (Figure 6-4) presents U.S. vegetation coverage according to a more detailed classification of forests and grasslands.

Figure 6-4. Natural Vegetation Groups



<u>Source:</u> *Gen. Tech. Rep. RMRS-GTR-87*.

Currently the Forest Service and Interior are developing standard methodology and protocols for classifying and mapping fire regimes and condition classes at the finer scales needed for revising and amending Land Management Plans and Fire Management Plans, and for prioritizing landscape-scale hazardous fuel reduction and ecosystem restoration treatments (the LANDFIRE project).

FUEL TREATMENT METHODS

Firefighters agree that the conditions present when a fire starts determine how intensely it will burn, how much damage it will do, and how high the cost of suppression will be. Of the three leading factors (fuel, weather, and topography), only fuels can be managed effectively to help reduce the severity of potential wildfires. To reduce risk and achieve land management objectives land managers use the following three main treatments: prescribed burning, hand or mechanical thinning, and herbicides (chemical treatments).

Although no single treatment is appropriate in all situations, each can play an important role in restoring ecosystems. Therefore, it is important to understand the advantages and disadvantages of each method, as well as combinations of treatments. Various treatment methods vary in cost (some have potential to create enough revenue to offset operational costs), number of years necessary to achieve the desired conditions, and their ecological impacts. In addition, these treatments will need to be reapplied periodically to maintain desired conditions. Therefore, fuels treatments should be guided by systematic strategic plans that specify where the treatments are needed, what mix of methods is optimal for the specific types of forests and grasslands, and how the site should be maintained in the future. This is a critical role of FMPs.

Reintroduction of Fire

Prescribed fires, unlike catastrophic wildfires, can be managed to yield important benefits for ecosystem health and public safety. The main objectives of prescribed burning are reducing the hazard of catastrophic wildfires and restoring historic fire regimes. Also, allowing natural fires to burn (under careful oversight by specialized personnel) can be beneficial for certain fire-adapted ecosystems like ponderosa pine in the Interior West, or most of the eastern hardwood forests. This approach can be used when fire poses minimal threat to communities and other values to be protected (usually in wildland areas far away from any structures) and can benefit fire-adapted ecosystems where the intensity of fire will not be destructive for prevalent vegetation and soil types. In some fire-adapted ecosystems, fire can help seeds to germinate by removing ground cover (fallen needles, branches, and leaves) and allowing for a greater exposure to sunlight. Some plants, like lodgepole pine, need fire to reproduce. In addition, fire supports natural nutrient recycling.

The Moose fire, studied by the Academy, is a good example of fire use. When the fire burned off of the Flathead National Forest and onto Glacier National Park, the park had the flexibility to use minimal suppression strategies and did so. Risks to the Park were considered minimal, not only because the resource values in this area were low, but also because previous fires which burned adjoining park areas served as fuel breaks to keep the fire within the desired area. Using minimal suppression saved money and implemented tentative plans to undertake fuels reduction in the area affected by the fire.

In other Academy case studies, however, more aggressive suppression was used. For the most part, structures and public safety considerations drove decisions toward aggressive suppression.

From the perspective of most of the parties affected by these fires and making the decisions, aggressive suppression was the only safe alternative.
Two of the concerns associated with burning are the impact of smoke on air quality and the potential for burning the habitats of threatened and endangered species. In addition, there is great controversy about the risk associated with fire; even a burn that is carefully managed and monitored can get out of control, posing a risk to communities and firefighters.

Although risks will always be associated with fires, some techniques can be used to minimize those threats. Prior to conducting a prescribed burn, a written plan must be prepared that takes into consideration existing conditions (amount of fuel, fuel moisture, temperatures, terrain, weather forecasts, etc.) and identifies people responsible for overseeing the fire. Natural fire that is allowed to burn also needs to be carefully monitored to ensure that it will not threaten communities, other values to be protected, and ecosystems. This may require special expertise such as the Fire Use Management Teams that have been developed to support the overall fire management program by supplementing the general purpose Incident Management Teams.

Negative smoke impacts can be minimized by conducting burns under favorable weather conditions in certain fuel types. Still, burning will have some short-term negative impacts on air quality. However, in the long-term, the frequent use of small, low intensity fires, in those forest and grasslands types that are fire-adapted, will reduce the risks associated with large wildfires that burn at high intensity for several days and result in considerably more severe smoke and pollutant emissions.

One of the challenges associated with prescribed burning is choosing the least risky seasons of the year in which to do it. Burning is the most "natural" treatment method, mimicking nature closely to achieve ecological benefits. Since most of the fires historically were ignited in summer due to lightning, some ecologists argue that prescribed burns also should be conducted in this season of the year. Also, during summer, the plants are usually more resistant to fire, unlike in spring, when fire can negatively affect sprouting shrubs. However, in many instances, excessive buildup of flammable fuels and extremely dry conditions make prescribed burns in summer most risky. Therefore, land and forest managers are faced with a dilemma of following historic patterns by prescribing burns in summer, or conducting these operations in other seasons when the conditions make them safer and less costly. In some cases, it is possible to take advantage of some natural and accidental fires during the natural burning season, to let them burn if they do not pose a serious threat.

Although burning has proven beneficial to some ecological regimes, it will not benefit all species and can negatively affect ecosystems that are not fire-adapted, such as Rocky Mountain subalpine fir. These ecosystems have not developed an ability to regenerate after the fire and have no mechanisms for resisting fire. Therefore, use of fire should not be considered a universal solution to the fuels reduction problem.

Mechanical Treatments

Thinning can help to reduce unwanted overgrowth by cutting, chipping, piling, and removing small trees (usually smaller than 9 inches in diameter) and dead fuels. Thinning can help to remove fuel ladders that could carry fire up into the canopy, initiating dangerous crown fires, and can significantly reduce the amount of aerial canopy fuels that sustain crown fire runs. It can also be used to reduce or modify surface fuels before prescribed burning is conducted, especially in environmentally sensitive areas or in those instances when excessive fuel buildup makes prescribed burning extremely hazardous.

Thinning consists of a set of mechanical and manual treatments primarily aimed at reducing crown fuels. In addition to reducing crown fuels, thinning methods must also treat surface fuels so that potential fire flames are shorter in length, resulting in less destruction and limiting the hazard of crown fire igniting. Common techniques used to treat surface fuels include tractor crushing, tractor piling, and mastication (shredding unwanted woody vegetation into small pieces). Thinning removes small and medium trees in order to raise tree crown base heights, and lowers crown densities. Manual treatments are usually applied in environmentally sensitive areas or when the area to be treated is small in size. Hand treatments of surface and ladder fuels are typically accomplished through hand cutting and felling, grubbing, and piling of small material up to 3 inches in diameter. Manual treatments are usually more time and labor intensive, and more expensive.

In order to conduct some of the mechanical treatments and then haul the thinned material away, the site needs access for mechanical equipment. Roads can make the sites more accessible, not only for thinning purposes, but also for fire suppression equipment. In addition, they can serve as firelines. However, roads have become very controversial. Many environmental groups oppose them because of their potential to facilitate logging and other intrusions into wild areas (such as high-volume recreation). Roads are also associated with an increase in accidental human-caused fire starts resulting from carelessly discarded cigarettes, abandoned campfires and warming fires, and equipment failures. In addition, roads if not maintained can increase the risk of sedimentation, landslides, floods, and resulting in water and soil disturbance in forests and streams.[7]

Thinning alone, with adequate disposal of residues, can help reduce fire hazard, but it may need to be accompanied by prescribed burning in order to meet ecological objectives that cannot be obtained without fire. In addition to reducing the risk of disastrous wildfires thinning can also provide economic benefits when removed biomass can be utilized. This subject is discussed later in this chapter.

In some areas needing thinning, commercially valuable trees must be removed to achieve the desired reduction in canopy fuel density, increase tree spacing, or change the species composition to favor greater fire-resistance. As controversial as this issue is, timber sales are a valuable tool where selective removal of individual trees can reduce risk. This issue is discussed later under the challenges section.

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[7] Sierra Club, *Restoring America's Forests: Protecting Habitat, Saving Streams, and Generating Jobs in Our National Forests* (the 2002 Sierra Club Report), July 18, 2002.

Chemical Treatments

Herbicides are specially formulated chemicals for killing all or parts of target plants (including noxious weeds). There is a wide variety of herbicides ranging from broad-spectrum (effective against all plants or specific broad classes of plants such as woody or grass-like plants) to narrow-spectrum herbicides (effective against specific kinds of plants). Herbicides can be either "foliar active" (taken up by the target plants through their leaves and stems) or "soil active" (taken up by root systems). Similar to thinning, herbicides can help reduce the risk of disastrous wildfires, but cannot replace the beneficial effects of fire in fire-adapted ecosystems.

Herbicides are generally used to prevent live fuels from accumulating, or to kill excessively fire-prone species, but they do not remove the dead fuels, so may need to be supplemented with other treatments. Also, application of herbicides is usually manual and, therefore, labor-intensive and costly.

BIOMASS UTILIZATION (RECYCLING)

Thinning treatments result in a large amount of small diameter material—called biomass—that must be disposed. Typically this disposal involves costly, time consuming operations such as piling and burning, chipping, or hauling to a remote disposal site. In community-wide thinning, homeowners often do not know what to do with thinning residues. Disposing of it can be difficult and expensive. Therefore, methods of using this "waste" for commercial or other beneficial purposes are needed to help offset some of the costs of both thinning and disposal. Such methods also can reduce air pollution when they replace burning.

If the thinned trees are smaller than 9 inches in diameter, they are considered to be "non-commercial" and woodcutters may purchase a low-cost permit from the agencies to remove them. In some areas, there is an existing, but limited, market for small-diameter materials used to manufacture particle-board, pulp chips, mulch, compost, landscaping material, or to generate energy, which will be further explored in the following section. But currently the economic feasibility of this production is limited, mainly due to the small number of processing plants that can utilize such materials, the resulting high long-distance transportation costs, and to the unpredictable nature of the supply. However, in areas where large and steady amount of thinning is needed, a large enough guaranteed supply of small diameter material could be developed to support new small-scale production facilities and lower transportation costs.

Some studies have been conducted as a part of a Flagstaff project, for example, to evaluate the feasibility of developing an industry in northern Arizona to utilize small-diameter timber.[8] They conclude that there are no technical obstacles to economic feasibility of small-diameter utilization. The problem is a lack of nearby processing plants due to uncertainty about supply. This results in prohibitive transportation costs. Those studies recommend active management of the supply-side by the federal land and forest agencies, including developing the infrastructure needed and providing financial incentives.

[8] More information can be found in the report prepared for the Academy by Kathleen Hemenway, *Wildfire Risk Mitigation and Emergency Preparedness: Flagstaff, Arizona*. (See Appendix I.)

Electric Co-generation

Electric co-generation, a method of utilizing the small diameter material produced by thinning, may have increasing potential. It burns the brush and/or small diameter trees removed from overgrown areas and transported to a co-generation facility to produce electricity. This process captures the energy that would be wasted if the biomass is simply piled and burned on site. In order for the fuel treatment to be most economical, the thinned material may be chipped on site to reduce transportation costs.

However, this option faces several hurdles:

- The cost of thinning and transporting biomass to the co-gen site must be offset by the value of the electricity produced. Moreover, the kilowatts produced by co-gen must be able to compete economically with electricity generated in the same area by coal, hydro, solar and nuclear power.

- At the present time, co-gen from biomass requires a significant subsidy. The amount of subsidy necessary fluctuates with the economics of electric power supply, transportation costs, and other factors, and would have to compete with the option of burning or chipping the material on site or making other use of it.

- Transportation cost is driven in part by distance from the treatment site to the co-gen facility. In order to treat a significant portion of the fuels on federal land, there would have to be an extensive network of small-scale co-gen plants situated close enough to federal lands to make transportation economical. Adding material from community-based biomass recycling might help increase and steady the supply of such materials.

- Companies are reluctant to invest in co-gen facilities unless they can be assured a long-term, steady supply of biomass. In northern California where, due to the growing conditions, biomass production is prolific year-round, this is feasible. It may not be as feasible in other areas such as the intermountain west.

- Removing biomass for fuels reduction and co-gen may face some of the same NEPA challenges and resistance from the environmental community as logging.

- Although the use of biomass machinery is an option in many locations, it may be neither practical nor possible at other locations because of lack of roads and steep or rocky terrain.

The bottom line is that millions of acres need some sort of mechanical treatment and co-gen offers one option that may be feasible in some areas.

DOES FUEL MANAGEMENT MAKE A DIFFERENCE ?

As presented in the pictures below[9] (Figure 6-5), fire effects in areas where fuels treatments had been conducted were much less destructive because fire burned less intensely there.

Figure 6-5. Positive Impact of Thinning Treatments on Fire Behavior

This is an un-thinned forest. The trees are densely packed. If flames get into this area they will easily spread from tree to tree.

This is that same area of forest after a wildfire burned through. Note the trees in the stand that have been completely scorched.

This is a thinned area of forest. There is ample space between trees.

This is the same area after a wildfire. A little scorched, but the trees retained their foliage.

Source: *Forest Service Cohesive Strategy.*

Below are examples of some success stories where various fuel treatments have made a difference in suppressing the fire more quickly and at less cost.

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[9] Pictures from California Fire Plan website at http://www.fire.ca.gov/FireEmergencyResponse/FirePlan/SuccessStories/ForestManagement.asp

Stream Fire, Plumas National Forest, California July 28 - August 3, 2001

The Stream Fire started from lightning and then spread to multiple spots, which burned with different intensities. Low fuels moisture and high temperatures combined with strong winds spread this fire quickly. Some of the fire spots were in areas where recent fuel treatments, including underburning, thinning from below with biomass removal, hand thinning, pile burning, and timber sale, effectively reduced the fire spread and its intensity. Lower fuel buildup in these areas resulted in reducing the intensity of the fire, allowing for direct attack and quick containment. The stands sustained only minimal damage.

Fire in Lake Meredith National Recreation Area, Texas, June 18, 2000

The Lake Meredith Fire started in the South Canyon area due to a spontaneous ignition of one of the oil and gas well-heads. The temperatures were high and the winds were strong. However, the fuels build-up was very low due to a recent 715-acre prescribed burn, which was conducted to protect the oil and gas facilities, urban interfaces, and cultural resources from a wildfire. Consequently, the fire was easily contained with one fire engine.

The Caylor Fire, Tuolumne County, California, July 14, 1999

The Caylor Fire was caused by an equipment spark on July 14, 1999, near the town of Soulsbyville in Tuolumne County. Driven by wind and high temperatures, the blaze spread rapidly. As fire crews responded, the fire was actively approaching a subdivision. However in 1998, this area was identified as hazardous for wildfire, and homeowners were encouraged to create a "defensible space" between their land and the nearby wildland by clearing flammable vegetation around their properties. Knowing the homeowners had taken precautionary measures to protect their property, firefighters were able to concentrate their attack on the head of the fire. This allowed firefighters to contain the fire quickly and with fewer resources. While the Caylor Fire did burn 105 acres, no damage occurred to the 14 homes in the area. The "defensible space" program saved approximately $2.4 million in total value of homes.

The Winton Fire, California, September 9 - September 12, 1999

The fire started by lightning during a very dry summer. When fire crews responded to the call, they already knew that as many as 40 homes could be threatened if they were unable to quickly contain it. Fortunately, due to past logging and prescribed burning projects, the fuel was significantly reduced in some areas, resulting in lower intensity and slower spread of the fire. In addition, the main road, which was used by fire personnel to access the head of the fire, ran through this treated area. These factors allowed the firefighters to concentrate their efforts on the more actively burning areas of the fire. While one home and 115 acres were burned, fire commanders estimated that 40 homes and 300 acres of timber were saved due to the ability of the crews to quickly contain the fire. This is an example of how pre-fire planning and treatment can save homes, resources and money.

The strong message from these examples is that immediate benefits are available from the fuels management program. Although it will take many years to make all of the nation's wildlands less vulnerable to wildfires, those areas that are treated become safer right away. An appropriately prioritized program can make increasing numbers of high-risk communities, people, and precious natural resources safer each year.

STRATEGY FOR FUEL TREATMENTS

Recently, the Forest Service and the Department of the Interior have expanded their fuel treatment programs, including prescribed burning and mechanical thinning. These initiatives were possible because of significant increases in funding under the National Fire Plan. However, this effort is still not as large as it would need to be to begin reversing the build-up of hazardous fuels. Analyses by agency researchers supporting their Joint Cohesive Strategy, has predicted changes in land condition and risk over the next 15-30 years for numerous fuel treatment program levels.[10] Results show that a substantial increase in the program is required to reverse current national wildfire trends, and the effort must become part of a long-term plan involving multiple stakeholders, and securing consistent, long-term funding and support. This approach to the hazardous fuel problem is a more programmatic way of implementing the jointly developed Interior/Forest Service strategy. Some of the program levels analyzed propose the most ambitious fuels treatment program developed so far. Although some critics believe this strategy needs further verification, it provides a science-based analysis of the expanded, long-term funding options for addressing the fuels problem, restoring ecosystems, and reducing the hazard of wildfire to human lives and property.

Estimates based on course-scale data indicate that about 18 percent of federal lands, or approximately 75 million acres, are in Condition Class 3 (previously presented in Table 6-2). Those are primarily the ecosystems adapted to frequent low- and mixed-severity fires that are now at high risk of losing key ecosystem components due to wildfire. However, more recent estimates based on limited finer-scale data suggest that up to 45 percent of federal lands, or 190 million acres, could be in Condition Class 3.[11] In 2001, according to data on the National Fire Plan website, 2.1 million acres of federal land were treated to reduce hazardous fuels, including 731,216 acres in community interface areas (Table 6-3). At this rate, it might take more than 35 years to treat today's worst areas, not to mention the new growth that can be expected during that time. This management challenge includes not only the work needed to reduce the current risk, maintaining improved conditions once the work is completed, but also managing vegetation that is constantly growing and dying, adding fuel for future fires.

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[10] *Restoring Fire-Adapted Ecosystems on Federal Lands. A Cohesive Fuel Treatment Strategy For Protecting People and Sustaining Natural Resources: Predicting Outcomes*, USDA Forest Service Rocky Mountain Research Station General Technical Report. Hann et. al. (in press).

[11] *Predicting Outcomes*.

Table 6-3. Hazardous Fuels Reduction, Acres Treated in FY 2001

Agency	Community Interface Areas Acres and % of Total	Other Areas Acres and % of Total	Total
USDA Forest Service	566,879 **41.7%**	794,000 **58.3%**	1,360,879
Department of the Interior	164,337 **22.6%**	563,775 **77.4%**	728,112
Total	731,216 **35.0%**	1,357,775 **65.0%**	2,088,991

Source: National Fire Plan website http://www.fireplan.gov/hazfuels_1_28_02.cfm

Predicting Outcomes identifies and analyzes eight options for fuels management that vary in the amount of funding and in the relative emphasis between community protection and ecosystem health. Four of these options are displayed (Table 6-4).

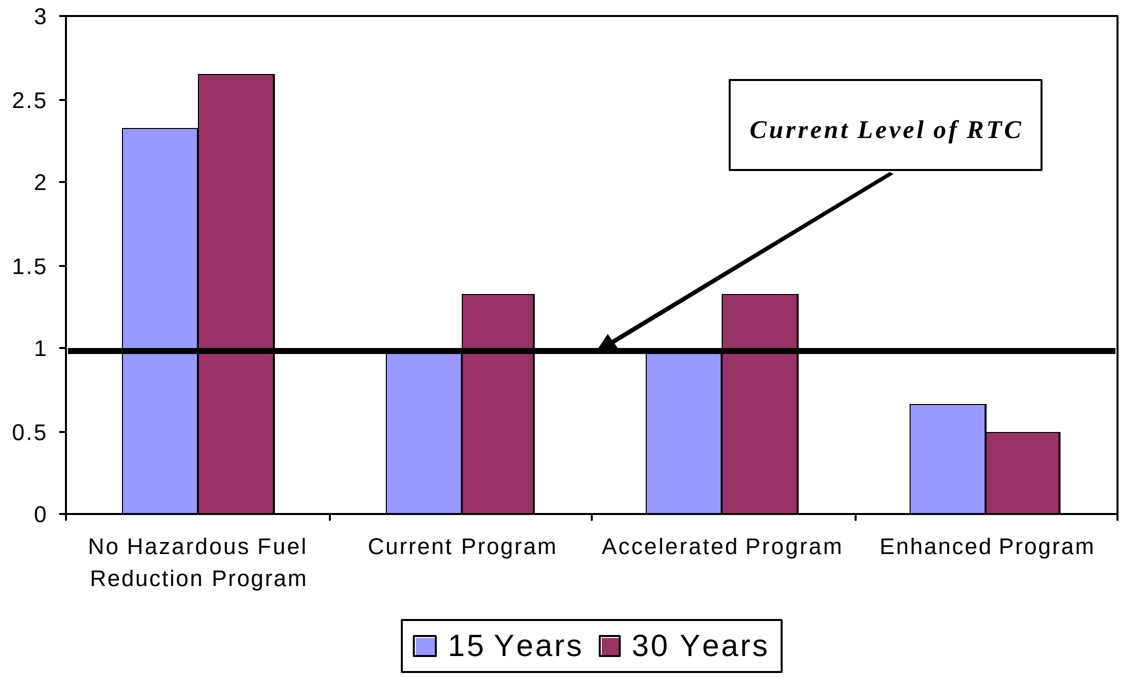
Table 6-4. Summary Description of Four Alternative Programs of Fuels Treatments to Reduce Wildfire Risk to Communities (RTC) and Risk to Ecosystems (RTE) over 15 and 30 Year Periods

Alternative Program Options	Program Definition	Annual Budget Levels (in millions of dollars)
1. No Hazardous Fuel Reduction Program	No hazardous fuel treatments would occur.	**$0**
2. Current Program	Current National Fire Plan budget level that emphasizes treatments to protect high-risk communities while still providing funding for some ecosystem restoration and maintenance treatments.	**$400** ➤ 67% of budget spent on reducing RTC ➤ 33% of budget spent on reducing RTE
3. Accelerated Program	This program would stop the increase in both RTC and RTE	**$868** ➤ 31% - RTC ➤ 69% - RTE
4. Enhanced Program	This program would significantly reduce RTC and arrest RTE	**$1,200** ➤ 50% - RTC ➤ 50% - RTE

Source: Based on *Predicting Outcomes*.

The projected results of each option are expressed as a relative change in RTC and RTE at both 15- and 30-year intervals (Figure 6-6). Figure 6-6 clearly shows that only accelerated and enhanced programs (alternative options 3&4) have a potential to arrest and/or reduce the risk to communities and to ecosystems compared to the current level within a 15-years period. However, in 30-year perspective, only the enhanced program, with an annual budget triple the current NFP budget level, would result in reduction of both RTC and RTE. The accelerated program, with its doubling of the NFP budget, would only slightly decrease RTE; while allowing RTC hazards to increase.

Figure 6-6. Projected Risk to Communities and Risk to Ecosystems within 15 Years and 30 Years Schedule of Four Alternatives in the Joint Cohesive Strategy



Source: Based on *Predicting Outcomes*.

The impact on suppression costs of each of these fuel treatment program options, which is the main focus of the Academy's study, is presented in Table 6-5. The *Predicting Outcomes* analysis did not consider economic costs of potential losses from fire.

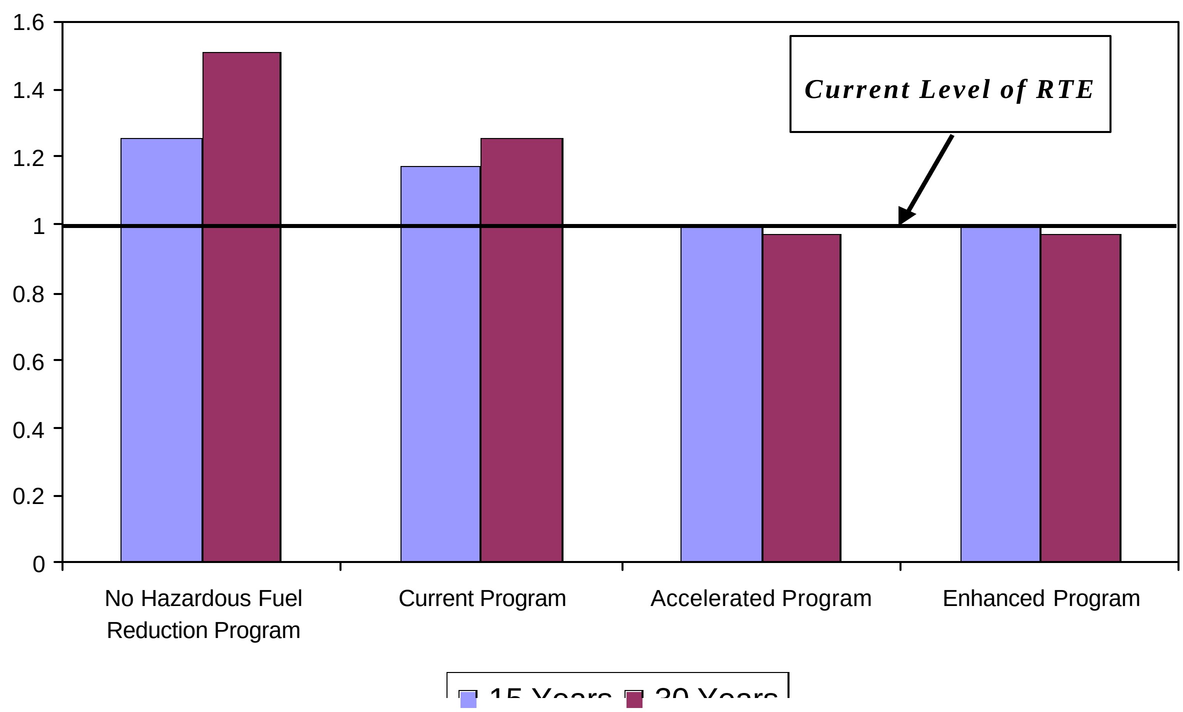


Table 6-5. Relative Impact of the Proposed Joint Cohesive Strategy's Options on Future Suppression Costs after 15 years (measured as a change in the current funding level)

Option Number	Option description	Annual Budget (maintained for next 15 years)	Percent change in suppression costs from current funding level ($400 m/y)*
1	Eliminate the program	$0	+ 35%
2	Maintain current program	$400 million	+ 5%
3	Hold RTC & RTE constant	$868 million	- 15%
4	Significantly decrease RTC & hold RTE constant	$1,200 million	- 30%

* Estimates from histograph (Based on *Predicting Outcomes*.)

The Joint Cohesive Strategy argues that until hazardous fuel has been treated across considerable portions of the landscape, large wildfires will continue to threaten communities and ecosystems, inevitably resulting in higher suppression costs. Under existing conditions (particularly on lands identified as Fire Condition Class 3), each unwanted wildland fire has a potential to become highly damaging and costly. It not only poses risks to human lives and property, but also affects land productivity (by damaging natural resources such as timber, watersheds, rangelands, air, and wildlife habitats), and can result in serious damage to ecosystems. The high intensities and temperatures of those fires can seriously damage all plants (even the fire-adapted ones), soil, watersheds, and landscapes in their path.

The Joint Cohesive Strategy emphasizes the need to increase the long-term investment in fuel treatments to reduce risks and save future suppression costs. Even though local benefits will be realized as soon as treatments are completed, on a national scale, reversal of broad trends in wildland fire specifically attributable to fuel treatment will not be measurable for several years. Therefore, this strategy depends on long-term, large-scale, strategic efforts to address the current situation.

The Joint Cohesive Strategy is an ambitious, policy-relevant approach that clearly identifies the need for expanded fuel treatments. Its modeling approach to predicting programmatic outcomes appears reasonable, based on the summary of the methodology included in the report. However, the issues raised are so important and costly that this methodology needs a closer look. A thorough independent peer-review by modeling experts and policy analysts to evaluate its reliability and validity, could address its credibility and assist in refining and prioritizing the needs.

CHALLENGES

In cooperation with the National Association of State Foresters, the Academy updated and expanded a 2000 survey of state forestry officials to obtain their views about containing wildfire suppression costs. In this survey, almost 60 percent of the respondents identified fuel management as the single most significant activity with potential to reduce the costs of fire suppression. The fuels problem does not stop at the borders of the federal lands; it crosses state, local, tribal, and private lands, and requires a collaborative effort by all of the affected stakeholders. The main challenges to success in this complex fuel treatment effort include the magnitude of the job (already discussed), administrative and regulatory complexity, controversies over timber harvesting, inadequacy of federal funding, the long-term nature of needed investments, and the need to prioritize. These challenges are discussed below.

A Complex Statutory, Regulatory, and Administrative Framework

The complex legal framework within which the federal land management agencies operate includes: the National Environmental Policy Act, the Endangered Species Act, the Federal Advisory Committee Act, the National Forest Management Act, the Federal Land Policy and Management Act, the Administrative Procedures Act, the Clean Water and Clean Air Acts, and other legislation, rules, and regulations, some of which are specific to individual agencies.

As noted earlier, current and complete versions of LMPs and FMPs provide the basis for fuel management activities on all lands of the five major federal land management agencies. These plans identify where and what kind of fuel treatments should occur to progress from current to desired conditions on particular sites. In addition to identifying the specific areas suitable for fuels treatment, the planning processes need to complete the environmental analyses needed to determine and document the appropriateness of planned treatments, to identify risks and hazards on both federal and nearby lands, and to prioritize areas needing treatment. Without these plans, the fire management approaches available are largely limited to suppression. But when these plans are in place, fire can be used as a treatment option if the opportunity presents itself, and planned thinning and prescribed burning can be implemented. Two of the six fires studied by the Academy—Moose and Arthur—illustrate the benefit of having updated LMPs and FMPs relevant to current fuels treatment needs. In both examples, the responsible agency administrators had considerable flexibility in selecting a range of strategies for managing the wildfires.

The current forest health crisis requires quick, creative responses from federal agencies and others. Unless the federal land management agencies are able to more quickly achieve results on the ground, they will not be able to reverse the increasing risk of severe wildfires or restore burned areas. To do so will require efficient and effective decision-making to implement time-sensitive projects. However, the agencies, in general, and the Forest Service, in particular, are experiencing process delays that slow their completion of the LMPs, FMPs, and environmental reviews needed to obtain authority to proceed with needed fuels treatment projects.

Of the five federal land management agencies, the Forest Service seems most limited by its statutory, regulatory, and administrative framework in moving efficiently and effectively to reduce hazardous fuels and restore burned areas. Forest Service administrators in charge of individual land units often find themselves bound by costly procedures where a single fuels reduction or burned area restoration project can take years to implement and planning costs alone can exceed $1 million. On occasion, this delay results in catastrophe when a wildfire consumes an area awaiting approval to be treated. They also lose revenues when delays reduce or eliminate the commercial value of the material to be removed.

According to a June 2002 Forest Service report,[12] some of these problems can be traced to the Forest Service's own budget structure, rules and administrative requirements. For instance, forest planning regulations require line officers to maintain "viable populations of native and desired non-native species within the planning area." This "viable populations" requirement is (1) responsible for much of the time and expense that goes into project planning, (2) far more time-consuming than the landscape-scale analyses of habitat diversity required by legislation, and (3) arguably more rigorous than any provision in the Endangered Species Act.

However, as noted in the Forest Service's report, part of the problem also lies beyond the agency's ability to control. For example, federal regulatory agencies are primarily focused on the short-term risks to single resources, such as threatened and endangered species or the quality of air on any given day, rather than on long-term outcomes and landscape-scale conditions. In addition, according to this report, some courts have increasingly directed the Forest Service to obtain information beyond that which the agency views as required to comply with legislative requirements.

The Forest Service is also the only federal land management agency with a legislatively required appeals process, which the other federal land management agencies have only administratively established review procedures or none at all. For some groups, post-decisional review opportunities (through appeals and litigation) discourage them from pre-decisional collaboration on a project. Parties opposed to a particular activity, such as timber harvesting, can delay the Forest Service significantly or cause it to withdraw hazardous fuels reduction or burned area restoration projects by filing the administrative appeals and judicial challenges available under by statutes or regulations.

The Forest Service's legislatively authorized Stewardship Contracting Pilot Program, designed to encourage commercial investment in fuels treatment, has also been delayed by these procedural problems. Since its inception in fiscal year 1999, many of the authorized projects have been delayed directly by the consultation process under the NEPA and ESA. Twenty-five percent of the projects also have been appealed or litigated. In many of these cases, environmental organizations and other parties are seeking to eliminate commercial logging on the national forests.

On August 22, 2002, President Bush announced a new initiative to restore forest and rangeland health and prevent catastrophic wildfires on public lands.[13] His Healthy Forests Initiative is intended to expedite federal and local efforts to restore forest health through active land management efforts, such as thinning and prescribed burning. Toward this end, the President directed the secretaries of the Interior and Agriculture as well as the Chairman of the Council on Environmental Quality (CEQ) to:

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[12] USDA Forest Service, *The Process Predicament. How Statutory, Regulatory, and Administrative Factors Affect National Forest Management*, June 2002.
[13] *Healthy Forests: An Initiative for Wildfire Prevention and Stronger Communities*, Aug. 22, 2002.

- Improve the procedures for developing and implementing fuels treatment and forest restoration projects in priority forests and rangelands, in collaboration with local governments.

- Reduce the number of overlapping environmental reviews by combining project analysis with concurrent project clearance by federal agencies.

- Develop guidance for weighing the short-term risks against the long-term benefits of fuels treatment and restoration projects.

- Develop guidance to ensure consistent NEPA procedures for fuels treatment activities and restoration activities, including development of a model Environmental Assessment for these types of projects.

The President has also proposed legislation to facilitate more timely, efficient, and effective implementation of forest health projects. His initiative would:

- Authorize agencies to enter into the long-term stewardship contracts with the private sector, non-profit organizations, and local communities needed to provide incentives to invest in equipment and infrastructure for productively using the material generated from forest thinning, such as small-diameter logs, to make wood products or to produce energy.

- Expedite implementation of fuels reduction and forest restoration projects, particularly in high priority areas.

- Ensure that judges consider long-term risks of harm to people, property, and the environment in challenges based on short-term risks of forest health projects.

- Remove the rider that imposes extraordinary procedural requirements on the Forest Service appeals that are inconsistent with pre-existing requirements of law.

However, the purposes for which environmental laws were enacted are still valid and relevant to sound decision-making, including public participation, interagency consultation, and careful environmental studies. Therefore, any changes to these laws to streamline processes and procedures will require a systematic and comprehensive analysis to avoid making changes that would damage these critical components of informed management.

Controversies over Timber Harvesting

The most controversial issue related to reducing hazardous fuels and restoring forest health is the role of timber harvesting. On one hand, many experts agree that fuels must be reduced in many areas, at least initially, by mechanical means, including commercial timber harvesting;

prescribed fire may come later.[14] In some cases, removing larger trees is necessary to reduce the density of the crown canopy and minimize the risk of disastrous fires. And, revenue from commercial timber harvesting can be used to fund additional fuels treatments or other programs and activities. However, this revenue potential may provide an incentive for land managers to (1) focus on areas with high-value commercial timber rather than on areas with high fire hazards or (2) include larger, commercially valuable trees in a timber sale than are necessary to reduce the accumulated fuels. Thus, some parties believe that the federal land management agencies, in general, and the Forest Service in particular, cannot be trusted to focus on areas with high fire hazards rather than on areas with high-value commercial timber. They also believe that the effectiveness of mechanical thinning in protecting communities and restoring forests is not conclusive and that the long-term effects of timber harvesting are not known.[15]

As mentioned earlier, the current forest health crisis requires quick actions targeted strategically to areas at highest risk from disastrous wildfires. To facilitate such actions, on a larger, nationwide scale, the diverse stakeholders governmental and environmental need to find common ground and reach compromises.

One possible approach for addressing current problems, often cited by scientists and land managers, is adaptive management. This concept is based on the premise that (1) decisions are necessarily based on incomplete data and a less-than-perfect understanding of natural processes, (2) the understanding of ecosystems continually evolves, and (3) unexpected events can and will occur. It accepts uncertainty as a normal condition that need not interminably delay decision-making. Thus, adaptive management allows decisions to be made on the basis of the best information available, then monitors the results, learns from experience, and adapts future management accordingly. In addition, new developments in information technology are making it easier to share information and to collaborate across traditional jurisdictional boundaries on a landscape scale. Moreover, public participation in the Forest Service's decision-making continues to evolve and now includes multiparty monitoring and evaluation of certain fuels reduction projects to assess whether ecological management objectives and administrative efficiencies are being achieved and whether the needs of rural communities are being addressed.[16]

Inadequacy of Federal Funding Alone

The inadequacy of funding presents another challenge to successfully reducing fuels and restoring forest health. The *Joint Cohesive Strategy* estimated to significantly reducing the long-term risk to communities and arresting the long-term decline of fire-adapted ecosystems could require a budget of up to $1.2 billion a year—about triple the fiscal year 2002 funding for fuels

[14] See, for instance, Jay O'laughlin. Federal Land Policy, Programs to Reduce Wildfire Risk and Improve Forest Ecosystem Health Must Overcome Barriers to Active Resource Management. Contribution No 913, Idaho Forest, Wildlife and Range Experiment Station, University of Idaho, 2000.

[15] See, for example, *Restoring America's Forest* and *Scientists Letter* sent to President Bush and Members of Congress on September 17, 2002 by a group of fire researchers and ecologists.

[16] *Present and Future Ability of the Forest Service to Enter into Stewardship Contracts*, Testimony by Andrea Bedell Loucks, Program Associate, Pinchot Institute for Conservation, July 18, 2002.

reduction.[17] This huge cost, coupled with projected budget deficits, will necessitate finding alternatives to relying on appropriated funds alone.

Giving federal land managers flexibility to use the full range of fuel treatment methods—including timber harvesting where appropriate to restore desired forest conditions—may offer some opportunities to offset the costs of fuels treatments and restoration activities. For example, ponderosa pine restoration studies in Eastern Oregon, Colorado, and Montana have concluded that comprehensive projects, including thinning, selective timber harvesting, and burning, can achieve ecological benefits and help pay for themselves.

Another potential source of revenue is the Forest Service's Stewardship Contracting Pilot Program. Under this program, the Forest Service is testing new authorities, processes, and procedures that include the exchange of goods for services and retention of receipts to offset the cost of performing desired hazardous fuels reductions. In addition, some of the projects receive contributions from cooperators.

Of the 32 projects for which fiscal year 2001 data were available, 20 included activities designed to reduce hazardous fuels. Planned activities included mechanical treatments (such as biomass thinning), commercial timber harvesting, fires set by federal land managers (prescribed fires), and crushing and mastication (chewing up) of surface fuels to protect resources in the wildland-urban interface. They were aimed at decreasing the risk of unwanted severe wildland fires, protecting valuable wildlife habitat, and improving overall forest health conditions.

Harvesting fire-damaged trees also provides potential source of supplemental revenue. Fire-damaged trees have a high mortality rate and lose much of their commercial value after approximately two years. If not harvested, they die and add to the fuel bed, increasing the risks of future large wildfires. After the Virginia Lake Complex Fire—studied by the Academy—the Colville Indian Reservation promptly harvested and marketed the fire-damaged trees to avoid wasting this resource. In contrast, on the three Forest Service fires included in the Academy's study, few of the trees were harvested because of the controversial nature of the practice, the length of time required to get approval, and the likelihood of legal challenges. Like mechanical thinning, salvage sales are viewed by some as an indirect way of justifying commercial timber harvesting.

The Bitterroot National Forest in western Montana provides a recent example of an effort to harvest post-fire timber on large tracts that burned in 2000. Earlier this year, after three days of court-ordered negotiations between the Forest Service and environmental groups, the Forest Service was allowed to begin harvesting 14,000 of the 41,000 acres it originally proposed to salvage. The parties who challenged the Forest Service proposal perceived it as a timber sale rather than a fire safety matter, and also argued that leaving the dead trees would benefit the natural recovery process. In the Bitterroot case, the negotiated compromise involved removing most of the designated roadless areas from the salvage effort.

Despite these difficulties, harvesting fire-damaged trees may be an option to consider on lands where such work would be consistent with the applicable LMPs and FMPs. As with other

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[17] *Predicting Outcomes*.

aspects of fuels treatment discussed in the previous section, having up-to date LMPs and FMPs that include salvage issues as explicitly as possible may help enable agencies that seek to use salvaging fire-damaged timber as a fuels reduction method to do so in time to capture the commercial timber values that could help offset associated costs.

Fuel Treatments as a Long-Term Investment

Another challenge associated with the fuel treatment program is that it will take many years before it will make a measurable reduction in nationwide suppression cost trends, even if funding is increased. The lack of a long-term cost-benefit approach to those costly and long-term investments makes justifying the increased funding more difficult. The Joint Cohesive Strategy demonstrates that fuel treatments have to be understood as long-term investments and focuses on the need to verify its reliability. To some extent, the effectiveness of fuel treatments in comparison with alternative fire program investments is now a matter of faith. The lack of trust in the federal land agencies, which has sometimes hindered meaningful communication between them and some interest groups, needs to be moderated to allow sound projects to proceed.[18]

Existing attempts to address this critical issue include the Joint Fire Science Program.[19] It is a peer-reviewed, science-based program designated to provide a comprehensive approach to fuels inventory and mapping, evaluating various fuels treatments techniques, scheduling of fuels treatments as a part of long-range planning, and monitoring/evaluating different fuels treatment activities. The successful implementation of this program will improve forest and land management by improving scientific rationales and tools for fuel treatments.

The Need to Prioritize

Because the magnitude of the fuels reduction remaining to be done is so vast compared to the amount of acres being treated currently, the *Joint Cohesive Strategy* and numerous other reports[20] call for increased, nationwide fuels treatment programs to respond to current and future conditions. But, even if the funding for these programs is significantly increased, not all areas could be treated, nor need to be treated to satisfactorily address the problem. Therefore, identifying and prioritizing the areas at highest wildfire risk is necessary.

Wildfires tend to be the most costly and destructive in community interface areas. Therefore, fuel treatment priorities should be high in these communities, and care should be taken to begin safety treatments in the communities before working outward to more remote, wildland areas in the vicinity. This is necessary to avoid potential disasters like the Cerro Grande fire that began as a remote prescribed fire, but burned out of control into the Los Alamos community. The distinction between wildland and community-interface for reducing wildland fire risk is important because they vary significantly in terms of the main objective of the fuel treatments.

[18] See Sierra Club: *Restoring America's Forests*.

[19] More information about the Joint Fire Science Program can be found at: http://www.nifc.gov/joint_fire_sci.

[20] To name just two: *2000 Report on the Policy Implications of Large Fire Management: A Strategic Assessment of Factors Influencing Costs*, A Report by the Strategic Overview of Large Fire Costs Team, Jan 21, 2000; National Association of State Foresters, *Cost Containment on Large Fires: Efficient Utilization of Wildland Fire Suppression Resources*, July 1, 2000.

In wildland areas, fire managers should be looking at improving the ecosystems' health and restoring historic fire regimes, taking into consideration ecological and scenic values that need to be protected. In contrast, fuel treatment efforts in community-interface areas should focus mainly on protecting lives and property. Those two areas require different criteria for evaluating their relative need for fuel treatments and should be analyzed separately.

Both the Congress and the federal land management agencies have recognized the need to prioritize fuels management projects. Responding to Congressional direction provided under the FY 2001 Interior appropriations act, federal land management agencies asked the states to submit a list of all the communities within their borders that are in high risk from wildfire based on a set of provided standardized criteria. The list that resulted from this effort consists of 22,000 communities,[21] which is far too many to treat right away. A more precise identification of the location of these areas, risk assessments of them, and prioritization is needed to target the areas that are at the highest risk from wildfires. This strategic planning process requires consistent nationwide data on vegetation types, fire condition classes, and values at risk, and these data should be detailed enough to support local planning. To be successful, this prioritization process should be based on consistent criteria established by a national body, such as the Wildland Fire Leadership Council, acting in consultation with affected state, local, tribal, and private stakeholders.

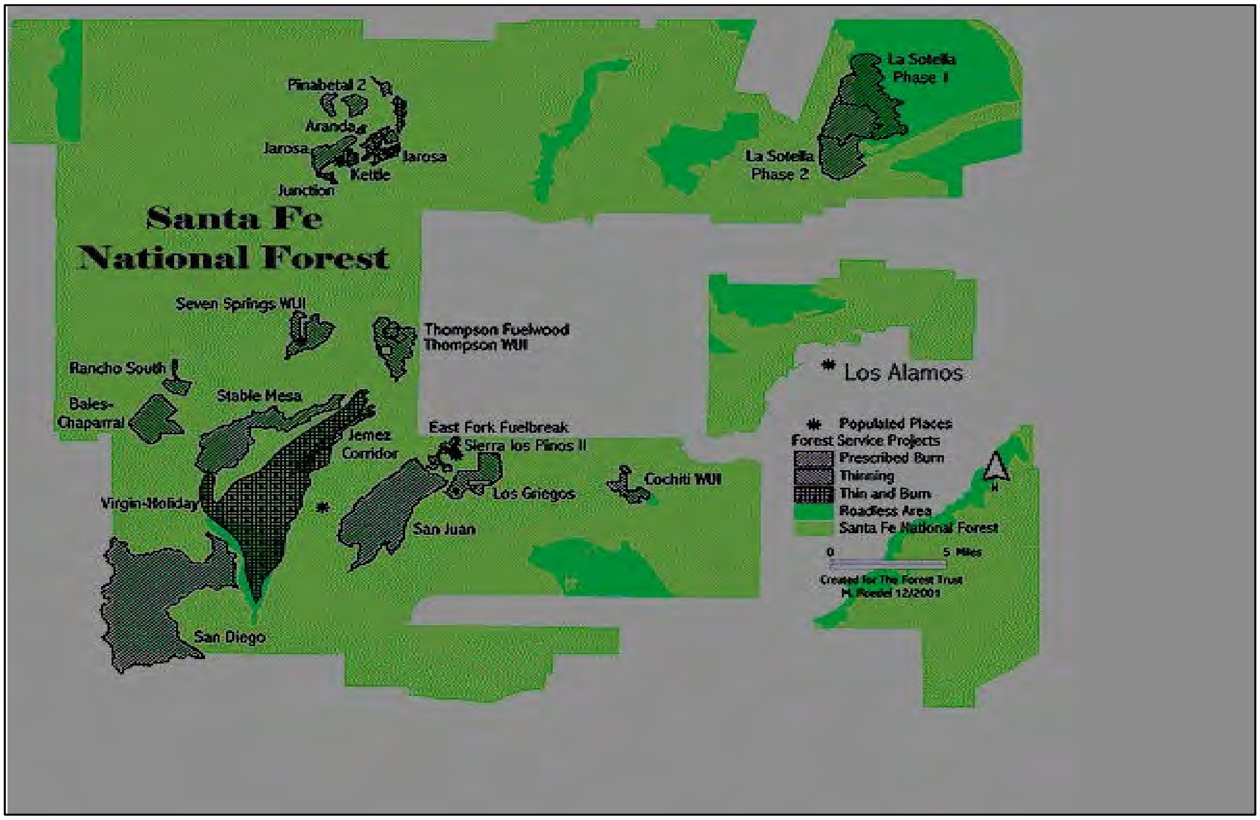
GIS technologies have already proved beneficial for such risk assessment using consistent graphic presentation of vegetation types and fire- condition classes in the context of other layers of geographic data—such as watersheds, roads, values to be protected (including ecological and archeological data), communities with structures and infrastructure, and other data. Such data could also facilitate the collaborative involvement of multiple stakeholders in solving local fuels challenges. While GIS is increasingly utilized, it remains limited primarily because of insufficient data, staffing, policies, standards, and resources to make full use of this capability.

Although technology that could be used for prioritization is readily available, it is not being widely used by the federal land management agencies for some of these purposes. Recently, the Forest Trust,[22] prepared a GIS map of hazardous fuel reduction treatment projects on the Santa Fe National Forest in New Mexico (see map below Figure 6-7). The map provides a view of how the fire plan is scheduling hazardous fuel treatments in and around this particular forest. In addition, the Forest Trust team developed a set of guidelines for thinning to reduce excessive fuels build-up that calls for implementing the projects in wildland-urban interface areas before proceeding with projects in wildland areas in roadless areas or threatened and endangered species habitats.

[21] A complete list of over 22,000 communities as published in the federal register on August 17, 2001 is available on line at http://www.fireplan.gov/community_papers.cfm

[22] More information on Forest Trust's work can be found on their website: http://www.theforesttrust.org

Figure 6-7. Hazardous Fuel Reduction Projects on the Western Half of the Santa Fe National Forest, New Mexico.



<u>Source</u>: http://www.theforesttrust.org/natfireplan.html

Based on their experience in this project, the Forest Trust concludes that "the Santa Fe National Forest does not have a methodology for mapping all thinning and burning projects to produce a cumulative analysis of their proposed projects. The Forest Service's main reasons for not having such a methodology are time and budgetary constraints." The bottom line is that such methodology should be developed to help federal land management agencies to determine which projects are the top priorities for hazardous fuels treatments and to work more closely with nearby cooperators.

LARGE-SCALE FUEL TREATMENT PROGRAMS

Faced with a dilemma of deteriorating health of many ecosystems and numerous challenges in responding to those problems, the Federal Wildland Fire Management Policy recognizes that land management agencies need to take innovative approaches to fulfilling their organizational missions through collaboration with affected agencies, state, local, and tribal governments, interest groups, and citizens. They all have significant interests in restoring the health of ecosystems and reducing their exposure to the hazards of destructive wildfires. The massive investments over long periods of time that are needed to address the excessive fuels build-up problem will require a multiparty, large-scale planning and budgeting process that crosses jurisdictional boundaries.

A good example of such an innovative approach to managing fuel treatment programs is the Fire Learning Network initiative, which is a collaborative effort of The Nature Conservancy, Forest Service, and Department of the Interior. The aim of this pilot project is to demonstrate how a process of using science and collaborative planning to restore 25 diverse landscapes across the nation can reduce wildfire risks. The large-scale areas chosen for this project are of mixed ownership and include federal, state, local, tribal, and private lands. Of 25 projects, five were chosen to serve as special demonstration sites. They are managed by project teams, which are required to develop conceptual ecological models of the structure and dynamics of their landscape's ecosystems. These models are aimed at answering four questions:

1. What is the current fire hazard status of the ecosystem?
2. How did the ecosystem get to this condition?
3. How is the ecosystem expected to become less hazardous in the future?
4. What is the desired future risk status of this ecosystem?

To answer those questions for each landscape area, the researchers are developing models for each landscape that describe them in terms of forest types, natural fire regimes, environmental factors and constraints, and the effects of human-caused disturbances and land uses. The Fire Learning Network encourages agencies' and partners' staff to work collaboratively to develop those ecological models, and then to use them as planning tools for fuel management purposes. Some of the teams have found the models useful in establishing a common understanding of ecosystem dynamics among stakeholders; others have used the models to create shared goals for landscape restoration. Whatever the approach was, the process of creating these models has resulted in intense interaction among the stakeholders. The Fire Learning Network program has been designed to produce fire restoration plans for 38 million acres across multiple ownerships.

Multiparty large-scale projects, such as these, require consistent and adequate funding that would ensure their continuance. Limited ability to finance those massive investments from federal sources, and the nature of the cross-boundary problem, calls for sharing the costs among all the parties affected. Also, it should be ensured that the best use of limited resources is being made—the funds are being directed to areas that are at the highest risk from disastrous wildfires, and the right mix of fuels treatments is being used.

One of the approaches readily available to address the need for consistent, multi-scale prevention and fuels management programs is the Risk Assessment and Mitigation Strategies (RAMS) program.[23] This new BLM-developed program integrates several previous wildfire risk assessment, prevention, and fuels treatment analysis programs into a single package designed to produce action plans and budget options for the fuels program. It offers a holistic approach that can be used by forest and land managers to identify and prioritize areas within planning units,

[23] More information about RAMS can be found on the BLM's website at http://www.nifc.blm.gov/nsdu/fire_planning/rams/

consider different prevention and fuel treatments options and choose the right mix of projects considering costs, benefits, and the individual unit's own priorities and management objectives. RAMS can be a helpful tool for developing the budget for different prevention and fuel treatments activities based on thorough analysis of the individual units' hazards, management objectives, and needs.

CHAPTER 7
COMMUNITY INTERFACE CHALLENGES

Human activity continues to migrate onto the nation's wildlands at an ever-increasing rate, with two main consequences for fighting wildland fires. First, this wildland-human interface reduces strategies available for fighting fire and, second, it increases firefighting costs.

This growth has occurred over an extended period without an adequate response. Almost all of these rising costs are paid by the federal government. The communities and other property owners attracted to these areas often take too little action to protect themselves. The federal wildlands once were far from civilization and managed as independent holdings. Today people are permanent inhabitants of wildlands and must face the accompanying risks.

In short, the ways of urban America have been inserted into the wilds with minimum adaptation. Wildfire is a natural occurrence, but most of these newly inserted human activities—which take many forms—are not adequately prepared for fire.

This chapter explores the growing wildfire risks, and options for addressing them, where nature and human activities come together. This challenge is often referred to by the federal land management agencies as the wildland-urban interface (WUI). It should be understood, however, that this term is used to refer to a very broad set of interactions between human activities and the nation's wildlands—not just cities and towns close to or surrounded by forests and rangelands, but also municipal watersheds, long distance power lines, and even individual houses among the trees. More will be said about this complex definition later in the chapter, but the problem will hereafter be referred to as the community interface.

THE BIG AND GROWING INTERFACE PROBLEM

The community interface problem is a product of two main forces. One is some individuals' urge to move into wooded or remote areas. The other is that these people tend to perceive these areas as safe, and they expect to be protected. There is no question that fields and forests are very attractive, but they can also be very dangerous if proper precautions are not taken.

Wildland Demographics

Forest Service and other reports in the 1990s have documented the expansion of urban, suburban, and exurban expansion into wildlands in the 1970s and 1980s, and have noted a quickening of this trend in the 1990s.[1] The joint Forest Service/Interior Cohesive Fuel Treatment Strategy draft emphasized how this trend is concentrating in some of the most hazardous wildfire states of the intermountain West. In one of those states, Colorado, a new study by the U.S. Forest Service projects that the number of people living in wooded areas will increase from 953,000 residents to

[1] *Restoring Fire-Adapted Ecosystems on Federal Lands: A Cohesive Fuel Treatment Strategy for Protecting People and Sustaining Natural Resources*, USDA Forest Service and U.S. Department of the Interior (April 2002 Draft), p. 3.

1.25 million by 2030—a 31 percent increase.[2] By the same year, 2.2 million homes are expected to "stand in fire-prone, forested areas of the Rocky Mountain West—a 40 percent jump from current levels."[3] Already, 30 percent of the state's population lives in the "red zone" where they are at high risk of wildfire damage.[4]

Perceptions of Risk

When they move into these areas, many new residents have little appreciation for the dangers from wildfires. They often come from areas where wildfire hazards were not a concern, and give them little thought. The area is attractive, and it allows the new residents to escape the more crowded and confining closed-in spaces of the city where neighbors and government restrictions seem to be ever-present. It is the wide-open spaces and greater freedom that most often attracts them.

Against this backdrop, it is difficult to give them a realistic sense of the danger they are in and the actions they should take to protect themselves and their property. In addition, local governments in these areas often are anxious to attract development, not to regulate it. So they seldom have active wildfire mitigation programs that could be interpreted as telling people what they can or cannot do with their property.

Add drought and the accumulation of hazardous fuels and the result is that the risk of catastrophic fire increases, the values to be protected escalate, and the costs of fighting fires in these areas multiply. When fire occurs, the most expensive methods of fire suppression become necessary and the federal government almost always bears most of the cost.

The Many Faces of Community Interface

It is not just the border of the city or the suburban tract that causes this expensive all-out suppression reaction, but also the municipal watersheds from which the residents get their water, the long distance electric lines that bring vital power to them, and other scattered facilities and homes. As the pictures in Figure 7-1 show, these evidences of human activity can be pervasive in areas that most people would not classify as "urban." But despite their non-urban look, they demand high levels of protection because of the human services and values that are threatened.

If the states and local governments desire to continue to permit such development, the way to avoid the added costs and dangers of catastrophic loss in these areas is to act before fire strikes to make these developments less hazardous and more defensible.

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[2] "Siren Song of the Forest Stays Strong," Mark P. Couchand and Kristi Arellano, *Denver Post*, June 30, 2002.
[3] Ibid.
[4] "30% Live Amid Wildfire Danger," *Denver Post*, David Olinger and Trent Seibert, June 23, 2002.

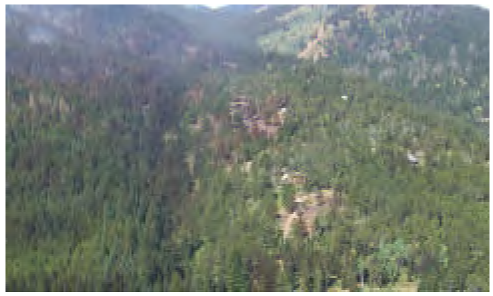
Figure 7-1. Many Faces of the "Community Interface"

Fire Approaching Urban Community

Municipal Watershed

Suburban Wildfire Burn-Over

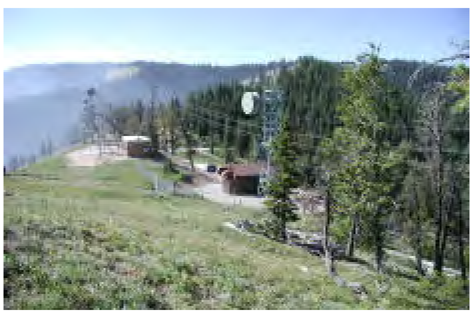
Rural Subdivision in Fire-Prone Wooded Area



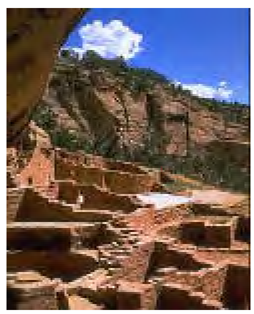
Isolated Rural Residence

Isolated Telecommunication Structure

Telecommunication and Power Lines on Federal Wildland



Cultural/Historic Values



NOT A RESPONSIBILITY FOR THE FEDERAL GOVERNMENT ALONE

The federal government has long been a prime leader in fighting wildland fires, and for the federal land management agencies it is a mature function. This makes sense because the federal government owns and manages so much of the nation's wildlands—approximating one-third of the nation, and much higher percentages of the land in many of the most fire-prone western states. But the agencies have traditionally focused primarily on their own lands rather than what is around them.

"Urban" firefighting oriented to protecting non-federal structures is not the federal agencies' normal function. Local fire departments, fire protection districts or associations, and others—wherever they exist—have responsibility for urban firefighting. So, at this new and growing interface, there is a need to create effective linkages among fire protection organizations as well. This overall task is underdeveloped at the present time. Although there are some relationships for linking firefighting activities, through mutual-aid agreements and some joint dispatching operations, much less cooperation has been achieved to reduce fuels and other fire hazards prior to ignition.

It is vital in the interface environment to create fuels treatment and wildfire hazard reduction partnerships as well as to strengthen multi-unit firefighting cooperation. The federal program cannot and should not take responsibility for or foot the bill and supply the workforce for the entire task. Ultimately, as the human presence in wildlands expands, losses of buildings, firefighters, and other lives will increase if better preparation does not occur.

EDUCATION AND VOLUNTARY ACTION IS NOT ENOUGH

For many years, the USDA Forest Service has sponsored the Firewise program in cooperation with the fire insurance industry and others. Firewise is administered by the National Fire Protection Association (NFPA), and its thrust has been to raise the awareness of property owners about fire hazards in wildland areas. Through lectures, brochures, and other informational media, NFPA has sought to motivate individual property owners to use fire-resistant building materials, leave space between buildings, create easy access for fire engines, and remove flammable vegetation and other materials near structures.

Despite this long-standing informational program, many property owners do not take such advice seriously until they actually experience a serious wildfire near their own property. For example, a survey of homeowners in Teton County, Wyoming (site of the large Green Knoll Fire near Jackson Hole in 2001) found a large gap between knowing about practices to protect their homes and actually taking recommended actions.[5]

Several authoritative reports over the past seven years have observed that this voluntary, information-based approach has not worked satisfactorily. For example, they have found that:

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[5] "Citizens' Knowledge and Actions Regarding the Green Knoll Fire," A Draft Summary Report by Dr. Jonathan G. Taylor, USGS, Fort Collins, CO, September 5, 2001.

- People moving from urban to wildland areas "give little thought to wildland fire hazard, and bring with them their expectations for continuation of urban emergency services. Further, property owners believe that insurance companies or [federal] disaster assistance will always be there to cover losses. There is a widespread misconception by elected officials, agency managers, and the public that WUI protection is solely a federal concern,"[6]

- Similarly, a July 2000 report by the National Association of State Foresters found that citizens and decisionmakers across the country remain dangerously unaware of the raw power of wildfires and the inability of local, state, and federal firefighters to protect development from catastrophic events.[7]

These and other reports[8] attribute much of the escalation of wildland suppression costs to permissive planning, zoning, and building regulations that allow poorly controlled development to occur in high hazard areas. This situation is aggravated by government and insurance programs that allow rebuilding in these areas without prudent protections. These studies have recommended a variety of mandatory zoning, fire safety, and building code regulations, plus improvements in basic fire protection infrastructure, insurance and fire-protection grading and rating systems, and fire protection agreements.

COMMUNITY INNOVATIONS

A number of communities have begun to find their own solutions to their wildfire vulnerabilities. Together, the following cases suggest a series of approaches that might be brought together as a "best practice" model for widespread use in the wildland-urban interface. Summaries of some of these approaches follow.

Three General Approaches

Several communities with high wildfire risks have begun to make themselves safer. Some are doing it on their own, but others are responding to three recent federal initiatives: (1) FEMA's Project Impact, (2) the multi-sponsored Fire Learning Network, and (3) the NWCG-sponsored Firewise Communities/USA project administered by NFPA. Each of these initiatives takes a somewhat different path, so it is useful to examine their general approaches before describing actual cases of communities, several of which participate in these new initiatives.

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[6] *1995 Federal Wildland Fire Management Policy & Program Review*. A review of this policy document seven years later found the situation had not changed: *Review and Update of the 1995 Federal Wildland Fire Management Policy and Program Review*, January 2001.

[7] *Cost Containment on Large Fires: Efficient Utilization of Wildland Fire Suppression Resources*.

[8] The additional studies referred to include: *Restoring Fire-Adapted Ecosystems on Federal Lands: A Cohesive Fuel Treatment Strategy for Protecting People and Sustaining Natural Resources* (April 2002 Draft); *Course to the Future: Positioning Fire and Aviation Management* (May 1995); and *Strategic Assessment of Fire Management* (January 1995). See Appendix D for full citations.

Since these are pilot programs, participation in them has been voluntary. Modest federal funding has been provided to some of the local participants. Although some characteristics of the projects have similarities, each community's project is unique.

Project Impact

As the nation's lead agency for coping with natural and other disasters, FEMA sees the job as four interrelated tasks: (1) **being prepared** to respond when a disaster occurs, (2) actually **responding** to an event/incident when it does occur, (3) **aiding recovery** from the damage, and (4) **mitigating the hazards** and risks that result in disasters. Over the past decade, FEMA has placed increasing emphasis on mitigation in order to help contain rapidly increasing costs in the other three phases of its program.

Project Impact has been the leading FEMA initiative to involve communities in mitigating their vulnerabilities to natural disasters—including floods, earthquakes, tsunamis, tornados, coastal storms (hurricanes), landslides, and wildfires. The purpose of the program is to encourage local communities to assess their vulnerabilities to whichever of these natural hazards affect them, and take action to make themselves "disaster resistant." It strives to be an "all hazards" effort in the community. The thrust of the program is to reverse the traditional top-down nature of most FEMA programs, make it bottom-up, and encourage local responsibility.

To participate in this pilot program, a community had to be nominated by its state emergency management agency. Each state could nominate just one community each year, and FEMA decided which ones to fund. Each funded community received a one-time grant of $300,000 to be used over a three-year period to begin its process of becoming disaster-resistant. Project Impact stressed the need for this process to become self-sustaining so it would continue in each community after the pilot funds ended.

The states decided what constitutes a community for purposes of this program. It could be a city, a county, a village, town, a combination of local jurisdictions, or some other geographic area. There were not consistent criteria.

Of the 250 Project Impact communities funded under this program, two chose wildfire disasters as their focus for making themselves "disaster resistant." They are Deschutes County, Oregon (the Bend metropolitan area) and Teton County, Wyoming (the Jackson Hole area where the Academy's Green Knoll Fire case study was conducted). The thrust of what these two communities are doing to reduce their vulnerability to wildfires will be described later in this chapter.

Building on Project Impact, the *Disaster Mitigation Act of 2000* (Public Law 106-390) takes this approach nationwide. It requires all states and communities to prepare natural disaster mitigation plans by November 2003 in order to remain eligible for FEMA mitigation funds after that date. This new program, which replaces Project Impact, is designed to facilitate integrating state and local mitigation planning and implementation. FEMA has issued regulations to govern the planning process, has begun issuing a series of "How-To Guides," and has requested $350 million in annual appropriations to support on-going planning at state and local levels. Wildfire is one of the types of natural disasters that must be included in these disaster mitigation plans to the extent that it represents a significant risk to the state or community for which the plan is prepared. This new planning process requires:

- Organizing the planning process
- Identifying the relevant hazards and assessing vulnerability to potential related losses
- Setting mitigation priorities and goals
- Evaluating potential mitigation measures, using benefit-cost analysis and other techniques
- Creating a mitigation plan and implementation strategy
- Incorporating special circumstances, such as historic structures
- Implementing the plan and strategy, including project funding
- Revising the plan periodically as changes occur

Fire Learning Network

The Fire Learning Network is a consortium of 25 organized conservation areas sponsored jointly by The Nature Conservancy, the USDA Forest Service, the Department of the Interior, the Landscape Conservation Networks Working Group, and the Rodney Johnson/Katharine Ordway Stewardship Endowment. The consortium's purpose is to encourage very large "landscape-scale" wildland fire management practices that cross many jurisdictional boundaries and bring together public and private leaders responsible for these entire areas to share, peer-review, and publicize their individual and joint accomplishments. Five of the 25 participating areas have been funded through the Network to demonstrate particular emerging best practices. The management tools that the Network is demonstrating include:

- Multi-scale ecological models
- Collaborative fire management goals
- Compatible and adaptive fire management strategies
- Cooperative agreements
- Long-term, multi-scale management and monitoring plans
- Cumulative effects analyses
- Collaborative funding proposals
- Community education plans
- Methods to reduce barriers to multi-ownership fire management planning

These conservation areas range between 22,000 acres and over 3 million acres. They have a strong natural ecology thrust, and some consist of nothing but wildlands. However, most involve some urban interface lands. The 2-million-acre Upper Deschutes Basin conservation area includes the heavily urban Deschutes County (Bend, Oregon) Project Impact community, which will be described later in the chapter. This combination of a community interface area with a much larger natural resources conservation area helps to illustrate how these two types of activity can work together.

Firewise Communities/USA

The Firewise program run by the National Fire Protection Association began an NWCG-sponsored pilot project in 2001 called Firewise Communities/USA. Through this project, NWCG's Wildland/Urban Interface Working Team seeks to encourage a community-wide approach to maximizing fire protection in selected communities. Seven communities entered the program in 2001 and six more in 2002. The objective is for these communities to:

- Enlist a wildland/urban interface specialist to complete an assessment and create a plan that identifies locally agreed-upon, achievable solutions that the community can implement.

- Sponsor a local Firewise task force, committee, commission or department which maintains the Firewise Community program and tracks its progress or status.

- Observe a Firewise Communities/USA Day each spring that is dedicated to a local Firewise project.

- Invest a minimum of $2.00 annually per capita in local Firewise Communities/USA efforts. (Work by municipal employees or volunteers using municipal and other equipment can be counted for meeting this requirement, as can state and federal grants dedicated to that purpose.)

- Submit an annual report to Firewise Communities/USA, documenting continuing compliance with the program's requirements.

Communities meeting all these proposed provisions would be recognized as Firewise Communities. NWCG expects to rollout this program nationwide in late September 2002. Examples of activities in these communities are provided later in the chapter.

Common Elements

All three of these pilot programs address, in one way or another, six main program features: (1) the geographic extent of the pilot project, (2) who will govern it, (3) the need for risk assessment, (4) the nature of required plans, (5) financing, and (6) project implementation. With respect to geography, all allow the participants to self-define the project boundaries. All also call for a collaborative body of some sort to govern the project and to identify an administrative home for it. Two require risk/vulnerability assessments, while the other requires ecological assessment with a cumulative effects analysis. With respect to financing, one looks for a long-term strategy to replace temporary start-up funding. Another focuses on collaborative funding proposals for proposed projects. The program looks for a self-sustaining program that maintains a minimum of $2.00 per capita annually. All three expect evidence of project implementation, although the nature of projects differs among them.

Table 7-1. General Characteristics of Community Interface Innovation Programs

Main Program Elements	Community Interface Initiatives		
	Project Impact	**Fire Learning Network**	**Firewise Communities/USA**
1. Geographic Area	Defined by state or applicant	Defined by participant	Defined by applicant
2. Governing Body	Local elected officials should be involved; integration into local governments; inclusive partnerships	Multi-owner collaborative body	Task force, committee, commission, or department
3. Risk/Vulnerability Assessment	Required	Ecological assessment and models; cumulative effects analysis	Required
4. Plans	Risk reduction plan Public education strategy and plan	Collaborative fire management goals, strategies, and monitoring Community education	A plan that identifies locally agreed-upon, achievable solutions that the community can implement
5. Financing	Long-term funding strategy	Collaborative funding proposals for projects	$2.00 per capita annual minimum Self-sustaining
6. Project Implementation	Implementation projects to reduce risk; promote public education Land use and building codes	Cooperative agreements for fire management and community education projects	Firewise Communities/(USA) Day Projects in the plan Annual reports documenting continued compliance

Innovative Communities

Following are brief descriptions of selected communities that illustrate the types of activities that are being pursued to make interface communities safer from wildfires.

Bend, Oregon

The FEMA Project Impact program for Deschutes County,[9] headquartered in Bend, Oregon, is one of two such projects that concentrate on wildfire hazard mitigation.[10] It is housed administratively within the county government, but it also works with the Bend city government, homeowners' associations, fire protection districts, the three-county Central Oregon Intergovernmental Council, and others. The Intergovernmental Council serves 10 local

[9] www.deschutesimpact.org
[10] The other Project Impact community that focused on wildfire is the one in Jackson Hole, Wyoming. It is described below.

governments and a population of about 150,000 on a land area of about 7,787 square miles (4.48 million acres).

The three-year, $300,000 Deschutes County Project Impact, which began in 1999 and is now coming to the end of its FEMA sponsorship, is exploring organizational alternatives for continuing after the end of the federal funding. During its FEMA-sponsored phase, the Project brought over $800,000 worth of projects to fruition. One of the keys to the Project's success has been its 25-person Steering Committee. This mechanism for overseeing the Project and promoting involvement in it is broadly representative of Central Oregon. It includes: insurance companies, media, county government, 911 Service District, federal land agencies, state land agencies, local business, chambers of commerce, private consultants, GIS professionals, fire agencies, law enforcement, community development (county), and homeowners associations. The Project has also been a member of and active participant in The Fire Learning Network (FLN) established in 2001 to focus on fire-related ecological stewardship in large areas that cross multiple land ownerships.[11]

The Upper Deschutes Basin FLN eco-region to which the county belongs is one of 25 nationwide that are learning from each other how to most appropriately manage these large fire-prone areas. The basin covers over 2 million acres and 100,000 people within the Intergovernmental Council's jurisdiction (nearly half the area). Although 71 percent of the eco-region is under federal or tribal management, the very sizable urban populations in several parts of the region add a heavy community interface element to the FLN project. In this setting, FLN brings together the interests of The Nature Conservancy, Deschutes National Forest, Ochoco National Forest, Prineville District of the Bureau of Land Management, multiple city and county governments, the Oregon Department of Forestry, and the bordering Warm Springs Indian Reservation. Within the area are four wildernesses, one national grassland, one national monument, one area of critical environmental concern, one wilderness study area, and two wild and scenic rivers.

Central Oregon is a fire-dominated ecosystem that puts expanding communities and populations at extreme risk unless they take adequate precautions. Over the past 25 years, the average size of wildfires has increased ten-fold to 10,000 acres, spurring the fire agencies to come together to share resources, programs, and public education efforts. The largest wildfire in the county during 2002, the Cache Mountain Fire near Black Butte Ranch, burned 4,200 acres and consumed two homes.

The Deschutes Project Impact has chosen to dedicate its efforts mostly to wildfire safety, education, and preparedness. Through local partnerships, government support, and business participation, the project involves its communities in creating and pursuing four long-term wildfire mitigation strategies:

- **FireFree** public education effort to encourage homeowners to reduce their own risk of wildfire by creating defensible space. This is a joint project of several fire departments, Bend Garbage and Recycling, several media companies, and SAFECO Insurance

[11] www.tnc-ecomanagement.org/Fire

Company.[12] The education effort also includes partnering in a statewide public service announcement program and support for various student and public educational projects.

- **GIS and Hazard Mapping** utilizing the advanced GIS mapping capabilities of Deschutes County to identify critical areas and facilities, geographically display information, and ensure that disaster planners who are identifying hazards and analyzing vulnerabilities have the most current data available to work with.

- **Address Signs** to be posted visibly at entrances to rural residential properties for quick identification by emergency vehicles.

- **Access and Egress Routes** in high-risk wildland areas to be improved to provide alternatives where only one exit/entrance exists now.

Project Impact has used National Fire Plan community assistance funds to help support its FireFree education program, create a new emergency egress route, add fire data to the county's GIS system, establish a multi-hazard emergency preparedness network (EPN),[13] and create a Project Impact website. As a result of Project Impact, Deschutes County has adopted a county-wide ordinance supporting greater fire safety through building codes. The project is also urging the county's three cities to enact similar provisions.

Within the larger Upper Deschutes Basin FLN area, community protection also carries high priority. National Fire Plan community assistance funds have been used there for the following activities:

Community Interface Fuels Management

- Common lands fuel treatments by the Sunriver Homeowners Association
- Ladder fuel reduction around 300+ homes in the LaPine community, using local contractors
- Treatment of 135 acres around the High Desert Museum by the Oregon Department of Forestry
- Community interface fuel treatment cost sharing by the Oregon Department of Forestry
- Hazard fuel reduction by the Walker Range Protection District
- Fuel treatment of 300 homes in the community interface by the Global Action Plan Livable Neighborhood Program
- Goat grazing to manage fire-prone vegetation

Fuels Utilization and Marketing Program

- Small wood utilization by the Central Oregon Intergovernmental Council

[12] http://www.firefree.org/

[13] QWEST awarded Deschutes County nearly $50,000 to set-up the EPN network. EPN is the name of QWEST's system.

- Dry kilns for Juniper utilization, by the Northwest Wood Products Association

Prescribed Burns Planned in Fall 2002 (an illustrative example of systematic project scheduling by multiple parties)[14]

- September 5—3000 acres
- September 9—3000 acres on one site and 1040 on another
- September 15—4150 acres on private, BLM, and National Monument lands
- September 17—400 acres on National Monument land
- September 19—1800 acres on National Park Service, private, and BLM lands
- September 21—1200 acres
- September 24—120 acres
- October—200 acres

One particularly noteworthy activity is a biomass utilization project at the 4000-lot Sunriver Resort community that involves multiple cooperators and some federal funding.[15] It combines the resort company's operation of the sewage treatment plant and two golf courses with the homeowner association's program of brush clearing and disposal, and is being promoted and assisted by the Deschutes County Soil Conservation District which believes this project can be a model for other such activities. The district secured a National Fire Plan grant to help develop this demonstration. Before the project began, the homeowners association cleared brush from the community's common areas, collected brush cleared from individual homeowners, took all the material to a nearby meadow, and burned it. Now the association chips the material and delivers it to the resort's sewage treatment plant for use in composting sewage sludge. The resort uses some of the compost on its golf courses and sells some back to the homeowners association and individual property owners for use as fertilizer and mulch. The project reduces air pollution and homeowner complaints about burning, and enriches the naturally poor soils in the area. Although the sponsors anticipate this practice will produce savings, and have experienced some already, it is not far enough along to have had a thorough economic analysis.

Boulder, Colorado[16]

Boulder County, the county surrounding the City of Boulder 35 miles northwest of Denver, is one of Colorado's ten counties along the Front Range where explosive population growth is surging into fire-prone, mostly forested wildlands. Many of the county's people live in the Red Zone outlined by the State Forester to designate lands at high risk of large-scale wildland fire.

Although this danger had been growing in the county for many years, the 1989 Black Tiger Fire, which burned 2,100 acres and destroyed 44 homes, forever changed the way wildfires are treated in both the city and the county. This event initiated a drive to mitigate wildfire hazards rather than to merely respond to wildfires when they occur. Another major fire in 1990 reinforced this drive, and many more have occurred in or near the county since then.

[14] www.fs.fed.us/r6/centraloregon/mediainfo/news/020906blmprescribe
[15] www.jgpress.com/BCArticles/2002/010237
[16] This section is based on information supplied by Nan Johnson, Land Use Review Planner, City of Boulder Planning and Development office

The County Commissioners took the lead in 1989 by establishing the Boulder County Wildfire Mitigation Group (BCWMG) to bring community leaders together to work on wildfire issues.[17] It is chaired by the county's chief building official (from the county Land Use Department), is staffed by a wildland fire coordinator and others, and now has two other important subgroups working with it. By 1990, the City of Boulder also had established a wildland fire coordinator and launched a complementary effort.[18]

Under Colorado state law, the county sheriffs have the lead for disaster response, including response to wildfires.[19] In addition, a state law enacted in 2000 enables all counties to prepare, adopt, and implement collaboratively developed countywide fire management plans covering all state and county properties in the county. In counties that choose to follow this new approach, the plans are to detail county policies on fire management for prescribed burns, fuels management, and natural ignition burns. The sheriff is designated to oversee the process in collaboration with the State Forest Service and appropriate state and local entities. Public involvement is also required. Federal and private lands in the county may be included in the plan under the terms of memorandums of understanding between the county commissioners and the other parties, although the plan is prohibited from infringing on the ability of agricultural producers to conduct burning on their own properties. Counties that adopt such plans are accorded liability protection, and the federal Bureau of Land Management is working with some of the state's counties to help fund and implement this legislation.

In the Boulder area, however, wildfire hazard mitigation did not wait for this law. It has much earlier roots and has been maturing apart from this recent statewide initiative.

Boulder County has taken a strong, proactive, interagency, cross-jurisdictional approach to wildfire mitigation and emergency response. Its jurisdiction extends from the Great Plains on the east to the Continental Divide on the west. In rural parts of the County, much of the private land is developed in large-lot residential properties. Four water reservoirs are located in the mountains. The county also includes a state park and several large federal holdings. The federal lands include the Arapaho and Roosevelt National Forests, Rocky Mountain National Park, and lands under the control of the Bureau of Land Management. There are also four small, incorporated mountain towns. The eastern part of the county contains five small cities and large agricultural grasslands many of which are protected from development.

The county's wildland fire coordinator oversees the review of site plans for new development, public education efforts, coordination of BCWMG and subgroup activities, wildfire mitigation projects, and acquiring grants and other assistance to support these activities. Among these activities, one of the most important is the Wildfire Hazard Identification and Mitigation System Working Group established in 1993. It is in charge of developing a powerful geographic information system (GIS) that brings together information from a wide variety of local, state, and federal sources to support wildfire hazard identification, risk assessment, homeowner education and motivation, pre-attack planning, emergency response, land use planning, and disaster

[17] Boulder County Land Use Department at http://www.co.boulder.co.us/
[18] City of Boulder Fire Department & City of Boulder Planning Department at http://www.ci.boulder.co.us/
[19] Boulder County Emergency Services at http://bcn.boulder.co.us/emergency

assessment. This system is known as the Wildfire Hazard Identification and Mitigation System (WHIMS). It is considered to be a major breakthrough because of (1) the large number of cooperators brought together to create and use it, (2) its role in tying together all facets of the wildland fire program, and (3) its role in facilitating communication among all the affected parties, including homeowners and the public. WHIMS puts all types of information into the GIS format, makes sense of it, and makes it available in easily understood formats for a wide variety of users. The county land use department provided a long-range planner to manage the program; a county GIS technician provided 10 percent time to implement it; and the State Forest Service provided $21,500 for materials and supplies. Volunteer firefighters and Student Conservation Association Fire Education Corps volunteers (supplied through a state forest service program) are used to gather some of the local property and survey data needed by the system. In addition, the City of Boulder also contributed $100,000 to include information around the edge of the City and created a complementary GIS capability within the City.

Based on this work, the county added a natural hazards element to its comprehensive community development plan that discourages new development in fire-prone areas and seeks mitigation of the hazards created by any new development there. New developments proposed in fire-prone areas are required to undergo site plan reviews by the county and the State Forest Service. Volunteer fire districts are also invited to participate in the review. The site plan review process depends heavily on field visits and the plans submitted by the applicant.

The county works closely with the 19 independent fire protection districts within it, as well as with the City of Boulder and others, to achieve many of its fire mitigation goals. The State Forest Service provides technical and financial assistance.

Another notable initiative of BCWMG is the Boulder County Ecosystem Cooperative. Established in 1996, it has a much broader ecosystem health mission than wildfire hazard mitigation alone, but it contributes very substantially to the wildfire program through its attention to forest insect and disease cycles, wildlife habitat, watershed and water quality, land use, and ecosystem restoration. As a consortium of environmental groups, private landowners, public land agencies, and other stakeholders, it works across boundaries to develop, implement, and monitor landscape-scale forest restoration projects.

Since 1998, the Cooperative has been pursuing a 38,000-acre demonstration of restoration practices in a public/private urban forest area known as Winiger Ridge. This five-year Forest Management Reinvention Pilot Project, one of more than 20 being partially funded by the Forest Service, is demonstrating the value of:

- Developing community collaboration and participation
- Developing a boundary-less, ecosystem-based landscape assessment and action plan
- Economically sound means of pricing, extracting, and disposing of small-diameter wood products and wood wastes

Among the wildfire mitigation accomplishments within the Winiger Ridge project are:

- Prescribed burns and thinning on several plots of land owned by local, state, and federal governments, and private parties
- Stewardship plans for thinning on private lands, and at one of the public water supply reservoirs
- Roadside fire breaks by the City of Boulder
- Defensible space around 37 houses performed by a fire protection district
- A local forest product industry focus group meeting to identify opportunities and challenges for marketing and utilizing small-diameter material produced by forest restoration activities
- Visits to private landowners to provide wildfire mitigation technical assistance
- Two forest information and demonstration fairs to demonstrate "light on the land" harvesting of small-diameter wood products

The County also has a program that shares the costs that mountain communities incur for chipping and disposing of materials removed to create defensible space each year. The communities hire contractors to do the work, and the County pays 40 percent of the costs for up to four days of work. The communities pay the rest.

The City of Boulder began its wildland fire program in 1990 when it hired its first wildland fire coordinator, who is funded by the fire and parks departments. The 27 square mile city owns 40,000 acres of public land that requires fuels management, but otherwise is relatively fully developed. Its population is 104,000, including 25,000 students at the University of Colorado. The city's wildland fire management staff includes a division chief, a wildland fire management officer, a wildland fire mitigation supervisor, a prescribed fire management specialist, and a seasonal mitigation crew.

The City has banned wood shake roofs and developed an aggressive open space fuels management plan for its parks and other public areas. The open space plan features both prescribed burning and mechanical thinning. Additional building code and land use regulations relating to wildfire safety may result from its GIS mapping and analysis program.

The Boulder area presents complex challenges for coordinating wildfire suppression activities. Under Colorado law, the Boulder County Sheriff leads this effort, and the Boulder County Firefighters Association provides a discussion forum for working out issues and procedures. Although, wildfire response is coordinated by both local and federal interagency dispatch centers, these centers are not always well coordinated.

Mutual aid and cost sharing among firefighting units on a fire are provided for under a state-federal master agreement and subordinate state-local and local-local agreements. The presence of 19 separate volunteer fire protection districts within Boulder County presents a significant coordination challenge. There is no central repository for all the intergovernmental agreements.

The state provides limited financial assistance to counties and local fire departments to help defray both suppression and preparedness costs.[20] The first line of assistance for covering

[20] Colorado State Forest Service at http://www.colostate.edu/Depts/CSFS/

suppression costs is the Emergency Fire Fund, which is contributed to annually by member counties. When it runs out, the State Emergency Disaster Fund is called on, and then a gubernatorial executive order. Unusually high suppression costs may also be covered by a FEMA emergency fire fund. Also, the State Forest Service may share costs for preparedness, covering such items as training and equipment, under a discretionary grant program. However, that program is generally insufficient to meet the need.

Overall, the Boulder area has several attributes that serve it well in fighting wildfires. For example:

- The City of Boulder has trained 200 city and county firefighters in wildland firefighting techniques.

- The Cherryvale Fire Protection District maintains a four-person, seasonal ignition management crew in a particularly fire-prone area (known as Flagstaff Mountain) from May through September, as well as a 16-foot fire-equipped Zodiac boat on the Denver Water Board's Gross Reservoir. When these units are not fighting a fire, they are used on fuels management projects.

- The Cherryvale crew and the City of Boulder mitigation crew together comprise a larger group known as the Flagstaff Handcrew.

- With assistance from the State Forest Service, Cherryvale has also acquired several wildfire-equipped fire engines.

- An interagency Rocky Mountain Helitack unit was established in 2001 to support all of Boulder County's wildland firefighters on an on-call basis. It is a dedicated resource, always available even at the height of the fire season when other resources are unavailable. It is a contract resource arranged for by the non-profit Boulder County Wildland Fire Cooperators, a subgroup of the Boulder County Firefighters Association. An intergovernmental board governs the project, and the cooperating parties contribute the required funds to support it. This special unit significantly reduces response times on wildfires and can be used to meet other emergencies in the county when not on a fire.

While wildfire mitigation and emergency preparedness for wildfires has come a long way since the Black Tiger Fire in 1989, many challenges still lie ahead for the City of Boulder and Boulder County. The region is expected to see a continuation of existing severe drought conditions. These challenges include the following:

1. Sustaining the City's wildland fire response and mitigation capabilities of the Wildland Fire Mitigation and Response Crew with anticipated funding cuts in the city's budget.

2. Making sound plans for recovering from potential wildfire disasters.

3. Accurately determining potential economic losses to the city and county from a wildfire disaster in terms of risk and vulnerability assessments.

4. Maintaining commitments and dedicating resources to existing programs such as the WHIMS to provide local volunteer districts with the accurate maps and other information and tools they need to safely respond to wildland fires.

5. Helping local volunteer fire districts to safely protect homes in areas that lack easy access or water.

Continued leadership cooperation, interagency partnering, and public involvement will be needed to meet these challenges.

Flagstaff, Arizona[21]

The City of Flagstaff is the largest city in Northern Arizona and the main regional trade and educational center for that part of the state. With a population of 54,000 and an elevation of 7,000 feet, the city is situated at the base of the 12,600-foot San Francisco Peaks. It is also near the Grand Canyon, and is surrounded by the Coconino National Forest. Sections of the Kaibab and Prescott National Forests are also nearby, along with the Navajo and Hopi Indian Reservations. The area is known for its clear skies, clean air, and a high-desert climate.

The area is highly susceptible to wildfire damage and its people are well aware of the danger. The Radio Fire on Mount Elden 25 years ago caught their attention, the severe fire season of 1996 catalyzed their leaders, and the Rodeo and Chediski fires that merged in 2002 not far to the south and became the largest wildfire in the state's history reinforced this awareness and added a new sense of urgency.

The City of Flagstaff and Coconino County both have active wildfire protection programs, and have joined coalitions for both hazard mitigation and fire suppression. For suppression, the Ponderosa Fire Advisory Council meets monthly and brings together the Flagstaff Fire Department, other area fire departments, law enforcement, and emergency management personnel to coordinate plans for fire suppression and emergency response.

For mitigation, the Greater Flagstaff Forests Partnership takes the lead. It has 21 partners and a non-profit corporation to provide a paid staff of two, plus an office, an annual operating budget of about $100,000, and a website (www.gffp.org). The Partnership's organizational structure includes a Board of Directors, an Advisory Board, and a Management Team. It is associated with about 70 research projects as well as eight forest treatment projects and many educational and small business stimulation efforts.

Mitigation of wildfire risks is the primary focus of the Flagstaff approach. The effort revolves around landscape-scale forest restoration. Its philosophy is that the most cost-effective way to prevent catastrophic wildfire is to restore forest health on a broad scale. The Partnership believes that reducing fuels around homes, although essential, is not enough. Even if it saves homes with defensible space around them, a fast moving, high intensity wildfire with spotting ahead of it can

[21] The information in this section is drawn from a paper on the Flagstaff experience prepared for the Academy by Dr. Kathleen Hemenway. It is published in Appendix I.

easily breach an urban buffer and can also incinerate the nearby forest, destroying the community's watershed, real estate values, tourism, recreation, and infrastructure, as well as its aesthetic values. For this reason, the community defines its urban interface as including everything up to the top of the San Francisco Peaks.

The Partnership's members include:

- Arizona Game and Fish
- Arizona Public Service
- Arizona State Land Department—Forestry Division
- City of Flagstaff
- Coconino County
- Coconino Natural Resource Conservation District
- Cocopai Resource Conservation and Development District
- Ecological Restoration Institute at Northern Arizona University
- Flagstaff Chamber of Commerce
- Flagstaff Native Plant and Seed
- Grand Canyon Trust
- Highlands Fire Department
- Indigenous Communities Enterprises
- Perkins Timber Harvesting
- Northern Arizona Conservation Corps
- Northland Youth Conservation Corps
- Northern Arizona University College of Engineering
- Northern Arizona University School of Forestry
- Society of American Foresters—Northern Arizona Chapter
- The Arboretum at Flagstaff
- The Nature Conservancy
- U.S. Fish and Wildlife Service

The presence of Northern Arizona University and its multidisciplinary forest ecology and related researchers in Flagstaff has attracted a great deal of wildland fire research funding and expertise. Federal funding for research and action projects brought into the region through the Ecological Restoration Institute of NAU, alone, amounted to $11.6 million in fiscal years 2001 and 2002. The work has proceeded along the four main tracks noted next.

- **Forest Restoration and Fuels Treatment.** The Forest Service has completed about 3,000 acres of restoration work, but has been slowed significantly by environmental appeals by groups that are not part of the Partnership. In addition, the Flagstaff Fire Department's fuel management crew cleans up about 1,500 acres of public and private land in the city annually. At the state level, the State Land Department and the University of Arizona Cooperative Extension Service provide a correctional crew from a nearby prison that is cleaning up increasing amounts of private land in the county each year. Other local fire departments in the area are also beginning treatment projects.

- **Utilization of Small-Diameter Timber and By-Products.** Research contracted for by the Partnership to help establish an industry in Northern Arizona utilizing small-diameter timber has established that there are no technical or market obstacles. The problem is the lack of infrastructure due to uncertainty about a steady supply of material in the area. What is needed, then, is active management of the supply, and the NEPA process is an important part of that management problem. Small-diameter thinning projects must flow steadily through the NEPA process in order for the industry to establish a sawmill for logs of five-inch diameters and more. Studies to identify locations for such sawmills and related infrastructure are underway. In addition to lumber, the industry would produce laminated beams, compressed flooring materials, and molded wood products.

- **Fire Safe Construction and Vegetation Management.** The City of Flagstaff and Coconino County both require developers of new subdivisions and individual homes to submit plans for wildfire risk mitigation and emergency response. Within the City, whose boundaries extend far into undeveloped territory, the fire department works with developers to develop Forest Stewardship Plans. In addition, a new regional plan specifies that vegetation must be managed on ridges and steep slopes. One recent plan for a new development in the county comprehensively covers topics such as fire safe construction, vegetation management, power lines, house address marking, water supply and fire hydrants, emergency access and egress, a safety zone and helipad, and fire department response. The developer is using the plan as a selling point, and many of its provisions are being incorporated into the development's covenants. Flagstaff's ordinances require fire-resistant roofs (and roof sprinklers in some cases), but not many of the other provisions in the model wildland codes.

- **Public Outreach.** Extensive public education and outreach activities are provided by many organizations in Flagstaff, including the Forests Partnership, the fire department, Northern Arizona University, environmental groups, and The Nature Conservancy. Activities include neighborhood talks, Firewise meetings, mass media coverage, a special newspaper insert, interpretive hikes, pamphlets and brochures, and professional meetings.

Many challenges remain. Steps recommended in a July 2002 report by the Governor's Forest Health/Fire Plan Advisory Committee include increasing funding for community-based programs, acquiring more federal matching funds, promoting forest restoration businesses, overcoming environmental-review delays and smoke issues surrounding prescribed burning, improving coordination among communities, expanding use of the Firewise program, and focusing more effectively on post-fire rehabilitation.

Jackson Hole, Wyoming

Teton County, Wyoming, the center of the Jackson Hole resort area, was designated as a FEMA Project Impact community in 1998. Its three-year designation and funding expired in December 2001. However, it plans to continue on the path to disaster mitigation begun under the FEMA program. The county's vulnerability to disaster is primarily from wildfire, so its Project Impact work focused largely on that hazard, with floods and earthquakes as secondary concerns.

The county's previous 22-year old disaster plan was primarily designed to guide response. Project Impact funded a mitigation professional on the county staff and resulted in a new disaster plan in 2002 that is also a mitigation plan. The keys to the mitigation program are:

- A Disaster vulnerability assessment and plan, developed in consultation with over 40 agencies

- A field guide to all the agencies' policies, procedures, and contact numbers

- Maps showing property location and its vulnerabilities to natural hazards

- A Multi-hazard, interactive website where the new hazard maps can be accessed, and where links to Firewise and other information sources can be found to tell citizens how they can prepare for wildfires and to help schools explore related issues in geography and social studies classes

- Citizen workshops and attitude surveys about wildfire issues to raise their visibility

The Greater Jackson Hole Area in northwestern Wyoming includes Grand Teton National Park, the Bridger-Teton National Forest, the National Elk Refuge, Teton County, and the Town of Jackson. Perhaps the most notable feature of the wildland fire program in this 5 million acre area is the high degree to which all of these jurisdictions have integrated their fire management activities into a tightly knit partnership. This partnership began developing in 1994. Now, practically everything is done together, including:

- Federal interagency and community-based firefighters (from Teton County and the Town of Jackson) train together each spring and early summer, including cross-training on each other's equipment

- Agreements among all these parties allow them to fight fires together, not withstanding their formal jurisdictional boundaries

- All parties support the interagency Teton Crew (Type 3, 10-person) for initial attack

- The federal agencies also jointly support the Fire Information Center located in Jackson, and its nationally acclaimed website (www.tetonfires.com), plus two Type 3 helicopter rappel modules, and a joint environmental assessment for developing a new helibase at the Jackson Hole Airport

- Federal interagency management consolidation and shared fire-related positions, including interagency positions for fire planner, fire prevention officer, GIS coordinator, education and information specialist, and a fire effects monitoring team

- Interagency fire management plan under development

- Joint fuels management crew that focuses on mechanical hazard reduction near developed areas

- Prescribed burn partnerships with Wyoming Game and Fish and non-profit agencies

These close relationships moved the National Park Service to promote the Teton Area program as a model for the rest of the nation.[22] When the 4,470-acre Green Knoll Fire occurred in 2001, all this partnering paid off in remarkable success. The Academy's case study of this fire found that the community was highly pleased with the effectiveness of the firefighting effort.

Prescott, Arizona[23]

Prescott is a city of about 34,000 people, roughly half way between Phoenix and Flagstaff. It is a highly regarded retirement community and is also home to 28 youth camps that can house up to 12,000. The city's downtown is in a mile-high basin, but many of its neighborhoods are nestled in the surrounding mountains. The city shares 19 miles of border on the south and west with the Prescott National Forest, and state lands lie to the east.

Much of the vegetation in the area is ponderosa pine and chaparral. A community-interface assessment in 2000—which classified neighborhoods by vegetation (fuel type), access, infrastructure, and topography—identified 14,000 houses (home to 30,000 people) as being at high risk from wildfire. That is over 88 percent of the city's population.

The city's vulnerability is recognized, and leaders have been addressing it for a dozen years. The Prescott Area Wildland-Urban Interface Commission has the lead in this effort. It is a non-profit corporation established in 1990 by the city manager, the chairman of the county board of supervisors, and the national forest supervisor—largely in response to the 24,000-acre Dude Fire 60 miles to the southeast. That fire took the lives of six firefighters.

In 2002, wildfire came even closer. The Indian Fire began on May 12, 2002 just three miles south of town in the National Forest. It was a catastrophic crown fire with stand-replacement intensity that burned 1,300 acres of federal land, 30 acres of private land, five homes, and two outbuildings. In addition, the fire significantly damaged portions of the city's watershed and threatened 2,000 additional homes. The fact that this fire was stopped rapidly and did not do more damage has been attributed to several factors: fuel reduction treatments in the adjacent national forest, defensible space created in adjacent neighborhoods, a well coordinated emergency response, and a speedy air attack mounted by the Forest Service.

One of the Interface Commission's early successes was formation of the Interagency Fire Emergency Management Group, which concentrates on firefighting preparedness. Having this supplemental organization in place leaves the Commission free to focus on fuel treatment and forest restoration. Using dual organizations for these purposes is a common strategy in Arizona.

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[22] www.nps.gov/fire/success/grte (06/07/02)

[23] The information in this section is drawn from a paper on the Prescott experience prepared for the Academy by Dr. Kathleen Hemenway. It is published in Appendix I.

The Fire Group has held regular emergency response drills every year since being formed in 1990. These drills work out issues of interagency cooperation, teamwork, assignment of responsibilities, and the logistics of transitioning from a single-unit to a multi-unit effort over the course of an emergency. Prescott has placed greater emphasis on emergency response and evacuation than other Arizona communities, and it seems to have paid off in this 2002 fire incident. It has brought together strong leadership from the following cooperators: Prescott Fire Department, Central Yavapai Fire District, Prescott National Forest, Arizona State Land Department, and Yavapai County Office of Emergency Management. In addition, the Forest Service has located its Prescott Fire Center at Prescott's municipal airport.

Another of the Commission's major successes is the cleanup of fire-prone neighborhoods. In the Kingswood Estates neighborhood, 90 percent of the lots have been treated. In Timberridge, a newer project, 60-70 percent of the lots have been treated. These neighborhood cleanups are advocated and coordinated by volunteers. The Timberridge neighborhood is one of the first-year Firewise Communities/USA pilot projects, and the Prescott Commission has received national recognition from Firewise as a model for interagency and inter-jurisdictional cooperation and citizen involvement.

Although the Commission's cooperators include the city, the county, the Central Yavapai Fire District, the Arizona State Land Department, and the Prescott National Forest, the Commission has no paid staff, no office, and no website. It relies heavily on volunteers, half of whom are retired and have a great deal of skill, time, and commitment to offer. Nevertheless, the Commission holds monthly meetings that are now attracting about 40 people—including a number of organizations that are not formal members: the Prescott Yavapai Tribe, the county Extension Service, a church camp director, the owner of a waste hauling and salvage company, an insurance agent, and a realtor. In addition, federal funding is now playing a significant part in Commission-sponsored activities.

- A 2002 National Fire Plan grant of $230,000 with a 50/50 match is supporting a variety of brush-clearing projects in the city, youth camps, and state lands, as well as emergency evacuation plans for the youth camps. The corresponding amount in 2001 was $168,000.

- A 2001 National Fire Plan grant of $29,000 with a 75/25 match supported research into ways to use woody material generated by forest thinning and efforts to create defensible space in neighborhoods.

- Over the past two years, FEMA has funded two wood chippers with a 50/50 matching grant.

- Other FEMA funding to the county office of emergency management has supported a chipper for clearing roadsides (50/50 match) and a 100 percent reimbursement for costs of the 2002 Indian Fire.

The Commission also promotes a number of other well-organized activities. They include fuel treatments and forest restoration projects, utilization of by-products, fire-safe neighborhood regulations, and public education. These projects are briefly summarized next.

- **Fuel Treatments and Forest Restoration.** The Prescott Fire Department and Central Yavapai Fire District run a brush-removal crew and two two-man chipper crews. The Commission also has access to brush-crushing equipment and crews from the National Forest for use on non-federal lands after the federal work is complete. The National Forest has a 12,000-acre project underway for restoring the forest around the city, and another 30,000-acre project going through the NEPA process. In addition, individual contractors are available for hire by private landowners, and they advertise regularly in the newspaper.

- **Utilization of By-Products**. Fuel treatments in the forests and creation of defensible space in the neighborhoods produces large amounts of vegetation that needs to be removed from federal and non-federal properties. The material from the National Forest includes small-diameter trees. Currently, only one firm in Phoenix has been willing to buy this material, and it cannot take it all. A pulp and paper mill in Snowflake, Arizona had to close in the late 1990s because the Forest Service could no longer provide long-term contracts to keep it supplied with raw materials. The Commission has a research project to find new ways to use the materials, and a local waste hauling and salvage company has a business development grant from the Forest Service to expand it's green waste operation. However, the company's grant has been delayed by the Forest Service funding freeze imposed to help pay for 2002 fire suppression costs. The Commission is also in discussions with the groups working on this problem in the Flagstaff and White Mountains areas of Arizona.

- **Fire-Safe Regulations.** Spurred by the 2002 Indian Fire, the Prescott City Council adopted the 2000 International Fire Code and the 2000 Urban-Wildland Interface Code, with some amendments. These codes place construction and vegetation management requirements on new homes in at-risk neighborhoods, plus water supply and road requirements on new subdivisions. The Prescott Fire Department had already been working with developers of new subdivisions for a year on a voluntary basis to make them conscious of the need for defensible space, and several developers have made these features selling points for their developments. The city's codes override any conflicting private covenants in the neighborhoods.

- **Public Education.** The Commission believes that public education is one of its most essential continuing activities. It helps ensure that even newcomers to the community realize the wildfire dangers and comply voluntarily with good practice as well as city codes. Initially centered around neighborhood meetings, the Commission's education program now includes additional features such as annual town hall meetings (that attract up to 800 people), promotion of the Firewise Communities/USA program, widespread distribution of brochures and pamphlets, a 15-minute video presentation, a tour by the Texas Forest Service Wildland Fire Trailer (which contains exhibits and an interactive computer program that allows residents to assess their homes' fire risk), identification of plants for defensible landscaping for sale at a local nursery, a poster contest for school children, and frequent newspaper articles. Plans are underway for a cleanup demonstration program and a "Regional Alert" emergency information website.

Nevertheless, significant challenges remain. Most significant, perhaps, is the lack of a robust market for wood chips and small-diameter timber. The lack of an office, paid staff, and a comprehensive website also limits what can be done. In addition, progress continues to be held back by public attitudes and inertia that pits safety against aesthetics. Even at best, forest and neighborhood cleanup plans will take a decade or more, but many leaders worry that the next big fire in Prescott may not be that far off.

San Diego, California[24]

San Diego County is at the southwest corner of California, bordering Mexico. With a population of almost three million people, it is California's second most populous of 58 counties, and the third largest in land area. It stretches from the Pacific Ocean eastward to mountain peaks of 6,500 feet. Most of the county is hilly or mountainous, and very dry, but its extensive freeway system encourages commuting from large-lot country-living areas. Although the county is dotted with reservoirs for catching sparse rainfall, it is highly dependent on outside water supplies.

Irrigated residential and agricultural areas intermix with Indian reservations and public lands. Governments own 54 percent of the land in the county, and half of that is federal—either in the Cleveland National Forest or military bases. The natural vegetation is mostly chaparral, although some cedar, fir, and Jeffrey pine are found at higher elevations in the national forest. Sparsely populated private properties occupy 140,000 acres within the boundaries of the 427,000-acre national forest.

The Southern California Firestorm of 1993, which involved 22 major fires that began in late October, burned 200,000 acres in six counties, including San Diego, killed four people, and destroyed more than 1,200 structures, as well as valuable watershed and wildlife habitat. Also in the San Diego area, the Harmony Grove Fire in 1996, the Viejas Fire in 2001, and the 5,700-acre Gavilan Fire in early 2002, which destroyed 45 homes and 37 outbuildings in the county, have kept the need for fire protection at a high level of public interest.

California as a whole is vulnerable to wildfire hazards. The Southern California Firestorm of 1993 followed by only two years the state's most damaging wildland-urban interface fire, the Oakland-Berkeley Tunnel Fire of 1991 that destroyed 2,500 homes and killed 25 people. Many other California wildfires seriously affecting communities have been experienced over the last 80 years, and the problem got worse during the 1990s as three million new people moved into the state. Every year more development occurs in harms way. California's 1995 state fire plan classified 35 million of the state's 100 million acres as flammable mixed interface, and nine million of these acres as developed areas subject to wildfire conflagrations. Over 1,200 California communities are threatened, including one million housing units.

This high level of risk has spurred the state to action. It established a state Fire Safe Council in 1993 to coordinate hazard mitigation activities and to promote and coordinate community-level

[24] The information in this section is drawn from a paper on the San Diego experience prepared for the Academy by Dr. Kathleen Hemenway. It is published in Appendix I.

fire safe councils. Originally established to improve the state's public education capability for fire prevention, this non-profit corporation has become a vehicle for obtaining community and other inputs to the California Fire Plan, supporting the preparation of local fire plans, and facilitating implementation projects. As a result, nearly all of the state's 58 counties now have fire safe councils. In addition, many community-based councils have been created within counties—mostly in southern California and the central Sierras. This statewide effort has been encouraged in the last two years by National Fire Plan grants from BLM. Among the councils there are now approximately a dozen staff people, a half-dozen offices, and a comprehensive website. BLM and FEMA grant programs now are both available to motivate development of local fire plans.

The state Fire Safe Council now has 50 partners, including 15 from the insurance industry and others from public utilities, nurseries and landscapers, government agencies, construction industry organizations, environmental groups, and others. It meets monthly at different locations throughout the state to build consensus, deliver common educational messages, get local councils started, facilitate communication and collaboration among councils, and coordinate with state agencies on behalf of the local councils.

Basic wildfire responsibilities in the state reside in the California Department of Forestry and Fire Protection (CDF). CDF administers and provides fire protection to over 31 million acres of state lands (about one-third of the state). It also has responsibility for emergency services in 35 of the state's 58 counties through contracts with local governments. The state fire marshal is also part of CDF, as is the Fire and Resource Assessment program. Among the department's responsibilities are responding to an average of 6,400 wildfires per year (as well as about 275,000 non-fire emergencies), operating more than 600 fire stations and over 1,000 fire engines, and reviewing all plans for commercial harvesting of timber on non-federal lands. It also inspects private property to enforce the state law requiring 30-foot clearance around homes in areas where CDF has responsibility. CDF's annual budget is about $600 million, and it has about 18,000 employees.

In addition to establishing the Fire Safe Council in 1993, CDF started the California Fire Alliance in 1997. This organization coordinates pre-fire projects of local, state, federal, and tribal governmental agencies. The Alliance coordinates its monthly meetings with the community-based Fire Safe Council. Among the pre-fire projects coordinated are prescribed fire and thinning, creating defensible space, fire-safe landscaping, fuel breaks, distributing federal funds to community projects, distributing FEMA and Forest Service funds to local fire districts, and distributing BIA funds to tribal wildland-urban interface projects. The Alliance is also working on streamlining the environmental review process. Together, the Alliance and the Fire Safe Council provide an efficient organizational structure for mobilizing wildfire hazard reduction activities.

San Diego County's Fire Safe Council has existed for several years, but it gained new momentum in 2001 when it received $300,000 in National Fire Plan money. With a total budget of $500,000, the Council established an office and one staff person. Since January 2002, more than a half-dozen local councils have been started in the county. The county's councils have received significant amounts of media coverage and the citizens of several small communities are eager to participate. Projects promoted include developing accurate community maps, easily visible address markers, and intersection signs to guide firefighters, sponsoring brush clearing from roadways and home sites, and providing chipping services.

One particularly affluent fire protection district in the county has assigned 6.5 of its 42.5 employees to prevention, and has been ahead of the county in identifying its Top 10 fire hazards and taking action to abate them. Its ordinances now require non-combustible roofing, interior sprinklers, 100 feet of clearance around structures, 30 feet of roadway clearance, and clearance of all dead and dying trees. This district has also invested heavily in specialized wildland firefighting equipment for its engines. In addition, it has acquired a first class geographic information system to help it analyze risks, provide current maps, simulate fire behavior during a fire, and use fire simulations during public education sessions. It plays a lead role in the county Fire Safe Council.

The county also has progressive wildland-urban interface regulations. They were first adopted as an amendment to the county fire code in the mid-1990s, and incorporated into the county's Consolidated Fire Code in 1999 to encourage consistency among the county's 17 separate fire protection districts. The code requires fire resistive construction, setbacks, and vegetation clearance of 100 feet around structures in fire prone areas. In addition, a Memorandum of Understanding was worked out in 1997 with the wildlife agencies to help smooth approvals of vegetation clearance projects. The county is addressing community-interface issues in its General Plan 2020, which guides development of the county, as recommended by the Governor's Office of Planning and Research.

On the firefighting side, however, the organizational structure is not as clear. The county has no fire department and provides no clear focus for mutual-aid agreements. Instead there is a set of independent firefighting units consisting of 17 fire districts, 6 volunteer fire departments, about 15 CDF fire stations, several fire stations in the national forest, several more fire stations on military bases, and several organizations that provide firefighting resources and services to ships. The various jurisdictions have inconsistent restrictions on campfires, smoking, clearances around structures, and other matters—making it difficult to run a public information program that does not simply confuse people. This lack of coordination is considered by some to be a most serious problem.

There is no lack of wildfire mitigation challenges remaining to be tackled in San Diego County. They include safe access to small rural communities, better evacuation planning, adequate water supply for firefighting, ability to maintain fire insurance in some of the most vulnerable communities, removal of green waste, and getting environmental approvals to clear dangerous vegetation. Efforts are being made to address these issues.

Malibu, California

Another brief example of how a California community has responded to wildfire hazards was reported August 13, 2002 in the *Washington Post* (p. A3). Malibu is a community in Los Angeles County that has had numerous serious encounters with wildfires. As the newspaper reported, "Malibu homeowners now face some of the strictest residential building codes in the country and fines for noncompliance." Along with strict brush clearing and fire prevention programs, local ordinances have helped the community become better prepared to meet the challenge. "What this [preparation] really translates to is that the residential area becomes the fuel break," Cohen [a researcher with the Fire Sciences Laboratory in Missoula, Montana] said. "Malibu has burned that message into the public mentality. Firefighters drop by unannounced to see whether homeowners have cleared their land of highly flammable brush, such as sumac and chaparral. And they keep coming back. If residents don't comply, the county will fine them $431 and charge them for a municipal brush-clearing crew—which can run higher than $3000."

Firewise Communities/USA

The Firewise Communities/USA project of the National Wildfire Coordinating Group's Wildland/Urban Interface Working Team is the newest element of the Firewise program.[25] It is designed to involve whole communities in comprehensive efforts to bring their civic leaders, fire staffs, and homeowners together to meet their common wildfire challenges. Participating communities agree to follow a flexible template that includes a community-wide vulnerability assessment, establishment of an interdisciplinary local Firewise Board to govern their activities, sponsorship of an annual Firewise Day to reach out to the whole community, allocation of at least $2 per capita annually to financially support the activity, and issuance of an annual report and implementation plan to demonstrate public accountability and guide future activities.

During the first year of activity (2001), six communities met these standard requirements. However, each took a somewhat different approach. Notable activities of these six communities are listed below.

- **Briargate** in Ormond Beach, Florida, is a proposed new subdivision in the planned Hunter Ridge community of 2280 homes. It is near previously developed parts of the community that were seriously threatened by severe wildfires in 1998 and evacuated for over three and one-half days. The Ormond Beach fire department met with the developer, prospective homebuyers, and the Hunter's Ridge homeowner's board to explain the Firewise approach. As a result, a community assessment was completed in May 2001 and presented to the Ormond Beach Firewise workgroup. The effort developed features of the fire resistant houses to be built and a variety of fire resistant community features to be built into the subdivision. The redesign of the community resulted in construction of the first Firewise community in the United States. In addition to fire-resistant houses, the community has fire-resistant landscaping, a million-gallon water tank for treated wastewater that can be used for watering landscapes and fighting fires, plans for three lakes and firebreaks, thinning of trees in common areas, a road system that provides easy access for fire engines and two means of ingress/egress, and other fire-resistant features.

- **Hyde Park Estates** in Santa Fe, New Mexico, is at the edge of the City and adjacent to the city's watershed. It is an older neighborhood with wood shake roofs, only one means

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[25] National Fire Protection Association, *Firewise Communities/USA: Pilot Project Report*, Quincy, MA, December 2001. See also: *Firewise Communities: A Project History and Overview*, Quincy, MA, April 2002. www.firewise.org

of ingress/egress, and a highly flammable ecosystem. As the neighborhood began to organize with the help of the USDA Forest Service, the New Mexico Division of Forestry, and the Santa Fe County Fire Department, a community assessment was conducted. A neighborhood clean-up day was held the following month, and an action plan began to develop. Features considered in the action plan included a wildland code proposed by the county fire marshal (which later passed), an evacuation demonstration day, and a chipping day to help with disposal of green waste.

- **Sundance**, Utah is a community of about 250 homes surrounded by forest. Many of the homes are vacation homes, and they are organized into seven homeowner associations. Some of the homeowners are familiar with wildfire issues, and the county requires fire-resistant materials for all new construction. However, older buildings do not need to conform and most do not. The Sundance Resort held an all-day Fire Forum in 1998 and published a plan in 1999 that was circulated to all homeowners. From that effort, several elements of the plan were adopted and the North Fork Fire and Safety Council was formed to implement them. Implementation thus far has focused on fuels modification, early warning, evacuation, education, infrastructure development, and fundraising. The community has instituted regular spring and fall Chipper/Clean-Out Days and the advisory council is working with a major recycling company that seeks wood chips and offers free services to homeowners. Other specific steps have been taken toward achieving the early warning, evacuation, and educational goals. Supportive relationships have been developed with the Utah Department of Natural Resources and Brigham Young University, as well as local, state, and federal fire safety advisors.

- **Timber Ridge** in Prescott, Arizona, is adjacent to the Prescott National Forest. Construction began about 18 years ago and continues. Homes are built on 370 of the 443 lots and many have wood shake roofs. The larger Prescott area has a well-known, citizen-led Wildland/Urban Interface Commission that is supported by city, county, state, and National Forest officials. Nevertheless, the Timber Ridge homeowners' association was motivated by a Firewise Communities/USA presentation to become a pilot project on its own. It invited all its homeowners to sign up for individual lot inspections by the Prescott Fire Department and promote Firewise Construction on all new construction in the community. The community association has agreed to clean up its common areas and hold regular homeowner clean-up days using chippers. Other educational promotions have also been scheduled.

- **Wedgefield Estates** in Orange County, Florida, is a 5,000-acre planned community of 2-5 acre lots near Orlando. About 200 homes have been developed so far. Since development began, the traditional prescribed and natural burning practices have been curtailed, and vegetative fuels are building up to dangerous levels. The community has no fire hydrants and the nearest fire station is ten miles away. However, the community has plan review powers over new construction, and is becoming aware of the need to address wildfire hazards. Planning has begun on fuel mitigation for both developed and undeveloped lots, adapting community codes and covenants to address fire hazards, building relationships with adjoining state and private landowners to create fuel breaks at their borders, and improving emergency vehicle access to the community.

- **Whiting Woods** in Glendale, California, is a neighborhood of 170 homes at the base of the Verdugo Mountains. Dry, flammable vegetation abounds, but the city has progressive codes that require 100 feet of brush clearance around structures. Most people in the community understand the danger and comply with the fire regulations. Nevertheless, an additional spring clean up has been scheduled.

The Flood Plain Analogy

President Bush's proposed budget for fiscal year 2003 contained a proposal to buy-out the fire protection rights to properties in fire prone areas of wildlands to avoid having to defend those properties at great expense in the event of a wildfire. Dubbed the "fire plain" proposal, because of its similarity to federal buy-outs of repeatedly flooded properties to avoid repeated compensation to the owners for rebuilding in the same hazardous location time after time, these buy-outs would be from willing sellers who would rather have the cash than the right to expect public protection of their structures in the event of future wildfires. Although not enacted, this proposal raises an issue worth considering. If the public is expected to pay for protecting private structures from wildfires, why should it not be able to seek ways of limiting that liability?

Mapping fire prone areas and allowing only "expendable" structures in those areas would be one way of approaching this issue. Although not exactly analogous to the federal flood plain mapping and flood plain insurance programs, because of the less predictable and more widespread nature of wildfire risks, there may be some benefit from studying this issue more in the future. However, the voluntary nature of the fire plain buy-out proposal creates a significant practical difficulty. If an area threatened by a wildfire consists of structures some of which have accepted buy-outs and some not, many of the required suppression costs may remain almost the same as if there had been no buy-outs.

PREVIOUS ACADEMY FINDINGS AND RECOMMENDATIONS

The Academy's previous report on wildland fire management[26] addressed the need for the federal land management agencies to work more closely with state, local, and tribal governments to more effectively manage wildfire hazards in communities with wildland interfaces. In preparing that report, the Panel held a conference with about 100 experts and stakeholders to consider this issue, among others.[27] The conference examined FEMA's Project Impact, NOAA's community vulnerability assessment tool, and other intergovernmental topics. The conference's workshop on intergovernmental coordination emphasized the need for more bottom-up approaches and analytical tools to facilitate them.

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[26] National Academy of Public Administration, *Managing Wildland Fire: Enhancing Capacity to Implement the Federal Interagency Policy*, December 2001.
[27] National Academy of Public Administration, *New Tools for Managing Wildland Fire: Conference Proceedings*, June 2001.

In abbreviated form, Box 7-1 displays the key practices that led Project Impact communities to success, as presented by FEMA. They emphasize the bottom-up nature of the approach, the need to be inclusive, and the need for developing partnerships.

Based on this work, the previous Panel recommended "that the land management agencies use existing state and community-based organizations to the greatest extent possible to involve a wide range of governmental and non-governmental stakeholders in land management and fire management planning, coordination, and action programs at their field locations. It also recommends that the [Wildland Fire Leadership] Council establish principles and guidelines for conducting effective consultations, managing community-based programs, and working with communities to help them identify and reduce their vulnerability to wildland fire."[28] The previous Panel went on to explain these recommendations as follows:

> The Panel believes that using existing coordination bodies and proven principles for working effectively with multiple stakeholders can reduce start-up times for these activities, increase the credibility and cost-effectiveness of agreements, and reduce burdens on the stakeholders who need to be involved. The land management agencies should provide assistance to strengthen federal and non-federal participants' capacity in these field-level coordination processes. In return, the agencies should require that these processes produce action plans and commitments from the participants to implement those plans. This pragmatic approach will allow maximum flexibility for tailoring required planning and action to the needs, organizational situations, and resources in each specific location and region of the nation.

NEED FOR A MORE SYSTEMATIC AND EFFECTIVE APPROACH

The present Panel notes that the new approaches to community innovation described earlier in this chapter, as well as the intergovernmental *10-Year Comprehensive Strategy* (August 2001) *and Implementation Plan* (May 2002) negotiated over the past two years, are moving in the right direction. However, the present Panel believes that the current almost completely voluntary nature of these initiatives is not sufficient to get the job done. Additional incentives are needed to motivate coordinated action on a scale commensurate with the massive and still growing size of the community interface problem.

Intergovernmental matching grant programs have frequently been used by the federal government in situations like this to mount concerted efforts to address urgent nationwide problems in which the whole intergovernmental community has common interests. The matching provision in such programs shares the costs broadly, while the federal share and reasonable requirements for systematic planning and implementation build greater capacity for all the parties to participate more effectively. These types of programs leverage the ability of all the partners to achieve together more than they could achieve individually.

Federal requirements in such a program could establish flexible but comprehensive procedures for identifying and prioritizing community interface risks, determining responsible grant

[28] *Managing Wildland Fire*, p. 85.

recipients, getting community interface planning processes and action plans in place throughout the nation's fire prone areas, integrating state, local, and tribal efforts, and mobilizing the greatly needed joint effort that will be required to make headway against this massive problem. Coordination between this federal program and related ones in FEMA, Homeland Security, Agriculture, and Interior should be required and facilitated.

With this approach, every community with a wildland interface could aspire to become a wildfire-resistant community. The design of such a program could be the subject of another study.

Box 7-1. Key Components for Successful Project Impact Communities

- Local community leadership
- Inclusive coordinating mechanism
- Partnership development
    - Inclusive of sectors within community
    - External influences
    - Define what it means to be a partner
    - Develop strategies for long-term partner involvement
    - Develop means for public recognition of the partnership
- Conduct multi-hazard identification and risk assessment
- Public education strategy, plan and implementation
- Adoption of risk reduction plan
- Implement projects to reduce risk
- Strategies for sustaining community intention to become disaster resistant
- Evaluation of goals, strategy and implementation
- Mentoring and networking with other Project Impact communities

Source: *FEMA*, February 2000

CHAPTER 8
SCIENCE, TECHNOLOGY AND INFORMATION MANAGEMENT OPPORTUNITIES

INTRODUCTION

Most of the preceding chapters mention the technologies of fire management. For decades, the Forest Service and Interior agencies have had active research programs aimed at better understanding fire behavior and effects, creating useful tools for fire managers, and supplying knowledge on the outcomes of federal initiatives for managing forests and containing wildland fires.

As a part of this study, the Academy was asked to research "alternative firefighting methods and technologies that may have potential for reducing costs." The fieldwork showed that science, technology and information management are relevant to every aspect of fire planning and management, and are becoming increasingly strong components of federal wildland fire programs. Therefore, this chapter also attempts to answer the broader question of whether and how science, technology and information management can help improve performance and contain suppression costs. It begins with a discussion of the fire research and technology organizations and programs, which are located primarily in the Forest Service. This is followed by discussions of science, technology and information management contributions to planning and priority setting, fire management, fire suppression tactics, and fire suppression business management. These discussions seek to answer four basic questions:

- What did the Academy find in the six case studies and its other research?
- What are some promising new applications?
- What work is underway that could improve efficiency and effectiveness and lower suppression costs?
- What more needs to be done?

The chapter also discusses how user needs influence research and technology development in the Forest Service laboratories and elsewhere, and what special challenges arise in technology transfer across the complex and decentralized fire management environment. In addition, it addresses the growing importance of data gathering and measurement in assessing the outcomes of fire suppression initiatives.

In summary, the Academy Panel found that there are no major technology developments on the horizon that by themselves would significantly reduce wildland fire suppression costs. However, several technologies now available and being used by some can improve performance and efficiency. To date, fire science and technology programs have focused little on suppression costs, as such. The biggest challenges to improving these activities are (1) the complexity and decentralized nature of the fire management environment, (2) the need for improved communications between laboratory researchers in and outside the federal government and firefighters on the line, (3) the costs, integration requirements and system changes associated with many technology enhancements, and (4) the continued heavy reliance by fire managers on experience and instinct in responding to fire incidents.

DEVELOPMENT OF FIRE RESEARCH AND TECHNOLOGY EFFORTS

The Forest Service has evolved an extensive and active research and development program almost since its beginning in 1905. Interior agencies also sponsor some research projects, but they rely primarily on the Forest Service's extensive network of field research stations. They also rely increasingly on USGS research capabilities. Table 8-1 provides a chronological summary of some of the major technological developments in Forest Service fire science, primarily in the Rocky Mountain Region.

Over the past several decades, major advances in fire fighting technology and management enabled fire managers to hold fire losses relatively constant in the face of steadily building fuel loads. Most large fires were contained in 7-10 days and fires seldom exceeded 50,000 acres, except in Southern California and Alaska. Some of these major advances included smokejumpers, bulldozers, air tankers, retardants, helicopters, power saws, fire behavior prediction capabilities, improved communication systems, interagency coordination, national mobilization capabilities, and the Incident Command System.

However, in the late 1980s and 1990s, firefighters were confronted with huge fires, which burned uncontrolled for weeks, often until cool and wet weather put them out in the fall. In spite of the ability to mobilize up to 30,000 firefighters, aided in many cases by modern technology, firefighting forces since the 1980s have been overpowered by massive fuel-driven fires whenever there has been significant drought in the western United States. In 2002, Arizona, Colorado and New Mexico all experienced the largest fires in their history, and Oregon had its largest fire since 1849. It appears that the fuels build-up and years of drought have outpaced the deployment of new technology.

Table 8-1. Wildland Fire Research: A Selective Chronology

Year	EVENT
1913	Forester J. A. Larsen began gathering meteorological and climate studies in Idaho. He soon learned of their value in studying fire behavior
1916	The Forest Service asked its experimental stations to initiate research on forest fires.
1921	Larsen published several reports from research done at the Priest River Experimental Forest, showing the influence of precipitation, relative humidity, wind and temperature on forest fires.
1922	Harry Gisborne, forest examiner at the Priest River Research Station, implemented a working plan for his "Lightning and Fires" project designed to predict the approach of lightning storms.
1923	Gisborne and M. E. Dunlop developed and tested the first hygrometer used to measure moisture content in vegetation.
1931	Gisborne developed a fire danger meter that measured fire danger levels and linked them to the administrative action needed to cope with prevailing or probable fire danger.
1935	Tests began on using airplanes to drop fire retardants. However it wasn't until 1947 that a formal aerial bombing project began with the christening of a B-29 bomber called the Rocky Mountain Ranger.
1941	Priest River produced the first systematic study of daily variation of forest fire behavior as influenced by altitude and other factors.
1947	The Northern Rocky Mountain Station published results of experiments with the Army Air Force in aerial bombing of forest fires, and published the results of investigations of aerial seeding of burned-over timberlands.
1960	The Forest Service constructed the Fire Sciences Laboratory in Missoula, MT, that included the world's largest combustion chamber dedicated to wildland fire research.
1972	Scientists, in cooperation with the Bitterroot National Forest, MT, established the Forest Service's first and most successful (as of 2000) prescribed natural fire program in the Selway-Bitterroot Wilderness.
1973	The Forest Service established a national fire research, development and applications program.
Mid-1970s	A prescribed burning and fuels management research project was established in Tempe, AZ, focusing on better ways to use prescribed fire in southwestern ecosystems.
Mid-1980s	Techniques for assessing fuels and models for predicting fire behavior were developed and adopted for use by wildland fire managers throughout the United States.
1988	Following the Yellowstone fires, researchers developed the first computer-generated, three-dimensional fire behavior models overlaid on topographical maps. Extensive studies also were underway on the use of infrared aircraft scanners for fire discovery and mapping.
1992	Fire Sciences Laboratory researchers developed the first computer-based interactive program for public education about wildland fire.
1994	Station scientists and contractors developed the FARSITE fire behavioral model and tested its fire line application.
1997	The Rocky Mountain Research Station created a work unit in Flagstaff, AZ, for wildland-urban interface fuels management and forest health restoration and worked with cooperators to develop fuel treatment study plans applied on the Fort Valley Experimental Forest.
2000	Working with the University of Montana, scientists developed the application of thermal infrared sensors in fixed-wing aircraft that provide geo-referenced, digital, high-resolution fire data. They overlaid this data with other GIS data layers to provide fire planners with same-day tactical fire suppression planning.

Source: Forest Service Rocky Mountain Research Station: *An Historical Chronology of Wildland Fire Research in the Interior Western United States (1913-2000)*. (http://www.fs.fed.us/fire_res/fire_history.html)

National Fire Plan and Congressional Expectations

In the early and mid 1990s, federal land managers informed Congress that a serious wildland fuels hazard problem existed. However, the agencies lacked the scientific detail and specificity to answer relevant questions concerning the magnitude of the problem. Land managers sought improved knowledge of conditions, needs, and appropriate treatments that would be effective in dealing with the hazard. In response, Congress increased wildland fire research funding.

In 1998, Congress expressed concern "that both Interior and the Forest Service lack consistent and credible information about the fuels management situation and workload." The House Committee on Appropriations directed Interior and the Forest Service to use $8 million of their wildland fire preparedness and planning funds for this purpose. The bill's language became the authorization and funding for the Joint Fire Science Program (JFSP) with the expressed purpose of supporting research, development, and applications for fuels treatment programs. Subsequently, a formal federal advisory committee was formed to help guide this program.

In the year 2000, following the worst wildland fire season in recent history, Congress and the administration created and funded NFP, which doubled the funding for JFSP and substantially increased funds for applied wildland fire research in the Forest Service. These increases provided the potential acceleration of science and technology support for wildland fire.

NFP Research and Development Funding

As shown in Table 8-2, the Department of the Interior and Related Agencies Appropriation Act for FY 2002 further increased NFP funding for research and development (R&D) programs supporting the five key areas of the Fire Plan. It consolidated the funding for research provided under the Preparedness budget in FY 2001 into a single R&D component under the FY 2002 operations budget.

Table 8-2. NFP Research and Technology Funding
(in thousands)

National Fire Plan (key areas)	**FY2001 Final USDA/DOI**	**FY2002 USDA/FS**	**FY2002 DOI**	**FY 2002 Total USDA/DOI**
New Technology Development – Preparedness	$10,577	0	0	
Research and Development – Operations	$15,965	$27,265	0	$27,265
Firefighting and Predictive Services				
Fuels and Land Management				
Joint Fire Science Program	$7,982	$8,000	$8,000	$16,000
TOTAL	**$34,524**	**$35,265**	**$8,000**	**$43,265**

Source: National Fire Plan web site (http://www.fireplan.gov/fire_science_1_28_02.cfm)

Sixty-three research teams were funded in 2001, and they were funded at the same level in 2002. According to the NFP web site, these teams will continue to lead national efforts to better predict fire and smoke behavior, assess the risks associated with hazardous fuels buildup, and find better ways to rehabilitate burned areas and minimize the spread of invasive species. Researchers are developing new alternatives for managing fuels and using forest undergrowth and small-diameter material, and evaluating the effects of fire and fuels treatments on water, wildlife, recreation and other resources. Teams are also moving forward with developing methods for assessing the economic and social impacts of fires and discovering new ways for communities and individuals to live safely in fire-adapted ecosystems.

These teams are expected to make more rapid progress due to earlier access to their second year of funding and because of the momentum in research and technology transfer established in 2001. The progress made by each of these teams and the usefulness of their products is to be evaluated at the end of FY 2002.

Fire Fighting Systems and Predictive Services R&D

About $10 million is included in the research program for developing systems to support fire operations. These investments are to help prepare firefighters to make critical safety decisions and guide deployment of firefighting forces in ways that could save taxpayer dollars and reduce damages to resources, people, and property. These investments are dedicated to building research and development capacity in:

- Initial attack and suppression allocation modeling
- Risk assessment processes for fire management
- Use of remote sensing to monitor fire ignitions, fire behavior, and smoke dispersion
- Prediction systems using meteorological and other information
- Fire severity forecasting
- Smoke and fire behavior modeling

Current Fire Research Programs and Organizations

The Forest Service is primarily responsible for fire-related research. All five land management agencies help fund its research, and they participate in guiding and overseeing the research through various committees and working groups. Six Forest Service research stations, mostly in the West, and the Forest Products Lab to a small extent, conduct fire-related R&D. Total fire research funding in FY 2001 was $51.7 million, including $25.8 million from NFP appropriations and $6.2 million in JFSP funds.

The Fire Sciences Lab, an arm of the Rocky Mountain Research Station located in Missoula, MT, is home to multi-year initiatives such as the Fire Behavior Project, Fire Chemistry Project, and the Fire Effects Project. The staff of these projects perform a variety of research on fire-related issues and topics. For example, the behavior project conducts fundamental and applied research on wildland fire behavior needed by land managers for pre-fire planning, fire suppression, prescribed burning, and evaluation of first-order fire effects. Current research includes:

- Development of guidelines, models, and information to address firefighter safety zones and deployment zones

- Interaction of fire models with certain atmospheric models

- Home ignition potential during wildland fires

- Integrating products from the National Weather Service into the next generation of fire danger/fire behavior products

- Development of new fire behavior models

Similarly, the Riverside (CA) Fire Sciences Lab, a unit of the Pacific Southwest Station, performs research on topics such as meteorology for fire severity forecasting, prescribed fire and fire effects, forest economics, decision support, and fire management in the wildland-urban interface.

The four-year-old JFSP, funded by the National Fire Plan and designed to provide a scientific basis and rationale for implementing fuels management projects, focuses on activities that will lead to development and application of tools for managers. The JFSP research addresses the following four needs critical to the success of the fuels management and fire use program:

- Develop and implement consistent interagency fuels mapping and inventories with common classifications and resolution within ecosystems.

- Evaluate and compare fuels treatment practices and techniques, including prescribed fire, thinning and other mechanical methods, increased utilization of biomass, and no treatment.

- Develop treatment schedules, determine the frequency of treatments, and coordinate treatment schedules among agencies.

- Establish compatible interagency processes and procedures for monitoring, evaluating, and reporting fuels treatments.

The JFSP has established an oversight process and program to identify and meet fire information and technological support needs for the interagency fuels management program. Generally, funds are awarded based on proposals received from a broad range of scientists and organizations, including those in Forest Service research stations, but also including universities, non-profit organizations, and others. Through FY 2001, the program had funded researchers at 45 universities, 9 non-governmental organizations, 10 state and local governments, 4 private companies, and 5 federal agencies—in addition to the 6 JFSP partners. Within the JFSP funding, Congress earmarked $0.6 million in FY 2001 and $2 million in FY 2002 for the University of Montana's National Center for Landscape Fire Analysis.

The primary fire science component of the Interior Department resides in USGS. When the short-lived National Biological Survey was merged into USGS a few years ago, several fire ecologists from NPS, FWS, and other parts of Interior were brought together with other scientists in the Biological Resources Division to form the Fire Science Program.

USGS now has a series of biological research centers located across the country, and 13 of them have fire science programs. These programs support activities on fire ecology/fire effects, fire restoration and rehabilitation, fire impact assessment, firefighting operations, the NFP and Federal Wildland Fire Management Policy, and specific fire research projects requested by Interior agencies. USGS is also on the governing board of the JFSP and the newly formed Interagency Fire Research Coordination Council (described below).

NWCG, as the standards-setting and coordinating body for the federal and state fire communities, also plays a key role in technology-related issues and incident business management practices. It has several working teams that address specific aspects, including:

- Fire Danger Working Team—advancing the science and application of fire danger ratings

- Fire Equipment Working Team—coordinating fire equipment and chemical needs, development and implementation

- Fire Use Working Team—supporting use of fire to meet land management objectives; operating fire use qualification system

- Incident Business Practices Working Team—coordinating business practices for wildfire, non-wildfire, and FEMA emergency responses

- Information Resources Management Working Team—identifying policy-level information issues that affect, or are likely to affect, interagency fire management activities; providing advice to NWCG members on how to address those issues through information and communication systems. It also includes a Geospatial Task Group to address geographic information and related issues.

Integrating User Needs with Science and Technology

An appointed 10-member governing board manages the JFSP. Five of its members are from the Forest Service and five are from the Interior land management agencies and the USGS. The board holds bi-weekly conference calls and meets periodically to draft announcements for proposals, select and approve projects, review progress, and conduct other board business. Day-to-day activities are performed by a program manager and small staff located at NIFC.

This program also has a Stakeholders Advisory Group whose purpose is to provide advice and recommendations to the secretaries of Agriculture and the Interior through the JSFP governing board. This group held its first meeting in June 2001 and developed a comprehensive list of recommendations for future work.

The Forest Service's fire science labs under the regional research stations are supervised by the deputy chief for R&D located in Washington, DC. In 2002, the Forest Service created an Interagency Fire Research Coordination Council (IFRCC) to provide leadership in coordinating and representing wildland fire science and technology development and application under the NFP. IFRCC membership includes the Forest Service fire research program leaders and representatives from USGS, JFSP, schools of forestry, NOAA, Environmental Protection Agency, and National Institute of Standards and Technology. They are trying to get NASA, DoD, and National Science Foundation involved as well. IFRCC is seeking "effective and efficient approaches to accomplishing the research and development missions of agencies and other organizations, minimizing the duplication of activities, and making the most efficient use of research resources."

Among other activities, the IFRCC will develop ways of involving a wide variety of users in charting the fire research program's direction and providing feedback on research outputs and the implications of scientific results. It is not yet clear how firefighter and other external inputs will influence and help to guide IFRCC initiatives.

In addition to these national efforts to improve oversight and coordination, the Forest Service Eastern Area Fire Team has initiated an effort to chart current and desired outcomes and characteristics of key NFP elements in the Eastern Area. They have identified important issues for setting "action priorities," including:

- Improved practitioner-scientist communication
- Better understanding of what research scientists can do to improve technology transfer through meetings and other appropriate venues
- Prioritize science support for practitioners in meeting National Environmental Policy Act requirements

With the advent of the NFP and the growing urgency of developing and deploying science and technology innovations to strengthen fire planning and suppression efforts, the land management agencies have taken a number of steps designed to better coordinate research programs and projects, provide stronger leadership, and improve researcher-practitioner communication. However, no one below the Chief of the Forest Service has overall responsibility for directing fire-related research and technology. The Wildland Fire Leadership Council could help bring all this together, but there appear to be no direct ties between the council, the JFSP's governing board, and the IFRCC. Moreover, the Forest Service's deputy chief for R&D also has a major role in directing basic fire science work funded outside the NFP.

THE ROLE OF SCIENCE AND TECHNOLOGY IN MANAGING WILDLAND FIRES

Numerous applications of science and technology are found in nearly every major component of incident management teams' activities. An IMT's planning staff requires geographic information, accurate weather forecasts, and accurate fire behavior analysis using several computer models developed to predict fire behavior. The operations staff requires technology to detect ignitions, to monitor fire size, location and progression, and to suppress the fire using aircraft and retardants. Finance uses automated cost estimating software to track fire costs. Decision support tools, such as WFSA, are used to compare the costs of alternative firefighting strategies. All of this is supported by on-site computer systems, advanced telecommunications, and connectivity to weather and remote-sensing satellites, aircraft and other equipment, and vast quantities of data stored at various locations.

Getting rapid access to technology and related data, and putting it to good use, was a major challenge on most of the case study incidents reviewed by the Academy field teams.

Early Detection and Response

The fires reviewed by the Academy were typically discovered and reported by a person either on the ground or flying over the fire. Sometimes the report came too late for an effective initial attack, and the fire escaped before sufficient resources could be brought to bear to extinguish it. Typically, local land units rely on a combination of overflights, lookouts, and citizen reporting to detect new ignitions. However, the land management agencies increasingly use remote sensing capabilities to detect fires in their earliest stages and provide prompt reporting to responsible officials on the ground. Nevertheless, federal fire managers have not widely adopted these capabilities to supplement or replace existing detection methods.

One source of such data is NOAA's National Environmental Satellite Data and Information Service, which operates government-owned weather satellites. For example, the satellites provide much weather data used for various purposes including fire. The primary mission of data information service is to process and distribute data from several civilian earth observation satellites. Data products are provided through direct channels to the National Weather Service staff, including those on individual fires, but also increasingly through the Internet, using the new NWCG-sponsored Predictive Services units, and additional outlets.

Sensors on the Terra and Aqua satellites operated by NASA have been increasingly used for wildland fire detection and monitoring. Terra has been providing daily observations since December 1999. Terra's sister satellite, Aqua, was launched in May 2002, and is providing similar observations for different time periods. These daily observations are advancing fire detection and monitoring at many levels, and also enhance post-fire assessment and rehabilitation and recovery efforts.

The Forest Service's Remote Sensing Applications Center in Salt Lake City, UT is working with NASA, NOAA, and the University of Maryland, under what is known as the Rapid Response Project, to enhance the use of satellite sensing for wildfire detection and monitoring. It was first used operationally during the 2000 fire season. During that and the 2001 fire season, the Terra satellite beamed daily images of wildland fires in the western U.S. to NASA within a few hours. These images show the locations of active fires, where burn scars are still smoldering, and where smoke from the blazes is spreading. Use of satellite sensing for wildfires was enhanced for the 2002 season by positioning a receiver at the Remote Sensing Applications Center, enabling almost real-time data downloads for responder use.

Classified defense satellite resources also are used to detect and monitor fires and volcanic activity. They provide rapid continual sampling and full earth coverage. The Hazard Support System was envisioned by USGS and some collaborating Defense Department scientists in the early 1990's as a new, real-time, way to detect wildland fires and volcanic eruptions. They theorized that the sensitivity and coverage of the nation's ballistic missile warning satellites, fused with that of the world's environmental weather satellites, could enable early detection of these events in an unprecedented way. For wildland fires, the goal was to provide early detection and notification of fires that were less than a few acres in size when they are most easily suppressed. Early funding was provided by DoD, which was later aided by some civil agency funding through USGS and other agencies. Official development of this system began in 1997 with a $23.6 million appropriation to DoD.

Although some users expressed strong interest in and support for the Hazard Support System, overall interest was mixed, particularly on the part of federal land management agencies. Funding decreased significantly in 2000 after the prototype was completed. USGS was directed to end development of the system in June 2000 and the project was officially terminated in August 2000, although the satellite downlink remained intact. An independent study requested by the Executive Office of the President concluded that the system did not yet appear to meet the needs of the fire management community, particularly regarding false alarm rates and location errors (both too high). Nevertheless, the underlying concept was seen as viable, and the system was deemed to have potential to become a useful, even important, tool for state and federal wildland fire management organizations.

Custody of the support system was transferred from USGS to NOAA in March 2001 under the auspices of the National Hazards Information Strategy. Within NOAA, it is known as the Integrated Hazard Information System. Although there have been some delays since NOAA took over the system, efforts are underway with limited funding to bring it back into an operational testing status, including resumption of the data transmissions that had been suspended earlier.

Current plans call for a small demonstration to show the fire community that the Integrated Hazard Information System can be useful. It is described as a consolidated system for detecting and monitoring fires, volcanic eruptions, ash, smoke, and other gaseous emissions. The goal is to transmit warning messages directly to field sites. This system is to provide unclassified “derived products” for first responders and to serve as a platform for future data fusion and access streams. It is part of a larger effort known as NOAA's Hazard Mapping System, which includes experimental efforts to develop unclassified products from classified data. Work is underway for it to provide input to the Forest Service’s Remote Sensing Applications Center and the interagency Predictive Services Group at NIFC.

Regardless of the final outcome of this specific effort, there appears to be strong potential for further use of classified and civil agency remote sensing data for fire. However, it appears that none of the fire suppression funding for the NFP has been made available for developing data products that could improve the effectiveness of the fire suppression efforts. The Forest

Service's use of remote detection and monitoring sensors depends on year-to-year funding support because the funds are not in the base budget.

Monitoring Fire Size, Location and Progression

The current status of large fires is of vital interest to many people in different levels of government, in the media, in communities threatened by such fires, and especially on the front line of the fire suppression efforts. Within the federal fire apparatus, National Interagency Coordination Center needs to know the status and progression of all large fires in the United States. GACCs need similar, but sometimes more detailed, information on fires in their regions. IMTs and local land units need precise baseline data as well as data on fire location and progression for developing suppression strategies and tactics, as well as for monitoring progress.

In the cases reviewed by the Academy field teams, these data were gathered and maintained in several ways, including overflights, walking the fire perimeter with GPS receivers, infrared scanning, and satellite imagery. Increasing quantities of data are now available on several web sites to firefighters and the public. However, IMTs were dependent on data available from local sources, and such data varied from site to site, depending on the capabilities and inclinations of the local land units and their non-federal cooperators. The land management agencies do not have consistent data policies, standards and resources to ensure that base data available to firefighters is uniformly maintained and available.

GeoMAC, the Geospatial Multi-agency Coordination system, is another source of satellite imagery. GeoMAC is an Internet-based mapping tool originally designed for fire managers to access online maps of current fire locations and perimeters in the continental United States and Alaska. Using a standard web browser, fire personnel can download this information, pinpoint the affected areas, and view specific information about individual fires. While initially developed to help allocate firefighting resources to the western wildland fires in 2000, this application also became available to the public.

GeoMAC is based on a nationwide map of the United States that displays all the current wildfires, provides related background data, and runs on an internet map platform. GeoMAC also includes weather observations and a layer that is being developed to show the location of urban interfaces. Burn-severity maps also are being developed from other satellite imagery overlaid on ownership boundaries.

GeoMAC also began archiving fire perimeter maps in 2000, and will continue doing so. The lack of mapping standards among agencies was a problem, but an NWCG working team has developed the needed standard. Although this standard is in the process of being adopted by the individual agencies, issues remain to be resolved on data custodianship requirements and enforcement.

In a June 2002 briefing for Academy staff, USGS officials said GeoMAC was supporting at least two western GACCs and would be providing fuels reduction maps with congressional district boundaries on them to support the NFP fuels program. The GeoMAC group is also supporting a more refined, multi-layer wildfire mapping program in Utah that is to include threatened and endangered species, water, and other essential fire planning data. They also noted that GeoMAC was being pressed into service to support the firefighters in Colorado (where the Hayman Fire was active at the time).

Information for Managing the Fire

Each IMT has a planning section, which is responsible for gathering and sharing many types of information needed to plan and carry out the strategies used to fight the fire. The planning section's two primary products are maps and incident action plans. They keep track of the weather, fire behavior, fire perimeter, and crew status. They also perform the demobilization function. The planning section has a situation unit that typically has fire behavior analysts, weather experts, and now—more frequently—a GIS specialist and an incident meteorologist, though these latter two positions are not required. A resources unit also tracks assignment of crews.

The fire behavior analysts, weather experts, and GIS specialists often work as a team to provide predictions of future fire behavior, expected weather conditions and visual displays to brief the IMT leadership, division supervisors, fire crews, the media, and the public. The quality and timeliness of the data available to these specialists is critical to their value in supporting the management team. The planning section chief for the Green Knoll Fire explained:

> Typically these specialists bring their own computers with the necessary software loaded. Getting a good Internet connection is the key local ingredient. One concern was the availability of peripheral equipment, such as plotters, to print the maps they needed. They had been beggars at the local unit in the past, but they ordered a GIS person from NIFC with a plotter.
>
> For 2002, the IMT added a GIS person who will come with his own plotter. Two computer specialists from NIFC will also join the team and bring with them the necessary computers, printers, and possibly a plotter. Without this equipment on the team, they are set back a day in getting started. Now they can hit the ground running assuming adequate data are available about conditions in the local area.

Although overall ceilings on IMT staffing are set nationwide, the skill sets and equipment traveling with the teams varies between specific Type 1 teams, and especially between Type 1 and Type 2 teams. The GACCs determine the skill sets on IMTs located in their geographic areas. Thus, a Type 1 team from one region may have a GIS specialist, while a similar team from another region may not. Because IMTs are assigned where the fires are, regardless of region, transition problems can result.

On the Moose fire, the transition between a Type 1 and a Type 2 team was complicated by differences in GIS skill levels and equipment. The Type 2 team was unable to use the GIS files created by the Type 1 team because they did not have the software to translate them. As a result, the Type 2 team had to hire a staff with the necessary skills and equipment to convert the files for their use.

Academy field teams heard a similar story during a brief visit to the Hayman Fire in June 2002. This time, data problems occurred during the transition between two Type 1 teams, the first of which had GIS specialists, while the second did not. The latter's situation unit said:

> Transitions are a common problem. The prior team had all the GIS established, but took it all with them. They gave CDs to the incoming team, but there was no documentation. That's an ongoing problem with GIS—the lack of standardization. They couldn't even get paper quads [standard quadrangle maps, at the 1:24,000 scale produced by USGS]. They also had to find local maps for structures and roads.
>
> This team packs the Ozi program, which they used to download data off the Internet in order to generate maps. For the first few days, they scrambled to meet the IMTs mapping needs.

Another part of the data problem is the availability of local data to create needed maps. Local land units differ significantly in the types and quality of GIS data maintained on their lands. Often the data maintained depends as much on the needs of the resource program staff as the fire management staff. This problem often is compounded by the need for data on lands adjacent to the federal land units. The Hayman Fire, for example, spread over five Colorado counties, each with their own GIS and data. One county wanted to charge the Forest Service for the GIS data it provided to help defray their GIS costs. Finding and integrating these data, given the lack of common data standards and formats, was a big challenge.

Notwithstanding these data problems, the IMT senior managers for the case study fires, as well as the Hayman Fire, said they had the data they needed to manage fire operations. In fact, a few were concerned about the proliferation of GIS data, especially for public information use. One explained that as the media and the public become accustomed to better visual displays of the fires, they demand more of them. As a result, costs increase without a perception that the benefits increase commensurately.

In a report on the potential benefits of GIS for large fire incident management prepared for the Forest Service in 1999, the researchers said:

> The participants in this study overwhelmingly agreed that GIS would be a useful tool for large fire management. It would be a compliment to existing tools, providing information that is not available now, and allowing certain information to be gathered in a more timely or cost effective manner than it can be currently collected. They believed GIS would put accurate information in the hands of those who need it. Better information leads to better decision making, which in turn leads to fighting a fire more effectively, efficiently and safely. It will also facilitate the public information portion of fire management, freeing valuable resources for other efforts.[1]

Federal fire officials have begun to recognize both the promise of GIS and the problems of implementing it properly. NWCG has a Geospatial Task Group under the Information Resources

[1] Pacific Meridian Resources (Salt Lake City, UT), *Study of Potential Benefits of Geographic Information Systems for Large fire Incident Management*, February 10, 1999, p. 2.

Management Working Team. In a 2002 white paper on geospatial technology for incident support, the task group recognized that: "While geospatial technology for incident support has steadily increased over the past decade, it has been on an ad-hoc basis, agency-by-agency and state-by-state, with varying degrees of success."[2] The group recommended creation of a "geospatial position standard" for review and action by the NWCG Incident Operations Working Team this calendar year. (This position would be similar to what is required by the California and Oregon departments of forestry.) The white paper also proposed appointment and funding of a group to coordinate the identification of the minimum spatial data, applications and organization needed to meet incident management business needs. In addition, the paper supported the promotion of access to pertinent data sources within individual agencies and creation of links to data sources available on a central web site, possibly operated by the NWCG. For the longer term, the paper proposed developing a "comprehensive national interagency strategic planning process for using geospatial technologies for incident support."

At their May 2002 meeting, the group concluded that pushing forward with an official position for GIS could take a long time—about five years to get through the entire process. Instead it decided to work toward developing and promoting standards for

1. what an IMT GIS person should know and be able to do
2. what equipment is necessary on site to do the job
3. what standard data should be available
4. when the standard data products should be delivered

In addition, it was decided not to formally recommend a new position, given the five-year time required for full implementation, but to suggest rewriting the existing display processor position, effective in 2004. Although this position will not be required for all IMTs, at least there will be some specifications. The IRM Working Team agreed with these recommendations in their June meeting, and work is underway.

Weather prediction capabilities, staffing and data management are also key components of the intelligence apparatus on IMTs. Recently, a new National Fire Weather Program was created as part of a new interagency Predictive Services Group established at NIFC. The Predictive Services Group includes 20 meteorologists hired in 2001 by Interior, intelligence coordinators, fire analysts and fire danger specialists. The focus is on three parameters, including fire weather, fire danger and resource capability to provide answers about current conditions, problems and likely conditions in the future (weekly, monthly and for the season).

Weather data are made available to the fire community in various automated ways, augmented by human observation. NWS formerly employed most of the nation's premier fire meteorologists in an associated program. But, assessments by the fire community found that this program's performance had diminished in recent years. NWS still has some fire meteorologists in various locations and a facility located at NIFC. They specialize in forecasting fire weather. They support IMTs on major wildland fires by providing weather advice at incident command posts.

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[2] Geospatial Task Group, Information Resources Management Team, National Wildlife Coordinating Group, *Geospatial Technology for Incident Support*, 2002, p. 2.

However, outside assessments found that NWS was largely reactive and short term in their forecasting work. In addition, NWS work usually addressed only small geographic areas. Deficiencies and inconsistencies also were found in the fire capabilities of some of NWS offices, causing varying results in terms of weather reporting for fire as needed by fire responders. Differences in weather forecasts were observed in neighboring offices, leading to many questions and decisions based on differing information. NWS's established goals for standard weather reporting and forecasting related to fire were not fulfilled. NWS was reluctant to embrace the growing need to work more cooperatively and effectively with other agencies. Thus, the decision was made to create a Predictive Services Group in Interior to meet fire management's needs more effectively.

The fire weather program group leader told Academy field staff that what is missing is the skill set, capacity and availability of time by staff at the GACCs and dispatch centers. Additional dedicated fire meteorologists will be needed, he said. The coordinators have several roles, and they may not have sufficient time or skills to process and fully integrate all information available and provide useful input for real-time and longer-term decision-making. A key need is to distill and synthesize data quickly and make them accessible, by both traditional means and on the Internet.

Business Management

Also highly relevant to the Academy's mandate to examine wildland fire suppression costs is the finance section of IMTs. This section must be up and running when the IMT arrives. The urgency of major fire incidents requires the rapid deployment of aircraft and other equipment as well as hundreds or even thousands of firefighters and support staff. Daily cost estimates must be provided to IMT leadership, equipment orders and contracts for services must be tracked, and time charges for crews must be accurately recorded.

To help make these tasks easier and more efficient, the land management agencies are trying several competing programs that have grown up at different field locations. One of the most prominent is the I-SUITE software. The purpose of I-SUITE is to automate incident operations for greater efficiency in managing incidents and tracking resources, costs and supplies. As discussed in Chapter 3, the three programs in I-SUITE are the Incident Time System, the Incident Resource Status System, and the Incident Cost Accounting and Reporting System. All three can also be used as stand-alone programs, and used at local units and dispatch offices for resource tracking and time keeping.

Because much of the information needed by and entered into each separate application was redundant, such as names, home units, and crew manifests, a joint effort was undertaken by the Forest Service regions in 1999 to integrate the three programs. The end product was envisioned to be a single database to be used simultaneously by multiple users, having networked computers.

The Academy field teams heard varying reactions from staff responsible for implementing I-SUITE, especially about the accounting and reporting system, which was the component most commonly used during the 2001 fire season. (See Chapters 3 and 5 for details.)

According to an April 2002 paper on I-SUITE, the priorities for development in FY 2002 are[3]:

1. Correcting the occasional database stability problems identified during 2001.
2. Developing the ability for the resource system to produce and fill out all forms used in the incident action plan.

In addition, Forest Service Region 5 is working with the California Department of Forestry and Fire Protection to develop the ability to export data from their Multi-Agency Integrated Resource Processing System into I-SUITE. Two other major efforts are planned for FY 2003. The first is to develop a Supply Unit Module for automated issuance, inventory, and tracking of supplies using bar code technology. The other is implementing the bar code system for Red Cards, allowing for automated check-in at incident command posts. (This technology was successfully prototyped and field-tested during the 2000 fire season, but the regions lack the funding for widespread implementation.) The development team's goals for FY 2004 are to explore integration with agency payroll processes, the Incident Cache Business System, and the Resource Ordering and Status System (ROSS).

The ROSS project sponsored by the NWCG is being developed to automate the resource ordering, status and reporting process. While this system apparently will not directly impact operations at the IMT or local land unit levels, plans are for it to operate in nearly 400 interagency dispatch and coordination offices throughout the nation. The project focuses on automating current processes so dispatch offices can electronically exchange and track information in near real time. The goal is to reduce current labor- and paper-intensive practices, increase customer services, improve communications, and lower costs associated with delivering services to the field. The resource categories included in ROSS are:

- aircraft, including fixed-wing airplanes and helicopters
- crews
- equipment, including cars, trucks, fire engines, lowboys, and buses
- overhead teams (but not individual people)
- supplies

A two-phased approach is underway to implement ROSS, the first for administration and resource status, and the second for resource ordering. Personnel at the National Interagency Coordination Center and the Rocky Mountain Area Coordination Center are field-testing the ROSS application before nationwide training begins. Results of this testing are to provide

[3] The I-Suite Project Team, USDA Forest Service, *I-Suite Project Update*, April 1, 2002, p. 3.

information about using ROSS, training, development, and refinement, as well as application issues. Academy staff were informed in June 2002 that training and implementation had been delayed as a result of the intense early fire season in Colorado.

The Incident Qualifications and Certification System is another technology-driven innovation sponsored by NWCG, but it is not as far along as ROSS. The goal of the certification system is to efficiently document that personnel assigned to incidents are qualified to perform assigned functions in a safe and efficient manner.

Presently, there are several incident qualification and certification systems being used in the fire community at all levels of government, the most familiar one being the Red Card system. This redundancy has created management and record-keeping problems for field units. For example, a dispute arose during the Moose Fire about the qualifications of volunteer firefighters in Flathead County who were certified under a separate system operated by the county. Some local firefighters had Red Cards that were a year old, and they were not allowed on the fire lines.

In sum, several efforts are underway to systematize and automate processes at all levels of federal fire management. The major issues center around how well these systems will be integrated, and whether they will make fire planning and operations more efficient, improve performance, and lower costs in the long run.

MEETING SCIENCE AND TECHNOLOGY CHALLENGES

During the case study interviews, the Academy field teams asked incident commanders and other fire managers whether they were aware of any technological advancement on the horizon that would significantly improve firefighting performance or help contain costs. None was identified. One FMO summed it up this way: "The strategies and tactics being employed today will be the same in the future. No new technologies or equipment are being developed and tested that will significantly affect how fire is fought in the foreseeable future."

This is not to say that the Forest Service and other land management agencies are standing pat with existing practices. As previously noted, increasingly sophisticated imaging, tracking, and planning methods are being employed on the fire line. Each of these innovations has made some improvements in performance and some have helped contain costs, but, as one senior manager at NIFC noted, "There are no silver bullets out there." She warned, "This is an area where there is a need for considerable caution in separating hype from reality." The Forest Service operates two Technology and Development centers at Missoula, MT and San Dimas, CA to develop and test potential new products and to approve those that can make a difference.

Academy field teams were told that the most promising technology coming along soon was a new fire shelter. On the other hand, the lab recently tested a German tank that is light on the land and carries 5,000 gallons of water. The problem was that its cost is prohibitive at more than $800,000 a unit. The Forest Service is also looking into robotics, such as a fire engine that can be guided by a joystick. Researchers went to Russia last year and examined one piece of equipment that appeared highly useful for delivering retardants. However, it was environmentally unsuitable for use in the United States because it tears up the land with 2-3 foot deep tire tracks. Often the labs are asked by outside parties to test potential innovations that turn out to have little or no practical application.

In the Academy's survey of state foresters (Appendix E), the respondents identified a number of promising technologies in several areas:

1.	Research fire behavior and weather prediction	23%
2.	GIS/GPS	22%
3.	Early detection	18%
	a. Satellite, remote sensing	
4.	Management support systems	16%
	a. Consistent cost tracking software	
	b. Automated dispatch systems	
	c. Communications	
5.	Rapid initial attack	10%

Technology Transfer Challenges

In interviews and meetings with agency officials, the Academy study team was told repeatedly about the difficulties in understanding and applying the results of science and technology outputs from the Forest Service labs and elsewhere. One senior Forest Service manager at NIFC summed it up this way: "Research results often seem not to get on the line very promptly."

Forest Service officials have recognized the problem and have formulated a proposal to develop a strategic plan to guide the fire and research communities toward effective partnerships in the development, application, and maintenance of wildland fire science and technology. To accomplish this, they propose creating a permanent, applied fire research, development and applications planning and technology-transfer working group. This group would:

1. By June 1, 2003, complete a five-year strategic plan that would establish an effective process to ensure that research issues will be addressed at all levels of the fire community
2. Establish partnership guidelines and recommendations to ensure effective communication
3. Function as liaison to the Wildland Fire Leadership Council concerning the applied fire research missions of the participating agencies

The group would also create national-level partnership and technology transfer lead positions in the Forest Service and Interior, and establish a NFP research manager similar to the JFSP program manager. The working group would recommend changes to research evaluation standards to include more emphasis on applied research, partnerships, and technology transfer. Researchers who establish effective partnerships and provide useful products to end users would be rewarded accordingly.

As of June 2002, no decision had been reached to move ahead with this proposal, but it reflects the thinking of some senior managers about the need for additional steps to improve the relevance and utility of research projects to the user community and to accelerate transfer of new technologies to the front lines. There is a risk, however, that one more group would be created to deal with a piece of the problem without a strategic view of where and how research-practitioner relations could be strengthened across the board.

Consolidating Planning and Budgeting

A November 2001 report to the Forest Service and Interior by a group led by the Colorado State Forester[4] recommends integrating all the computer planning and budgeting models used by the land management agencies to meet the needs for land management planning, fire management planning, budgeting, and operations. This is a worthy goal to pursue in a way that produces incremental improvements from one year to the next under the overall guidance of the Wildland Fire Leadership Council. Reaching the goal will require integrating existing and new models to ensure they will complement each other within a national information technology framework (see below), relying on common data inputs to the greatest extent possible and providing common data outputs. This integrated approach could save money on data entry (which is usually an expensive element of the system), improve the consistency and quality of decision-making across all agencies' wildland fire programs, and ensure consideration of cost-minimizing alternatives in managing wildfires.

Needed Information Management Framework

As noted above, IMTs and local land units are using many diverse information systems and computer applications for fire suppression management. These are worthwhile individual efforts, but they could be more effective in improving the efficiency of wildland fire management and realizing cost savings if they were part of an overall framework that would enable them to work together. Too often, these innovations do not connect to one another and they do not roll up the information they capture into regional and national databases that can be used to evaluate results and improve program performance and cost-effectiveness. One consequence is that the full costs of a large fire are not known until many months (or even years) later. In addition, there is little ability to study national and regional cost experiences, or to analyze the cost-effectiveness of various types of firefighting equipment and various contract services.

A national information technology/information management framework is needed to guide future development and deployment of systems and information sources. This framework would provide architectures for systems, applications, data, and networks based on identified user needs. It would also provide the foundation for integrating key elements of sub-systems so they will eventually produce the desired overall benefits.

One potential model for this initiative is the DoD's Defense Information Infrastructure Common Operating Environment now under development. This is a software infrastructure that enables mission applications to share common support applications, such as the Commercial Joint Mapping Toolkit. It is not a system; it is a foundation for building a system. Various functions

[4] Report to the National Fire Plan Coordinators of the USDA Forest Service and U.S. Department of the Interior, *Developing an Interagency, Landscape-Scale Fire Planning Analysis and Budget Tool,* November 30, 2001.

can be easily added to or removed in small manageable units, called “segments.” Structuring the software into segments is a concept that allows considerable flexibility in configuring the system to meet specific mission needs or to minimize hardware requirements for an operational site. Site personnel perform field updates by replacing affected segments through use of a simple, consistent, graphically oriented user interface.

This software infrastructure was initially based on work from the defense communications and intelligence arena, but it has been expanded to encompass a range of other functional areas including logistics, transportation, base support, personnel, health affairs, and finance. Three representative systems that use it are the Global Command and Control System, the Global Combat Support System, and the Electronic Commerce Processing Node system. All three use the same infrastructure, integration approach, and components for common functions.

This approach represents a departure from traditional development programs. It emphasizes incremental development to reduce the time required to put new functions into the field, while not sacrificing quality nor incurring unreasonable program risk or cost. This approach is sometimes described as a "build a little - test a little - field a lot" philosophy. It is a process of continually evolving a stable baseline to take advantage of new technologies as they mature and to introduce new capabilities. The changes are done one step at a time so that users have a stable baseline product while changes between successive releases are perceived as slight. While not all elements are applicable to fire planning and suppression management, the basic concepts and DoD development experiences could be instructive to an information technology framework for fire management. Firefighters face demanding field conditions in a way similar to some combat situations.

On the civilian side of government, the Office of Management and Budget is promoting the Federal Enterprise Architecture as part of the President’s Management Agenda. It provides a common framework for cross-agency, government-wide improvement of business-type processes such as budgeting, information sharing, performance measurement and management, cross-agency collaboration, citizen service, and more. This initiative might offer assistance in developing similar systems to serve the wildland fire program. In addition, many federal departments and agencies, including Agriculture and Interior, have been developing their own agency-wide information technology architectures. It will be important to develop a wildland fire framework so that it will be consistent with the government-wide and agency-wide systems.

The overall framework for fire should be able to satisfy needs for:

- More efficient and timely financial and business management
- Geographic information management systems at many different scales
- Integrated planning and performance budgeting systems
- More efficient risk assessment and fire incident management
- Increasingly efficient and responsive supply and dispatch functions

- National databases to support program evaluation and program improvement

Data and Measurement for Assessing Performance

The information technology framework also should provide for the production and maintenance of the data needed to measure program performance. In the Academy's December 2001 report on implementing the Federal Wildland Fire Management Policy, the Panel found that:

> Program evaluation could be helpful to program managers at all levels, but neither the fire community nor the federal land management agencies have a systematic evaluation capacity in place. Similarly, the agencies have not developed a consistent, interagency set of performance measures—as required by the Fire Policy—that clearly articulate intended outcomes and results against which to evaluate performance.[5]

Since that report was published in December 2001, Interior and Agriculture have developed proposed goals and performance measures for wildland fire management. Moreover, the May 2002 implementation plan for the 10-Year Comprehensive Strategy, prepared by an intergovernmental group convened by the Western Governor's Association, sets forth four broad goals and three guiding principles, the last of which is "Accountability through performance measures and monitoring for results." Eighteen performance measures were established to "enable all parties to assess and track progress toward the desired implementation outcomes envisioned by each goal."[6] Efforts are underway to implement each performance measure, and a formal review process is being established to monitor and evaluate performance, suggest revisions, and make necessary adaptations to the strategy on a regular basis.

Many of the research and technology initiatives discussed in this chapter provide opportunities to improve the data available to assess fire community performance and cost-effectiveness, whether in the context of the goals proposed by Interior and Agriculture or the 10-Year Comprehensive Strategy implementation plan. As systems for fire management are further developed and implemented, awareness of data needs for assessing performance could enhance the outputs of these systems and facilitate such assessments.

In this connection, the agencies are developing joint performance measures to monitor progress toward achieving their shared program goals. These measures are beginning to be accepted by state, local and tribal governments as well. However, the usefulness of these increasingly interagency and intergovernmental performance measures will be only as good as the quality of the data collected by all parties to support them. To the greatest extent possible, these data should be produced as a by-product of program operations. This avoids the expense and potential unreliability of separate data collection programs. High priority should continue to be

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[5] National Academy of Public Administration, *Managing Wildland Fire: Enhancing Capacity to Implement the Federal Interagency Policy*, December 2001; p. 116.

[6] The Departments of the Interior and Agriculture, the Western Governors' Association, the National Association of State Foresters, the National Association of Counties, and the Intertribal Timber Council, *A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: A 10-Year Comprehensive Strategy,* May 2002, p. 10-16.

given to developing common performance measures and the high-quality data required to make them effective.

APPENDICES

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FIRE-RELATED EXPENDITURES 1970-2001

Prepared by the Academy Staff

in Cooperation with

Ervin G. Schuster, Project Director,

Suppression Cost Prediction Model, Missoula, Mt

National Academy Of Public Administration
Washington, DC

FIRE-RELATED EXPENDITURES[1], 1970-2001

METHODS/METHODOLOGY

Yearly Forest Service fire expenditure data from 1970 through 2001[2] were analyzed in three broad fire-related categories –Preparedness/Fuels (P/F), Suppression (S), and Total Fire-Related Expenditures (P/F + S). Comparable data for the other land management agencies are not readily available. The question of how applicable results from Forest Service fire expenditure data are to the total federal wildland fire program is analyzed in the section below, "How applicable are these results to the entire federal wildland fire program?" The finding is that the results from the analyses of these Forest Service expenditure data are applicable to the entire federal wildland fire program. The Appendix provides additional information on methodology and data limitations.

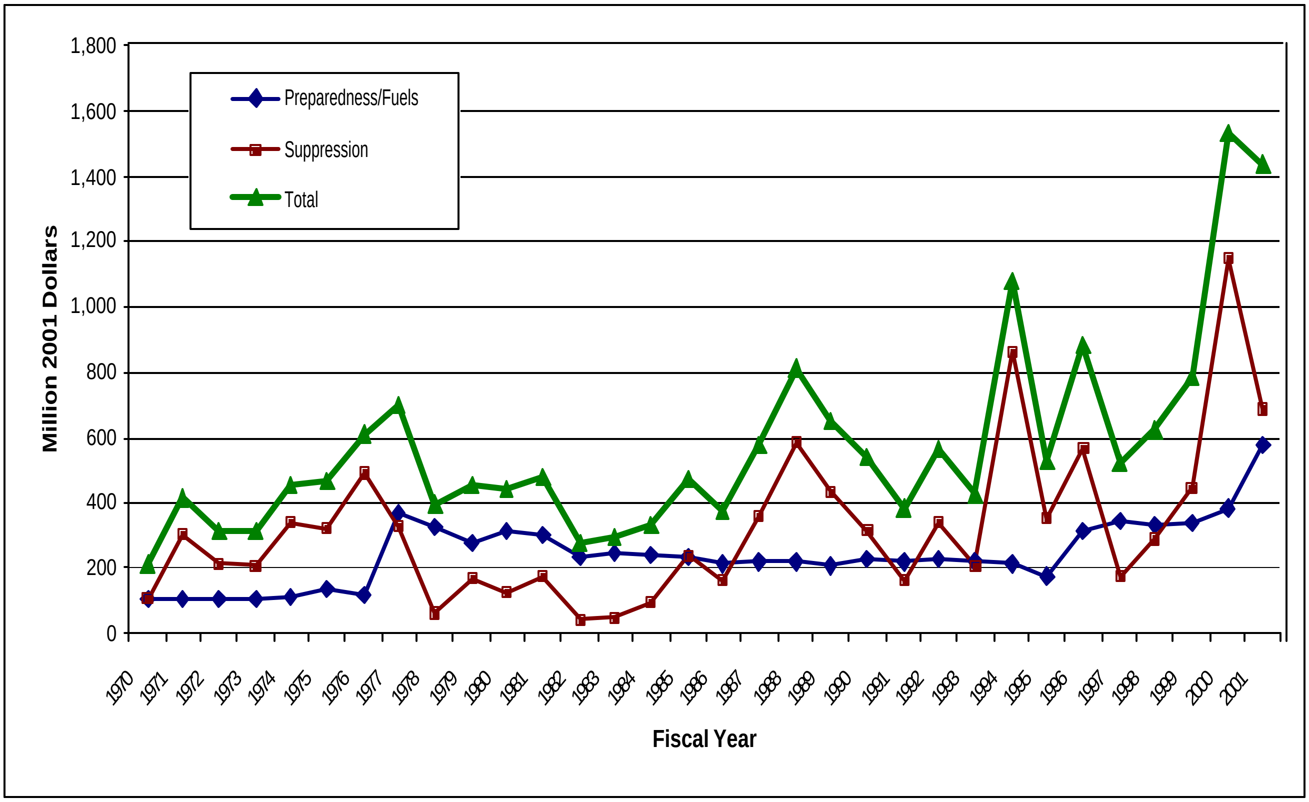
Summary of Results: Are Fire-Related Expenditures Rising?

Yearly inflation-adjusted fire-related expenditures (Forest Service) are shown in Figure 1. Clearly, expenditures have risen rather dramatically (albeit erratically) in recent years, but overall, this time-series does not resemble a program that is either "soaring" or "spiraling out of control."

[1] The convention followed here is to use the term "expenditures" rather than "costs". This reflects generally accepted economics terminology. "Expenditures" reflects payments for goods and services, whereas "costs" implies a broader concept based on the economic notion of opportunity cost (pecuniary and non-pecuniary). This distinction is made explicitly in Schuster, Cleaves, and Bell (Ervin G. Schuster, David A. Cleaves, and Enoch F. Bell, *Analysis of USDA Forest Service Fire-Related Expenditures 1970-1995*. Pacific Southwest Research Station, Research Paper PSW-RP-230, March 1997 (29p)).

[2] Schuster, et al. (1997) contains data only through 1995. That study was updated through 1998: Ervin G. Schuster, *Analysis of Forest service Wildland Fire Management Expenditures: An Update*, in: Proceedings of the Symposium on Fire Economics, Planning, and Policy: Bottom Lines, USDA Forest Service, Pacific Southwest Research Station, General Technical Report PSW-GTR-173, April 5-9, 1999, San Diego, CA. The senior author provided further updated data through 2001 to the Academy for this paper. While Schuster (1999) reports results in both nominal and real dollars, this paper reports results only in real dollars.

Figure C-1. Forest Service Fire-Related Expenditures, 1970-2001
(in millions of constant 2001 dollars)



Nevertheless, growth rates over the entire period (1970-2001) are notable. Annual compound growth for total Fire-Related Expenditures is 3.4 percent; for Suppression, the rate is 3.0 percent; and for Preparedness/Fuel, it is 4.3 percent. Figure 1 illustrates that these growth rates are driven, primarily, by fairly recent expenditures, notably 1994-2001. <u>It is important to note, however, that these rates likely overstate the situation because both the end points are statistical outliers (i.e., the early 1970s were "good" fire seasons and the last few years were "bad" years).</u>

For further insight, yearly expenditure data were aggregated into decades[3]. Figure 2 and Table 1 summarize the findings.

[3] The third "decade" – the 1990s – contains 12 years (1990-2001).

Figure C-2. Forest Service Fire-Related Expenditures, Average by Decades (in millions of constant 2001 dollars)

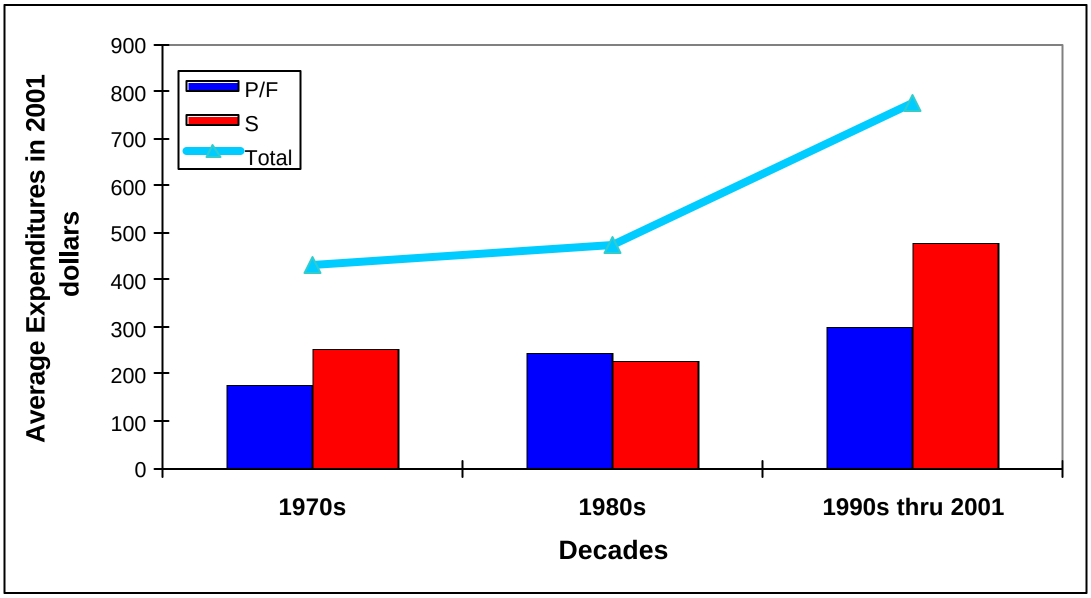


Table C-1. Fire-Related Expenditures (in millions of constant 2001 dollars; Forest Service data[4])

Time Period	Category	Average Annual Rate of Increase ($ mil/yr)*	Aver. Annual Expenditures ($ mil)	Statistically Significant??
1970-2001	P/F+S	20.8	573.1	Yes (High)
1970-'79	"	29.0	432.7	No
1980-'89	"	36.8	471.9	Yes
1990-'01	"	74.6	774.5	Yes
1970-2001	S	13.9	329.7	Yes (High)
1970-'79	"	2.0	254.6	No
1980-'89	"	46.8	228.2	Yes (High)
1990-'01	"	49.0	476.8	No
1970-2001	P/F	6.9	243.4	Yes (High)
1970-'79	"	27.0	178.1	Yes (High)
1980-'89	"	-10.1	243.7	Yes (High)
1990-'01	"	25.6	297.7	Yes (High)

*Average annual rates of increase are the slopes of the (linear) regressions.

? Note on statistical significance: Linear regressions were run with expenditures as the dependent variable. "Yes (High)" means statistically significant at the 99% confidence level (two tails); "Yes" means statistically significant at the 95% confidence level (two tails).

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[4] As noted earlier, Forest Service expenditure data is from Schuster, et al. (1997) and from Erwin G. Schuster, Pacific Southwest Research Station, USDA Forest Service.

Total (fire-related) Expenditures ("P/F + S" column in the table). Total fire-related expenditures have been rising in inflation-adjusted (constant 2001) dollars. These expenditures rise in successively larger amounts in each decade (though the trends in the 1970s and 1990s are not significant statistically and the trend from 1990 through 2001 is barely significant owing to very high year-to-year variations). Specifically, they rose on average $29 million each year in the 1970s, $37 million in the 1980s, and $75 million in the "1990s"(constant 2001 dollars).

Suppression ("S" column in the table). The expenditure pattern for suppression is similar, but less straightforward than total fire-related activities. Suppression expenditures rise hardly at all in the seventies ($2 million), jump by $47 million per year on average in the 1980s, and then rise on average $49 million each year from 1990 through 2001. While the overall suppression expenditure trend is highly significant statistically, the trends in the 1970s and 1990s are not (again, owing to very high variability that primarily ties to underlying weather patterns).

Preparedness/Fuels ("P/F" column in the table). In contrast to suppression, average annual preparedness and fuels (treatment) expenditures did not rise in each decade. While they rose $27 million per year on average throughout the 1970s, they actually fell $10 million per year in the 1980s, before rising again ($26 million per year) in the "1990s". As shown in the table, decade-to-decade trends, as well as for total Preparedness/Fuels over the entire period, are highly significant statistically.

Fuels Alone. Expenditure data for the "Fuels" budget category are available only from 1977. Distinct expenditures for hazardous fuels programs prior to 1977 are not available and are, presumably, subsumed in the pre-1977 Forest Fire Protection or FFP budget data. Fuels expenditures generally rose from 1977 through 2001, but the trend is not statistically significant. Excluding Fuels from Preparedness (i.e., "P/F") makes no difference, statistically, compared to the Preparedness trend (1970 – 2001) alone.

How Applicable are These Results to the Entire Federal Wildland Fire Program?

As noted, data used for these analyses are for the Forest Service only. Comparable data are not readily available from the Department of the Interior. Nevertheless, for the following reasons, the results likely apply to the overall federal fire-related program:

(1) The Forest Service has always had the largest part of the federal wildland fire program, generally equaling or exceeding two-thirds of total budgetary resources (though the proportion has slipped in recent years to just below two-thirds);

(2) While there are some differences in the "mix" of funding between agencies (e.g., the preponderance of air tanker-related resources is appropriated to the Forest Service) and activities, they are sufficiently similar for the broad purposes here.

(3) Although federal agencies do not bill each other for suppression costs, the direction and net magnitude of this practice may be assumed to be minor and proportionate to agency funding.

Appendix: Methodological and Data Issues and Related Studies

Need for Transforming Budget Data

Basic fire expenditure data are not always good indicators of on-ground activities (Schuster, et al., 1997). As a result, it is desirable to modify raw budget data in order to develop a data set that better reflects fire-related activities.

The principal challenge presented is to place relatively narrow budget expenditure categories into necessarily broader categories – such as "P/F" and "S" above. The reasons for this have to do with oddities or changes in the budget structure and/or definitions of budget categories or activity codes. Schuster, et al. (1997) and Schuster (1999) explain the significant methodological challenges in detail with respect to Forest Service fire-related budget data and describe how they transformed the data in light of several constraints, including missing data. Importantly for purposes here, their published data has been updated through FY 2001 and made available to the Academy.

Schuster and his colleagues chose to ignore possible impacts arising from the 1976 transition quarter (when the federal government changed the start of its fiscal year from July 1 to October 1). We explored various statistical treatments of the transition quarter and found no impacts that were statistically significant.[5]

Defining Expenditure Categories

Data limitations (discussed above) make analyses of narrower categories than used here dubious, at least for the broad purposes here. Expenditures for hazardous fuels work ("Fuels") are combined with Preparedness because (1) the basic purposes of the two are essentially the same (namely, to reduce suppression costs), and (2) until quite recently, expenditures to reduce hazardous fuels are small relative to Preparedness[6] (and an even smaller portion of Suppression expenditures). As a point of information, combining Fuels expenditures with Preparedness does not change any statistical results.

The Preparedness/Fuels category used in this study aligns closely with the broad budget category "Fire Preparedness" (previously "Forest Fire Protection" or FFP); likewise, the Suppression category used here is similar to the current "Fire Operations" budget category (previously "Fighting Forest Fires" or FFF). The adjustments we made follow the methodology of Schuster, et al. (1997) and Schuster (1999) for the purpose of making the budget categories comport more realistically to on-ground activities. For example, expenditures for hazardous fuels, which are funded through the Fire Operations appropriation, are shifted into the Preparedness/Fuels

[5] Specifically, we ran regressions with all of the transition quarter expenditures in 1976, all in 1977, and half in 1976 and half in 1977.

[6] Outlays for hazardous fuels work are generally only about 10 percent of total preparedness expenditures, 87 percent of which are for "Presuppression", which focus on supplying the personnel, equipment, and management and administrative support required for actual firefighting (i.e., suppression).

category. We also adjusted expenditure data for the fact that in the official budget accounts, "Fuels" was part of FFP from 1977 through 1997, after which it was moved to FFF.[7]

Related Studies

As noted above, the Schuster, et al. (1997) report is the principal research on fire-related expenditures. Indeed, it appears to be the "backbone" of several subsequent policy-oriented reports. It is an analytically and quantitatively robust study. The Academy is indebted to the authors not only for the basic data set and for generously providing updated data (through 2001), but also for documenting the various adjustments they made to the basic (raw) budget data.

While the authors of that study found that overall fire-related costs "have not increased significantly since 1970" (in real dollars), their conclusion is based on data only through 1995 and excluded 1994 from their analysis precisely because that fire season was anomalously high in terms of fire-related expenditures.[8] Schuster updated the 1997 study (1999; full cite in footnote # 2) using data through 1998 and including the 1994 fire season and obtained results similar to the findings reported herein (which are based on data that was further updated through 2001 and provided to the Academy by Schuster).

Other studies of fire expenditures have tended to use raw budget expenditure data, perhaps in part owing to the methodological challenges and sheer tedium of transforming budget data to better reflect fire program activities. In the studies examined, we found that does not change the conclusions. Those studies generally cover fewer and less current years than the Schuster, et al. (1997) study. Two studies – one by Schmidt and one by Brown[9] – used untransformed budget data and came to conclusions similar to Schuster et al's and those of this study.

Schmidt examined Forest Service "emergency suppression activities" from 1977 through 1994, and concluded that, "Emergency fire suppression expenditures are increasing" (in inflation-adjusted dollars), although it is unclear what is meant by "emergency fire suppression expenditures."

Similarly, in a non-technical, non-peer-reviewed outlet, Brown reports a "disturbing rise in both total suppression costs and the cost per acre burned" for 1980 through 1999 (also in inflation-adjusted dollars, and also based on Forest Service fire budget data). This trend is fairly obvious from the data presented, which may explain why the author did not report a statistical analysis.[10] Unfortunately, his report is no clearer than Schmidt's with respect to the precise source of his data.

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[7] While there were expenditures for hazardous fuels treatments prior to 1997, they are not available as costs distinct from FFP.

[8] In fact, the exceptionally high expenditures of the 1994 season actually led to their study. Excluding the 1994 fire season, they found that real fire-related costs rose at an average annual rate of just 2.3 percent which is not statistically significant.

[9] R. Gordon Schmidt, *Emergency Fire Suppression Expenditure Trends in the Forest* Service, Appendix A in: "Fire Suppression Costs on Large Fires: A Review of the 1994 Season", USDA/Forest Service, August 1, 1995; and Brown, Hutch, *Reducing Fire Suppression Costs: A National Priority*, in: Fire Management Today, Vol. 61, No. 3., Summer 2001.

[10] Just to be sure, we ran a regression and found a statistically significant rise, thus confirming Brown's conclusion.

Both Schmidt and Brown report rising per-acre suppression expenditures, which should not, in and of itself, be taken as indicative of rising suppression expenditures (even though the two are correlated over time). Rising per-acre fire expenditures may actually indicate greater suppression efficiency, but a more in-depth study would be required to resolve this question.

SUMMARY OF WILDFIRE-RELATED ISSUES AND RECOMMENDATIONS

IDENTIFIED BY OTHERS IN PRIOR STUDIES AND REPORTS

Staff Paper

National Academy of Public Administration
Washington, DC

CONTENTS

SUMMARY OF WILDLAND FIRE-RELATED ISSUES AND RECOMMENDATIONS IDENTIFIED BY OTHERS IN PRIOR STUDIES AND REPORTS

In 1994, the cost to the federal government to suppress wildfires exceeded $1 billion for the first time. Beginning in 1995 and continuing to today, the increasing cost of wildland fire management has been the subject of a stream of large studies and reports by federal and state agencies, the research and academic communities, and others. Many of these products have, in turn, drawn from other studies and reports at the national, regional, local, and fire-specific levels. These products have generated hundreds of observations and recommendations to improve wildland fire management, including many related to cost containment and cost efficiency and effectiveness.

As part of its study, the Academy capsulized the issues and related recommendations in 30 of the large studies and reports issued since 1994. This review organizes the issues and recommendations identified by others into three groups: key policy changes, key planning and budget changes, and key changes in managing individual large wildland fires.

A chronological bibliography of the documents cited in this summary is at the end of this appendix. The bibliography provides the short titles used to reference sources throughout the summary.

It should be emphasized that the views expressed in this Appendix are those of the organizations preparing the studies. They do not necessarily represent the views of the Academy Panel. The documents summarized here are intended to represent a diverse range of views.

KEY POLICY CHANGES

Prior reports have found that the forces tending to increase wildfire suppression costs greatly outweigh those tending to reduce costs. Consequently, they have proposed major changes in wildland fire management policy to alter this outcome. These proposals may be summarized as follows.

Containing Costs Is Not a High Priority When Suppressing Wildfires

The reports were unanimous in recommending that the protection of human life should remain the "first priority" when suppressing wildfires. The high cost impact of protecting human life while suppressing wildfires has been generally acknowledged and accepted.

While accountability for protecting human life has been repeatedly affirmed, the 2000 NASF Report on Cost Containment notes that the concept of accountability has rarely extended to the costs incurred in suppressing wildfires and the cost-effectiveness of the strategies and tactics used. Instead, the protection of nonfederal lands and structures in the wildland-urban interface (WUI) is now second only to the protection of human life as the highest priority in suppressing wildfires. The Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs observed that the "negative after effects of burning homes on adjacent private lands are greater than the negative after effects of being a high-cost fire." According to the report, this will continue to lead decision makers to request and retain firefighting resources to deal with the most likely scenario or the worst-case scenario rather than the best-case scenario.

In addition, firefighting in the WUI is a high-visibility, high-stakes, exciting endeavor. Line managers and firefighters involved in this work are often rewarded with public recognition and thanks, as well as personal satisfaction for contributing to protecting life and valuable personal property. Conversely, failure to meet these public expectations often results in the opposite. One outcome has been that the cost of protecting private structures can exceed their value.

Recommendations

- The Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs observed that controlling costs has to be a vital concern to the Forest Service. It needs to be a predominant message. Being sensitive to budgeting for wildfire suppression and keeping expenditures within planned budgets needs to be a top priority and integral to wildland fire management decision-making.

- The 2000 NASF Report on Cost Containment recommended that (1) "containment of costs of suppression should be second only to firefighter safety;" (2) after each agency has formally established cost control in wildfire suppression as a high priority, they should hold every member of the nation's wildland firefighting organization accountable for his or her role in containing costs; (3) meaningful accountability for cost containment must be instituted throughout all levels of the nation's wildfire suppression program; (4) if cost containment is to be a key factor in the management of the incident, then the Agency Administrator must clearly and effectively communicate that priority to the Incident Management Team at the outset and throughout the incident; and (5) superiors must support Agency Administrators who make sensible yet difficult or politically unpopular choices in order to reduce costs.

Reimbursing the Forest Service for Its Costs to Suppress All Wildfires Provides No Incentive to Contain Costs

The 2000 NASF Report on Cost Containment stated that throughout the national wildfire suppression organization, costs and cost-effectiveness have rarely been regarded as a priority and many Incident Management Teams have operated under the assumption that they have an open checkbook available to them. Similarly, the Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs states that: "Emergency funding for firefighting lacks the rigor, discipline, and incentives for more efficient decision making." According to the report, the Forest Service "manages emergency firefighting funds as if they are unbudgeted, unlimited, unallocated, and without benchmarks on acceptable spending levels."

The 2002 Thoreau Institute Report on Incentives concluded that the most important factor increasing the cost of recent wildfires is "perverse budgetary incentives," specifically the "blank check" that the Congress gives the federal land management agencies, in general, and the Forest

Service, in particular, every year to put the fires out. According to the report, the Congress has created a budgeting process that "practically ensures waste, fraud, and abuse." The Congress gives the federal land management agencies a budget for fire. But when fire conditions get bad enough—and the agencies themselves decide when that happens—they can start spending non-budgeted "emergency fire suppression and pre-suppression funds." Under this process, funds budgeted for other programs and activities are used to pay for firefighters and firefighting equipment and supplies. The Congress then reimburses the agencies to repay these funds and accounts. As a result, the report observes that the agencies (1) spend a lot of money on fire suppression simply because they can and (2) continue to suppress fires that they ought to let burn because of the budgetary rewards from suppression.

Recommendations

- According to the Thoreau Institute report, the two most effective alternatives are for the Congress to (1) simply stop funding federal wildfire suppression or (2) decentralize federal land management and let each land unit fund itself out of its own receipts. In addition, hazardous fuels reduction efforts should focus only on the lands immediately surrounding homes and other structures in the WUI and not on the wildlands located near the structures. No effort should be made to treat lands away from federal land boundaries or to suppress fires that do not threaten borders, whether they are natural or human caused.

- According to the Forest Service's 1995 Large Fire Review, the agency could give its field offices incentives to reduce costs by (1) allocating a fixed level of fire suppression funds to each region and then require the regions to submit formal requests for additional funding, (2) establish regional thresholds for fire suppression spending and trigger a Washington office review when a region exceeds its threshold, and (3) allocate fire suppression funds to the individual national forests and then let them carry over unspent funds or deficits from year to year.

Federal Agencies Are Incurring Increasing Costs for Protecting Lands and Structures in the Wildland-Urban Interface

According to the 2001 Update of Federal Wildland Fire Management Policy, federal, state, tribal, and local fire protection agencies are still unclear on their roles and responsibilities for structural fire protection and suppression within the WUI. This is especially true when structural protection involves strategies to control the perimeter of the fire because it is heading toward a WUI. Moreover, under cost-share and mutual-aid agreements with state and local governments, federal agencies often end up with a disproportionately high assignment of costs because the agreements are based on acres burned. Studies over the last seven years have shown that the costs to federal agencies to suppress a wildfire increase the nearer it comes to communities and that when costs are allocated on the basis of acres burned, federal land management agencies end up with a disproportionately high assignment of costs. These studies have also observed that, given the current presence of fire protection agreements in rapidly urbanizing settings all over the country, continuation of current trends will result in substantially higher wildfire suppression costs for the agencies in the future.

Recommendations

- The Forest Service's 1995 Strategic Assessment of Fire Management and the agency's 1995 Course To the Future recommended that the Forest Service's role in fire management in the WUI should be redefined and renegotiated with partners in fire management. The goal of the negotiations should be the phasing out of the agency's primary protection role on private lands in urbanized and developing rural areas.

- Toward this end, the Forest Service's 1995 Large Fire Review recommended that the agency complete a comprehensive review of all interagency fire suppression agreements that commit the agency to the protection of private property.

- The Forest Service's 1995 Strategic Assessment of Fire Management also recommended that wildfire suppression costs should be distributed among federal and nonfederal agencies on the basis of the costs for suppression in an agency's area, not on the basis of the number of acres burned.

Developers and Homeowners Need Incentives to Adopt Fire-Safety Practices

Since 1995, federal land management agencies have recognized that to attain fire-safe attributes, public outreach and education are critical. They have, therefore, implemented a FIREWISE program, along with State Foresters and county and local governments, as a common strategy for educating homeowners and communities about how they can take effective measures to protect their property from wildfires. In addition, both the Department of the Interior and the Forest Service have programs designed to enhance the wildfire suppression capabilities of rural and volunteer fire departments by providing funds and technical assistance through the states to improve communication capabilities, provide critical wildfire management training, and purchase protective fire clothing and other firefighting equipment.

However, the 2001 Update of Federal Wildland Fire Management Policy found that little had changed during the intervening seven years. There are still many areas of the nation where planning, zoning, and building regulations are too permissive, allowing poorly controlled development to occur in high-hazard areas. In such areas, unsafe homes are built, they burn, and they are then rebuilt—most times incorporating the same designs, construction materials, or locations that originally led to their destruction. In addition, government and insurance programs and policies continue to allow rebuilding in high-hazard areas and rebuilding without prudent protections in location and construction.

Recommendations

- The 2000 NASF Report on Cost Containment observed that there is a need for local and state governments to use their regulatory authorities to strike a safe balance between the siting of structures, the use of FIREWISE construction materials and methods, and the creation of defensible space.

- The 2002 Joint Cohesive Strategy observed that (1) creating defensible perimeters around homes, (2) improving planning and building codes and zoning regulations, (3) employing fire-resistant landscaping, and (4) developing community-specific fire protection measures will help reduce wildfire risk to communities, prevent wildfires from burning homes, and reduce insurance premiums and suppression costs.

- The 2002 Thoreau Institute Report on Incentives observed that (1) the federal government could offer to cost share with private owners, paying half of the costs of new roofing and landscaping while the owners pay the other half, and (2) private owners can be given an additional incentive if insurance companies are prompted to charge people more if they do not treat their lands or offer discounts to those who do. Similarly, the Forest Service's 1995 Course to the Future recommended supporting tax and insurance incentives for fire-safe communities in the WUI.

- The 2002 report by the Thoreau Institute also observed that, to immunize the government against lawsuits, the Congress could pass a law declaring that property owners who fail to take advantage of the federal government's cost-sharing program to fireproof their properties would not be able to seek damages if their buildings are subsequently lost to a fire that started on federal lands.

- The Forest Service's 1995 Strategic Assessment of Fire Management recommended, among other things, that:

    1. States should (a) develop model state and local building codes/guidelines for communities in fire-prone areas in cooperation with the federal government and (b) be rewarded for taking steps to adopt such codes/guidelines.

    2. The receipt of federal funding for rural firefighting should be contingent on aggressive state and local efforts to implement the building codes, and federal funding to reduce hazardous fuels in the WUI should be targeted to areas where landowners have agreed to participate in fire-safe building designs and practices as well as other fire-safety projects.

    3. The Federal Emergency Management Agency (FEMA) should be encouraged to enforce its regulations requiring that grants for reconstruction be contingent on implementing building standards that ensure fire safety.

    4. Fire insurance practices should encourage fire-safe building practices and insurance premiums on structures should reflect the risk of wildfire associated with building in hazardous situations.

    5. A federal emergency assistance program should be established that is available when states are confronted with fire situations that exceed their capability.

    6. A national fire emergency fund should be developed that is available to states that maintain a prescribed level of capacity. The federal government could provide

initial funding. However, unless a state has a fire emergency fund of its own, it should be required to contribute to the fund.

The Forest Service's Statutory, Regulatory, and Administrative Framework Needs to be Tailored to Better Address Hazardous Fuels Reduction and Burned Area Restoration

According to a 1997 GAO Report on Forest Service Decision-Making, the agency lacks the statutory, regulatory, and administrative framework needed to efficiently and effectively address hazardous fuels and other forest health issues. The Forest Service's 2002 Report on its Planning Process identified the statutory, regulatory, and administrative requirements that impede the efficient and effective management of the national forests. According to the report, the Forest Service has created some of its own problems as its rules and administrative requirements have accumulated over time. However, much of the problem lies beyond the Forest Service's ability to control.

For example, federal regulatory agencies are primarily focused on the immediate risks to single resources, such as threatened and endangered species or the quality of air on any given day, rather than on long-term outcomes and landscape-scale conditions. In addition, some courts have increasingly directed the Forest Service to obtain information beyond that which the agency views as needed to comply with legislative requirements. Moreover, the Forest Service is the only federal land management agency with a legislatively required appeals process.

The Forest Service's June 2002 Planning Process report recognizes the importance to sound decision-making of public participation, interagency consultation, and environmental studies. While these critical components of informed management must remain, their current form tends to shift the focus away from the long-term health of the land and produces long decision-making delays that can prevent needed work from happening before it is overtaken by events.

Recommendations

On August 22, 2002, President Bush announced a new initiative to restore forest and rangeland health and prevent catastrophic wildfires on public lands. The Healthy Forests Initiative is intended to expedite federal and local efforts to restore forest health through active land management efforts, such as the thinning of small trees and brush and, where appropriate, prescribed burns. Toward this end, the President directed the Secretaries of the Interior and Agriculture as well as the Chairman of Council on Environmental Quality (CEQ) to:

- Improve the procedures for developing and implementing fuels treatment and forest restoration projects in priority forests and rangelands, in collaboration with local governments.

- Reduce the number of overlapping environmental reviews by combining project analysis and establishing a process for concurrent project clearance by federal agencies.

- Develop guidance for weighing the short-term risks against the long-term benefits of fuels treatment and restoration projects.

- Develop guidance to ensure consistent National Environmental Policy Act (NEPA) procedures for fuels treatment and restoration activities, including development of a model Environmental Assessment (EA) for these types of projects.

The President will also work with the Congress on legislation to allow more timely, efficient, and effective implementation of forest health projects. Such legislation would:

- Authorize agencies to enter into long-term stewardship contracts with the private sector, non-profit organizations, and local communities. Long-term contracts provide contractors the incentive to invest in the equipment and infrastructure needed to productively use the material generated from forest thinning, such as small-diameter logs, to make wood products or to produce energy (biomass).

- Expedite implementation of fuels reduction and forest restoration projects, particularly in high priority areas.

- Ensure that judges consider the long-term risks of harm to people, property, and the environment in challenges based on short-term risks of forest health projects.

- Remove the rider that imposes extraordinary procedural requirements on the Forest Service appeals process that are inconsistent with pre-existing requirements of law.

Distrust of Timber Harvesting Must be Overcome

The most controversial issue related to reducing hazardous fuels and restoring forest health is the role of timber harvesting. On one hand, many experts agree that fuels must be reduced in many areas, at least initially, by mechanical means, including commercial timber harvesting, in conjunction with prescribed fire. On the other hand, revenue from commercial timber harvesting can be used to fund other programs and activities. As GAO pointed out in its 1999 Cohesive Strategy Report, this provides an incentive for land managers to (1) focus on areas with high-value commercial timber rather than on areas with high fire hazards or (2) include more large, commercially valuable trees in a timber sale than are necessary to reduce the accumulated fuels. Thus, as noted in the 2002 Sierra Club Report, some parties believe that the federal land management agencies, in general, and the Forest Service, in particular, cannot be trusted to focus on areas with high fire hazards rather than on areas with high-value commercial timber. These parties also note that the effectiveness of mechanical thinning in protecting communities and restoring forests is still far from conclusive and that the long-term effects of timber harvesting are not know. Similarly, a 2000 Forest Service Report on Postfire Logging observed that the "information on the environmental effects of postfire logging is scanty at best" and recommended "caution" in its use.

According to the 2002 Incentives Report by the Thoreau Institute, "both sides are partly right and mostly wrong." On one hand, commercial timber sales, if they are done right, can play a role in reducing hazardous fuels. On the other hand, since the Forest Service can use the revenue from commercial timber harvesting to fund other programs and activities, the incentives are to focus on areas with high-value commercial timber rather than on areas with high fire hazards.

Recommendation

- One option for ending the existing gridlock, cited in the 2002 draft Joint Cohesive Strategy, the 2002 Forest Service Planning Process Report, and the 2000 Postfire Logging Report, as well as by scientists and land managers, is adaptive management. Adaptive management is an approach to decision-making based on the premise that (1) decisions are necessarily based on incomplete data and a less-than-perfect understanding of natural processes, (2) the understanding of ecosystems continually evolves, and (3) unexpected events can and will occur. It accepts that uncertainty is normal but tries to ensure that this fact does not grind decision-making to a halt. Rather, adaptive management is directed at making decisions on the basis of the best information available, monitoring the results, learning from experience, and adjusting future management accordingly. In addition, new developments in information technology are making it easier to share information and to collaborate across traditional jurisdictional boundaries on a landscape scale. Moreover, public participation in the Forest Service's decision-making continues to evolve and now includes multiparty monitoring and evaluation of certain fuels reduction projects to assess whether ecological management objectives and administrative efficiencies are being achieved and whether the needs of rural communities are being addressed.

Access Is an Unresolved Issue

Among the more contentious debates over how federal lands should be managed is the role of roads, particularly in areas that are now roadless. On one hand, roads provide access for fuels reduction and fire fighting. However, roads can also have negative environmental and economic effects. Therefore, the positive effects of improved access for fuels reduction and fire fighting need to be weighed against the negative ecological impacts as well as the costs to construct and maintain the roads.

Recommendation

- The Forest Service's 1995 Fire Economics Assessment Report recommended that access be improved on national forests for fire suppression activities. However, more recent products, including the 2001 Forest Service Transportation Policy, would require federal land managers to use science-based analyses to identify the minimum road system needed to administer, use, and protect their lands and resources.

The Value of Protecting Natural Resources Has Not Been Resolved

According to the 2002 Thoreau Institute Report on Incentives, most fires that do not threaten a WUI should be allowed to burn. According to that report, letting more acres burn would save hundreds of millions of dollars of fire suppression costs each year, not to mention the lives of dozens of firefighters. In addition, the agencies may not need to spend as much money on preparedness (pre-suppression). However, as noted in the Forest Service's 1995 Fire Economics Assessment Report, wildfires can also threaten resources protected by law, regulation, or policy, and protecting them can increase wildfire suppression costs. Examples include threatened and endangered species and their habitats, archeological and historic sites, riparian zones, wilderness areas, rivers and lakes, and special and geologic features. Moreover, trends in public opinion and changes in forest policy indicated that society might value the national forests more for their variety of non-commodities than for their commercial timber, according to both the Forest Service's 1995 Fire Economics Assessment Report and its 1995 Strategic Assessment of Fire Management.

Recommendation

- The Forest Service's 1995 Fire Economics Assessment Report raises the policy question concerning how much should be spent to protect a changed value mix. For example, would the Pacific Northwest forests, with their reduced timber harvest levels, be more efficiently protected by reducing pre-suppression levels and letting more wildfires burn, or would their implicit values, not yet quantified, warrant current or higher levels of pre-suppression funding?

KEY PLANNING AND BUDGET CHANGES

Each year, the administration and the Congress must make difficult decisions concerning the priority to be given to wildland fire management relative to other appropriations (budget accounts) as well as the priority to be given to the various wildland fire management activities. These activities include fire prevention and education, preparedness (initial attack and extended attack), hazardous fuels reduction, restoration and maintenance of ecosystem health (wildland fire use), suppression of large fires and simultaneous ignitions on a planning unit, protection of life and property in the WUI, rural fire assistance, and fire-related research.

Options Have Been Proposed to Prioritize Wildland Fire Management Activities for Funding

Many prior studies and reports provide a confusing message concerning the funding priority to be given to the various wildland fire management activities. However, options have been proposed, and recommendations made, to assist decision makers in reaching more informed decisions concerning the allocation of appropriated funds.

Recommendations

- The 2002 Draft Joint Cohesive Strategy, developed by the Department of the Interior (DOI) and the Forest Service, would establish hazardous fuels reduction as the wildland fire management activity warranting the highest priority for increased federal funding. It notes, among other things, that without a significant increase in funding to reduce hazardous fuels, the risk of wildfires to communities and ecosystems would continue to increase. The strategy also stated that (1) unless the rate of restoration is increased, greater burned acreages and higher wildfire suppression costs will continue and (2) wildfires that burn under extreme conditions often require extensive site rehabilitation treatments that significantly increase wildfire costs. It concludes that the "cost of restoring or maintaining an ecosystem through treatment activities is generally much less than the cost of suppressing a wildland fire and rehabilitating the land."

- The 2001 DOI and Forest Service Report on a New Wildland Fire Program Analysis and Budgeting Process recommends replacing the multiple fire management planning and budget processes being used by the five federal land management agencies with a single, uniform, cost-effective, objective-driven, performance-based, integrated wildland fire program analysis and budgeting process. This new process—named the Fire Management Analysis Process or Fire-MAP—would, among other things, provide federal land managers with the ability to evaluate the cost effectiveness of alternative fire management strategies to achieve the full range of wildland fire management goals, objectives, and activities. The process would (1) focus on the relative importance of goals and objectives over time and (2) allow each federal land management unit, such as a national forest or national park, to define its programmatic fire management needs by analyzing the integration of, and trade-offs among, the various wildland fire management activities.

Risk Assessment and Management Needs to be Integrated into the Agencies' Planning and Budgeting Processes

As noted in the Forest Service's 1995 Fire Economics Assessment Report, wildland fire management is a form of risk management. As wildland fire management decision-making has become more complex, contentious, and uncertain, the need to quantify and explain risks has become greater. To make informed decisions concerning the proper mix of wildland fire management activities, federal land managers must first establish an acceptable level of risk. In other words, they must decide whether to plan and budget for the worst fire years or strictly on the basis of economic efficiency. They then need to analyze the risks associated with the integration of, and trade-offs among, the various wildland fire management activities to identify potential program efficiencies. Currently, none of the existing planning and budgeting processes or computer planning models calculates levels of uncertainty in choosing a program level. However, there are vast data on historical fire weather patterns, and the computational capabilities of fire behavior and operations simulation models could support the development of a risk-based fire-planning model.

Recommendations

- The Forest Service's 2000 Strategy for Fire Management states that the agency could develop a continuum of wildland resource/political values and apply the appropriate suppression response to each. On lands with low resource/political values, such as wilderness, the agency would use very limited resources to monitor and confine a wildfire. Conversely, on lands with high resource/political values, such as the WUI, it would use "massive resources, with associated high cost." In between these extremes, it would develop appropriate suppression response tactics. These tactics would typically involve higher uncertainty and greater risk than the tactics applied at either end of the spectrum. The compelling reason for dealing with higher risk and uncertainty is the reward of lower cost for the agency.

- The Forest Service's 1995 Fire Economics Assessment Report recommended that the costs of risk aversion or excessive risk-taking be avoided through active evaluation of risk in fire management decisions, institutionalizing decision processes, training in risk analysis, rewarding the taking of measured risks, using new risk analysis software, and implementing advances in risk communication.

- The 1995 report also observed that with a better understanding of the level and nature of variability, agencies could use "insurance concepts" to design a funding mechanism to develop reserves for bad fire years and an incentive system to reward units for holding costs within rationally determined ranges of variability. This mechanism could help fire managers become aware of their risk behavior and better evaluate how their choices tradeoff acceptable risk against the cost of managing the fire program.

Completing and Updating Fire Management Plans (FMPs) May Lower Suppression Costs on Some Federal Land Units

According to the 2002 GAO Report on Preparedness, as of September 30, 2001, over half of all the federal land management units with burnable acres did not have fire management plans that meet the requirements of the 1995 Federal Wildland Fire Management Policy. If a fire management plan does not meet the requirements of the policy, local units do not have the option of letting wildfires burn and are required to suppress them.

The Forest Service and DOI have now developed consistent procedures and standards for fire management planning that will assist local units in their efforts to have fire management plans that are in compliance with the national fire policy. Their goal for completing and updating their fire management plans is set for 2004.

Recommendation

- In its 2002 report, GAO recommended that DOI and the Forest Service ensure that fire management plans are completed expeditiously for all burnable acres and are consistent with national fire policy.

Wildland Fire Management Needs to be Better Integrated into Federal Land Management Planning (LMP)

The 2002 Thoreau Institute Report on Incentives observed that, of the fire management plans that have been prepared, most do not allow fires to burn outside of large wilderness areas and that even in wilderness areas, fires are only allowed to burn under strict conditions. Thus, completing and updating their fire management plans "is hardly the panacea for natural burning that some people want to see in the future." Other products have placed this shortcoming on the failure to integrate wildland fire management into federal land management planning. For example, the Forest Service's 2000 Strategy for Fire Management observes that the lack of integrated planning results in competing and conflicting direction and objectives. Functional budgets and programs prevent integration, efficient funding, and staffing of projects and inhibit broad-based understanding of fire's role in ecosystem management.

Recommendations

- The Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs recommended that fire be placed as an equal resource in the agency's land management planning process.

- The 2000 NASF Report on Cost Containment observed that, in many areas, fire must be managed as any natural resource would be managed. Therefore, the preferable course would be to deal with fuel loads as a component in a sound resource management program well in advance of any potential incident.

Federal Agencies Need to Anticipate Needs to Protect Private Lands and Structures

Both the fire management plans—as well as the computer planning models that use information from the plans to determine the amount and kind of personnel and equipment needed to reach a given level of firefighting preparedness—only consider lands for which a federal land management agency has direct fire protection responsibilities. Therefore, the plans and models do not consider the federal and non-federal firefighting resources that are needed to protect nonfederal lands, including lands in the WUI that pose direct risks to communities and structures. According to several reports and studies, the resources to protect these lands and structures can be significant in some areas. As a result, the failure of the plans and models to anticipate the resources associated with protecting nonfederal lands from fires originating on federal land management units almost guarantees inadequate resources for initial and extended attack, inefficiencies, and ultimately excessive costs.

Recommendation

- Several reports—including the Forest Service's 1995 Fire Economics Assessment Report, the agency's 2000 Assessment of Factors Influencing Wildfire Costs, the 2000 NASF Report on Cost Containment, and the 2001 DOI and Forest Service report on a New Wildland Fire Program Analysis and Budgeting Process—have recommended that the fire management plans and the computer planning models be updated to keep pace with today's fire suppression complexities. This would include the lands in the WUI adjacent to the boundaries of the federal lands. Including these lands would address the increased pre-suppression resources needs.

Federal Agencies' Analytical Tools Need to Reflect the Costs Associated with Political, Social, and Media Expectations

A reality of today's wildland fire management is that the ever-increasing intermingling of human communities with wildlands brings increasing societal expectations for suppressing wildfire, even as it creates a situation in which fire suppression becomes much more difficult. Because of the increased population and private development within the interface, public concern and expectations influence decisions and the commitment of federal resources. In their belief that local, state, and federal firefighters are somehow able to prevent the loss of lives and property in the face of catastrophic wildfire, citizens, politicians, and the media have exerted substantial pressure on Incident Management Teams and Agency Administrators to employ costly extraordinary suppression measures to do so.

Recommendation

- The Forest Service's 1995 Course to the Future observed that large-fire decisions that result in the greatest expenditures are usually driven by non-economic factors, such as political and social expectations. Yet, the value and costs derived from these expectations are not reflected in the agency's analysis tools. Until such costs are considered, these tools will be unable to accurately guide large-fire management decisions.

Existing Computer Planning Models Need to be Enhanced

The five federal land management agencies currently use three different computer planning models to identify the personnel and equipment needed to respond to and suppress wildfires. Several reports have made recommendations to enhance one or more of the existing computer planning models.

Recommendations

- The 2001 DOI and Forest Service Report on a New Wildland Fire Program Analysis and Budgeting Process observed that the computer models that use information from the plans to determine the amount and kind of personnel and equipment needed to reach a given level of fire-fighting preparedness do not consider the fire-fighting personnel and equipment that are available in adjacent state and local jurisdictions. These resources could decrease the need for federal fire-fighting personnel and equipment in certain areas. Therefore, it is important to identify the best mix and location of fire management resources (federal, state, and local) to achieve the land management goals and objectives.

- The Forest Service's 1995 Fire Economics Assessment Report observed that the process used by the Forest Service, the Bureau of Land Management, and the Bureau of Indian Affairs encourages high valuation of resources damaged by fire to maximize pre-suppression funding. However, there is no similar activity to display the effects of restoring fire to the ecosystem and the benefits of increasing burned acreage are not generally modeled in the process. Fuels management is considered beneficial only in the sense that a reduction in suppression costs can be demonstrated. Therefore, the model needs to be revised to incorporate fuel treatments and the beneficial effects of fire in an interactive analysis.

- Other reports have noted that the Forest Service, the Bureau of Land Management, and the Bureau of Indian Affairs use one model to identify the personnel and equipment needed for preparedness and suppression, a separate set of programs to prioritize hazardous fuels reduction projects, and do not also identify the staffing and financial support requirements for wildland fire use.

- The 2002 Thoreau Institute Incentives Report identified a number of flaws in the process used by the three agencies. Specifically, the model does not, but should, take into account (1) the savings on suppression and pre-suppression costs of letting a fire burn, (2) annual variations in weather, (3) the effect that suppression in one year will have on suppression costs in future years, and (4) non-market resource values.

KEY CHANGES IN MANAGING INDIVIDUAL LARGE WILDLAND FIRES

No matter how well prepared federal wildland fire management agencies are, under severe weather and drought conditions, some unwanted wildland fires will escape initial and extended attack, especially in areas where extreme hazardous fuels exist. Prior reviews of the costs of suppressing large wildfires have observed that, once a wildfire overwhelms initial and extended attack and a decision is made to suppress it, there may be few opportunities to significantly reduce the costs of managing the fires. However, they have identified opportunities to improve the overall efficiency of the fire suppression efforts and, thus, reduce some costs. Toward this end, the 1995 Forest Service Fire Economics Assessment Report observed that, until major changes in fire management policy begin to take shape, keeping costs in check must be a key discussion topic at every management transition point, briefing, and oversight review.

Improved Integration of Risk Analysis into Wildfire Management Decisions Might Reduce Some Costs

Most Incident Management Teams and Agency Administrators recognize that they have the authority to select priorities and strategies that will reduce cost. However, at least six reports issued during the last seven years have observed that there are few incentives or rewards for Incident Management Teams and Agency Administrators to take prudent and acceptable risks that could lead to reductions in large wildfire suppression costs. Rather, the potential for litigation and claims, critical media coverage, and political pressure to suppress all wildfires are major disincentives to risk taking. However, the reports also recognized that the assumption of risk must be based on adequate risk analysis.

Recommendations

- The July 2000 NASF Report on Cost Containment recommended that federal land management agencies provide Incident Management Teams and Agency Administrators with better decision-making tools and then support and encourage calculated risk-taking as they set suppression objectives.

- The Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs and the 2001 DOI and Forest Service Report on a New Wildland Fire Program Analysis and Budgeting Process recommended that, to improve fire suppression capabilities, models like the Rare Event Risk Analysis Program (RERAP)[1] or the Fire Area Simulator (FARSITE),[2] be standardized, improved, and institutionalized.

- According to the 2000 Forest Service report, accomplishing the goal of "well analyzed risks" would require that the Wildland Fire Situation Analysis (WFSA) be integrated with other tools, particularly RERAP, FARSITE, and other fire behavior analysis methods. This would require better integration of the WFSA with information resources, such as GIS, according to the report.

- According to the 2000 Forest Service report, integration of the WFSA with other tools would also impose new training requirements. In addition, a risk analysis approach would require modeling of the effectiveness of fire suppression resources, both in terms of theoretical production rates (e.g., chains of line per hour per hand crew) and in the actual conditions under which the resources are deployed (e.g., environmental conditions, terrain, and fatigue).

- The Forest Service's 2002 Report on Cost-Containment recommended that the agency utilize its assessment capability for the risks of wildfire starts and risks of incurring large fires, as well as its new Predictive Services experts, to help with long-term fire behavior assessments and risk analysis. This would assist fire managers with questions about how and when to move what suppression assets to the highest priority locations. The geographic areas would then need to commit to moving these assets where needed, when needed, and not holding onto resources unnecessarily.

The Benefits and Costs of Restrictions on Suppression Strategies and Tactics Should be Identified and Analyzed

The Forest Service's 1995 Fire Economics Assessment Report observed that environmental and other laws, regulations, and policies can have both positive and negative impacts on fire expenditures. For instance, the use of Minimum Impact Suppression Techniques (MIST) can increase costs by increasing the likelihood of spotting across fire lines and extreme fire behavior. In addition, increased expenditures could result from additional efforts to either avoid or mitigate damage from the construction of fire lines, backfire or burnout operations, dropping of fire retardant, construction of fire camps, and other fire suppression activities. Conversely, MIST can decrease fire expenditures by reducing the need for rehabilitation of fire lines. The 1995 report observed, however, that the impact of environmental and other laws, regulations, and policies on fire-related expenditures was likely to continue to increase.

[1] RERAP determines probabilities that a wildland fire will exceed a maximum allowable perimeter before a fire-ending event will halt fire spread.
[2] FARSITE is a large fire growth simulator.

Recommendations

- The Forest Service's 1995 Large Fire Review recommended that the agency require a tradeoff or benefit/cost analysis of any restriction on suppression tactics, such as the use of dozers, retardant, or other suppression methods. This analysis should include any increase in resource damage caused by greater burned acreage that may result from the restriction.

- The Forest Service's 2002 Cost-Containment Report recommended that Agency Administrators should always evaluate all facets of MIST in the WFSA alternatives and include this direction in the Delegation of Authority.

A Younger, Less Experienced Federal Workforce Could Benefit from More Training and Mentoring

According to GAO's 2002 Preparedness Report, all five of the major federal land management agencies were expected to hire all of the fire-fighting personnel that they identified as needed by the 2002 fire season. However, this younger, less experienced workforce is being hired at a time when fire suppression is becoming much more complex. Recommendations to develop the required knowledge, skills, and abilities have focused on training and mentoring.

Training-Related Recommendations

- The 2000 NASF Report on Cost Containment recommended that federal land management agencies take the following training-related actions.

  1. Encourage federal and state employees to participate in training and then make them available to be dispatched for suppression.

  2. Include in every individual's position description a requirement for a training plan that identifies the suppression or prevention position(s) to which the employee is aspiring.

  3. Insist that supervisors allow employees the time to attend formal training to advance their fire suppression qualifications according to their training program.

- The Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs recommended that federal land management agencies should (1) review current training for incident management personnel and (2) amend the training as necessary to include methods of cost containment and efficient management of suppression resources.

Mentoring-Related Recommendations

- The 2000 NASF report recommended that federal land management agencies take the following mentoring-related actions.

1. Use recent federal and state fire program retirees as mentors.

2. Use qualified retirees for fire assignments where appropriate, particularly for "mentoring" posts.

- The 2000 Forest Service report recommended that federal land management agencies implement a mentoring program to improve fire management skills for all personnel engaged in fire suppression.

Non-Firefighting Personnel Are Needed to Fill Support Positions

Three reports—the Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs, the 2000 NASF Report on Cost Containment, and the Forest Service's 1995 Course To the Future—observed that, in the past, when a fire occurred, non-fire personnel would make themselves available to serve. This was the Forest Service's "militia." However, the traditional "militia" approach to large fire suppression is not working. The overall reduction in Forest Service field personnel over the last decade is the primary reason. This, combined with the decreasing availability of existing personnel to participate in fire suppression activities because of low pay incentives, higher priority work, and a variety of personal reasons, will require some changes to be made if the agency is to remain effective.

Recommendations

- The 2000 NASF Report on Cost Containment recommended that federal land management agencies take the following fire support-related actions.

1. Make available for fire assignments employees in local fire management agency offices who lack the skill, demeanor, or physical ability to serve in a red-carded position on a fire but are capable of performing wildfire suppression or prevention activities at some specific, defined level. This requirement should be inserted in every individual's position description.

2. Work with NWCG to promote an in-depth examination of factors contributing to the erosion of the pool of experienced forest fire suppression personnel and to develop strategies for reversing the trend.

3. Place a high priority on ensuring that qualified people are allowed to be available for suppression dispatches.

Agency Administrators Need to More Effectively Exercise Their Wildfire Management Responsibilities

The overall responsibility and accountability for an incident rests with the Agency Administrator, who must make immediate, high-cost decisions that directly influence the manner in which suppression efforts develop on a wildfire. However, according to the 2000 NASF Report on Cost Containment, Agency Administrators often have minimal experience and limited knowledge of fire effects, fire management, or fire behavior. As a consequence, inexperienced Agency Administrators (1) make decisions that lead to higher suppression costs and (2) fail to make important administrative or operational choices that could reduce overall incident costs. In addition, Agency Administrators often (1) delegate away the pivotal initial strategic decision on a wildfire, in part, because they do not feel qualified to address today's complexities of fire suppression and (2) fail to provide strong and effective leadership, guidance, and oversight to Incident Management Teams once they arrive to assist in managing a wildfire, according to Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs.

Training-Related Recommendations

- The Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs and the 2000 NASF Report on Cost Containment recommended that Agency Administrators be required to attend either a national or regional training course in fire management leadership to more effectively exercise their fire management responsibilities.

- The Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs recommended that federal land management agencies review current training for Agency Administrators and amend the training as necessary to include methods of cost containment and efficient management of suppression resources.

- The 2000 NASF report recommended that current training for Agency Administrators be reviewed and amended as necessary to include methods of cost containment and efficient management of suppression resources.

Mentoring-Related Recommendations

- The July 2000 NASF report recommended that federal land management agencies assign experienced Agency Administrators, including recent retirees, to mentor inexperienced Agency Administrators prior to an actual incident and to coach them during an actual incident.

- The January 2000 Forest Service report recommended that federal land management agencies implement a mentoring program to improve fire management skills for all personnel engaged in fire suppression.

- The Forest Service's 1995 Course To the Future recommended that an oversight system be developed to reinforce and support inexperienced Agency Administrators during large wildfires. The abilities and skills of Agency Administrators should be strengthened through, among other things, oversight reinforcement for inexperienced Agency Administrators. Each region should form Agency Administrators support teams to coach less experienced local managers during times of critical fire suppression decision making.

Other Recommendations

- The 2000 Forest Service report recommended that Agency Administrators remain appropriately engaged in the management of an incident after an Incident Management Team arrives to ensure that a fire is managed in a safe and efficient manner. This would include (1) constructing a more systematic and consistent approach to oversight of Agency Administrators and (2) providing a predominant message that costs are a priority and are expected to be as low as practicable in the management of the incident.

- The 2000 NASF report recommended that, to assist Agency Administrators, fire management personnel keep a current, localized version of the Fire Management Leadership Desk Reference (developed by the National Advanced Resource Technology Center) available and review it annually.

- The 2000 NASF report also recommended that all Agency Administrators should become responsible for supporting the annual Fire Loss Tolerance report, what it contains, what goes into the report, and what the report means to accountability for cost containment nationally on large fires.

The Cost, Performance, and Productivity of Non-federal Crews and Equipment Need to be Evaluated

According to several reports issued over the last seven years—including the Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs, the agency's 1995 Large Fire Review, and a 1999 Forest Service Paper on Reducing Large Wildfire Suppression Costs—state, local, and contract crews and equipment generally cost more then using federal personnel and equipment. In addition, the performance and productivity of some non-federal crews have been questioned.

Recommendations

- The Forest Service's 1995 Large Fire Review recommended that the agency develop alternative methods for providing logistics and finance personnel for fire suppression assignments, including contracting and utilizing personnel from other agencies.

- According to the 2000 Forest Service report, if the agency must depend more on contract crews in the future, it will need better controls for contract preparedness, training, and safety. The report also recommended that the Forest Service (1) use only crews with proven qualifications who are sanctioned or certified as wildland firefighting crews and (2) be more aggressive in calling for available crews nationwide.

Changes Are Needed to Delegations of Authority to Better Consider Costs

According to the Flathead Forest's 2000 Line Officer's Wildfire Guide, few decisions by Agency Administrators obligate more money, commit more people to hazardous duty, have longer-term impacts on natural resources, or determine the scope of future management decision space than the selection of a large fire suppression strategy. Two documents assist an Agency Administrator in making this selection—a Delegation of Authority and a WFSA. Together, these two documents represent the most important procedural responsibility that an Agency Administrator has in managing a wildfire.

Recommendations

- The Forest Service's 2002 Cost-Containment Report recommended that the agency develop a new example of a Delegation of Authority. The new Delegation of Authority should include "trigger points" that would mandate an Incident Management Team to initiate a meaningful least-cost alternative and cost containment actions that should include effects on values at risk.

- The 2002 Forest Service report also recommended that the agency consider including a "cost restraint" (i.e., $800 to $2,200 per acre) in the Delegation of Authority. The expectation would be for the Incident Management Team to manage costs within this range and that the Agency Administrator review this expectation every day.

- The 2000 NASF Report on Cost Containment recommended that incident goals be measurable and attainable and that incident objectives be linked to the costs of attaining them. Well-developed fire management objectives should address environmental, social, economic, and political issues and therefore provide excellent insight into setting priorities, cost-benefit guidance, and the types of fire management strategies that are acceptable.

- The Forest Service's 1995 Large Fire Review observed that there are few incentives to take risks that could lead to reductions in large fire suppression costs. To address this finding, the report recommended, among other things, that the Forest Service assure that Agency Administrator objectives for fire suppression in the Delegation of Authority are measurable and associated with specific costs for attaining the objective.

An Incident Business Advisor (IBA) Should Be Assigned to Every Large Wildfire

Prior to 1995, very little economic analysis of strategies and tactics was being done on individual fires and, even if inefficiencies were detected, they were seldom being noted and corrected during the fire. However, the large wildland fires and lengthy fire seasons during the 1990s saw the introduction of the "comptroller" position on the Incident Management Team. The role of the comptroller—later renamed the Incident Business Advisor—is to advise the responsible Agency Administrator and line officers on cost issues specific to a single fire. By 1999, Incident Business Advisors were on some large wildfires.

Recommendations

- The Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs and NASF's 2000 Report on Cost Containment recommended that an Incident Business Advisor be assigned to a large fire throughout the incident to collaborate with the Agency Administrator and to provide proper fiscal oversight to the Incident Management Team.

- The Forest Service's 1995 Large Fire Review recommended that the agency define the role of the comptroller (Incident Business Advisor) to include (1) input and participation in the development of the WFSA, (2) participation in basic workforce planning in order to estimate the finance organization needed and to ensure that appropriate people and resources are ordered on a timely basis, and (3) selection of the suppression alternative.

Reviews of Large Wildfires Provide Effective Oversight and Feedback

According to the Forest Service's 1995 Fire Economics Assessment Report, periodic reviews of large wildfires, which include economic efficiency as a criterion for evaluation, are necessary to reinforce efficient and informed decision-making and to provide for national consistency. The Forest Service Manual now includes criteria on which to conduct a Large Incident Cost Review. One criterion is when actual or expected expenditures exceed $5 million. However, the Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs stated that indications were that these criteria needed to be applied more consistently.

Recommendations

- The 2000 NASF Report on Cost Containment recommended that annual reviews be conducted of a sample of large wildfires, focusing on the impact of strategy, tactics, and decision-making on cost, risk, and accountability. It also recommended that (1) better fire-cost thresholds be developed to ensure proper oversight of large fire management and (2) post-fire critiques be performed that emphasize the comparison between the costs and benefits of suppression.

- The Forest Service's 2002 Cost Containment Report recommended that the agency conduct post-fire reviews. These reviews should emphasize pre-attack planning and should hold managers accountable for deviating from pre-planned actions. The report also recommended that the Forest Service evaluate why Initial Attack failed on all large wildfires (greater than 1,000 acres) over the course of the 2002 and 2003 fire seasons. Each fire should be analyzed from the initial detection and reporting stage through the escaped fire declaration. Trends and commonalities should be sought to derive reasons so mitigations can be developed. The analysis should focus on causes where "returns" would be the greatest.

- The Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs recommended that the top leadership of the agency's State and Private Forestry mission area, specifically the Deputy Chief and the Associate Deputy Chief, needed to be more consistently involved in large wildfire cost reviews.

- A 1999 Forest Service Paper on Reducing Large Wildfire Suppression Costs observed that oversight reviews and studies that look at individual fires, season-long expenditures, and long-term trends in suppression costs offer important insights into large wildfire expenditures.

- The Forest Service's 1995 Large Fire Review recommended that the agency (1) assign oversight teams to review all major fires within 5 days of heavy resource commitment (or a specific dollar outlay) to analyze the cost effectiveness of the strategy and tactics and (2) review and assess the strategy and priority on large, costly fires anytime a key factor changes, including the delay of an expected season-ending event and repeated failures of a suppression strategy. The report also recommended that the Forest Service annually require regional and Washington Office reviews of a sample of large wildfires with the focus on cost, risk, and accountability. A comptroller (Incident Business Advisor) should be included on each review team.

Agreement Needs to be Reached on Measures of Cost Efficiency

According to the Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs, there are several measures of fire suppression cost efficiency. These include (1) total emergency fire suppression, (2) total cost plus net value change, (3) total cost per acre, and (4) total cost plus savings. However, as an agency, the Forest Service does not agree on a consistent measure to illustrate cost efficiency. On each large wildfire, the agency reports savings as well as costs. The Incident Commander or Agency Administrator approves the method of calculating savings. Methods vary and results can be questionable.

Recommendation

- The report observes that agreeing on which cost and savings measures illustrate the most appropriate picture of wildfire suppression cost efficiency is critical.

The Criteria for Prioritizing Wildfires Need to be Reconsidered

According to the Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs, the criteria for assigning priorities for resources are as follows: (1) the potential to destroy life, improvements, and property; (2) the potential for long-term natural resource loss (e.g., to watersheds or timber); (3) the potential for short-term natural resource loss (e.g., to grazing or crops); and (4) the difficulty of containment (e.g., difficult terrain).

Recommendation

- The report concluded that reconsidering the criteria for prioritizing fires in a multiple-fire situation would have direct positive impacts on fire management effectiveness in both the short term and long term. It also recommended the development of fire behavior software that can be used for regional priority assessment.

Agreement Needs to be Reached on the Standards of Cost Efficiency

The 2000 NASF Report on Cost Containment observed that the expenditure of resources in support of the suppression of wildfire is not guided by any standards to ensure efficiency. Absent a set of performance/cost standards, there is little incentive for Incident Management Teams and/or Agency Administrators to (1) evaluate their strategies and tactics from a cost/benefit standpoint, (2) enhance the efficiency of both mobilization and demobilization of resources, (3) strictly control the use of Type 1 aviation resources, or (4) eliminate over-ordering of resources.

Recommendation

- The NASF report recommended that federal land management agencies (1) develop national or regional suppression cost standards to assist Incident Management Teams in administering suppression efforts and to measure their efficiency, and (2) establish clear and uniform fire-related job performance standards for Agency Administrators.

High-Cost Centers Need to be Included in All Large-Fire Reviews

The Forest Service's 1995 Large Fire Review observed that the use of heavy lift (type I) helicopters had risen significantly and was one of the highest cost centers on large fires. While this resource can be a cost-effective suppression tool on some wildfires, the report observed that the use of type 1 helicopters on some wildfires during the 1994 fire season was ineffective and that they were being used primarily to show the viewing public and the media that active fire suppression was taking place.

Recommendation

- The report recommended that the Forest Service ensure that Incident Management Teams complete a benefit/cost analysis when using this often effective but very expensive resource, and provide adequate supervision and management. It also recommended that the agency include helicopter operations as a key item in all local and regional fire reviews.

Decisions to Lease or Buy Should be Reviewed

The Forest Service's 1995 Large Fire Review stated that, in 1994, the agency procured seven helicopters using an "exclusive use" contract rather than the more expensive "call when needed" contract. The actual cost for the seven "exclusive use" helicopters was compared to the cost for the same helicopters under a "call when needed" contract. The 1994 savings was $812,240 or more than $100,000 per helicopter.

Recommendation

- The report noted that a 1992 national study of type 1 and 2 helicopters had made recommendations on the most efficient staffing levels and procurement methods for large and medium helicopters. The focus of the recommendations was the mix of contracting methods that would result in the greatest potential cost savings.

The Agencies Could Benefit from Economies of Scale

The Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs stated that present contracts do not allow for reduced costs for long-duration events. Full daily rates over a long period resulted in paying the equivalent of the full price of some equipment, such as cars and trucks.

Recommendation

- The report recommended that the terms for fire contractors (goods and services) be adjusted to allow for cost adjustments on long-duration fires (economies of scale).

Nearby Resources Should be Used First

According to the 2000 NASF Report on Cost Containment, local resources are almost always available to fill support roles that do not require advanced firefighting skills, e.g., clerical and business functions. However, both the planning and the dispatch systems frequently overlook qualified resources that are available nearby, resulting in unnecessarily high administrative and transportation costs to bring distant resources to bear, according to both the NASF report and the Forest Service's 2002 Report on Cost Containment.

Recommendations

- The NASF report stated that emphasis should be on the use of nearby resources first, before importing distant resources that must be transported, housed, and fed. The report then provides ten specific recommendations to facilitate this goal, such as developing directories of local skills and prioritizing available resources on the basis of how distant they are and dispatching them accordingly.

- The Forest Service report recommended that the agency examine the mobilization of resources on a geographic area level and national level with the objective of cost containment.

Pre-Attack Planning Should be Improved

The Forest Service's 2002 Report on Cost Containment stated that strategic pre-positioning, as the strong foundation of preparedness, should be implemented as it reflects support to initial attack planning on the agency's land units.

Recommendations

- The 2002 Forest Service report recommended that preparedness and pre-positioning be an integral part of requests for severity funding to show what resources are needed and where they are needed in order to address predicted wildfire trouble before it occurs.

- The 2000 NASF Report on Cost Containment recommended that the federal agencies (1) expand their use of equipment caches and pre-position equipment and personnel to quickly bolster first-response forces, even to the point of co-locating federal and state resources and (2) ensure that communications networks are useable by all local groups.

- The Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs stated that better pre-planning of base camp locations would improve overall efficiency.

The Effectiveness of Incident Management Teams Could be Improved

The Forest Service's 2000 Assessment of Factors Influencing Wildfire Costs stated that having more flexible standards in place would significantly improve the overall effectiveness of the management of the fire.

Recommendations

- The Forest Service report observed that there needed to be better flexibility in team composition and rotation.

- The 2000 NASF Report on Cost Containment stated that federal land management agencies should (1) reemphasize the importance of Type 3 Incident Management Teams for extended attack and for smaller fires and insist on their use in appropriate situations and (2) avoid ordering a Type 2 team if an incident is of a complexity that will allow the safe use of a Type 3 team.

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VIEWS OF STATE FORESTRY OFFICIALS ON FIRE-SUPPRESSION COST CONTAINMENT

A Survey
Prepared by the Academy Staff
in Cooperation with
the National Association of State Foresters

National Academy of Public Administration
Washington, DC

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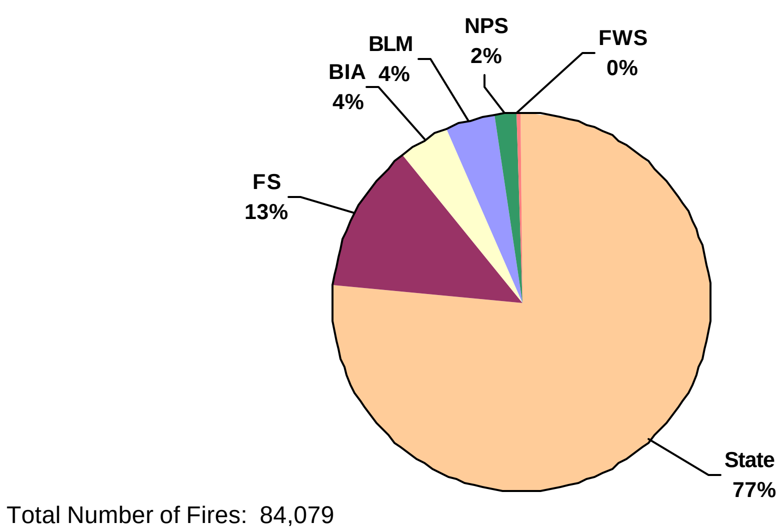
VIEWS OF STATE FORESTRY OFFICIALS ON FIRE-SUPPRESSION COST CONTAINMENT

BACKGROUND

The Academy complemented other research in this project with a survey of state forestry officials. This survey was conducted in cooperation with the National Association of State Foresters (NASF) to obtain state views about containing wildfire suppression costs. It also updates a similar survey of state forestry officials conducted by NASF in 2000. The 2002 survey was sent to state foresters in 50 states and seven U.S. territories, with a request to pass it along to knowledgeable persons on their staffs for response. Responses were received from 105 officials in 44 states. The results are presented in this appendix.

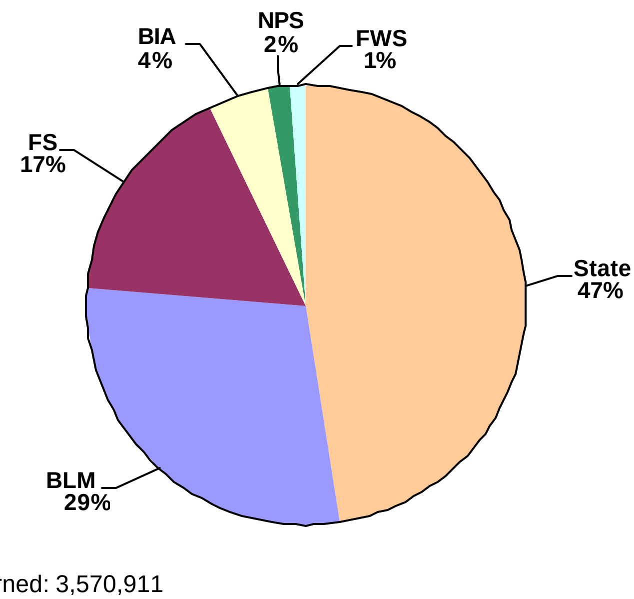
The Academy Panel and staff considered state perspectives about controlling wildland fire suppression costs essential for several reasons. In particular, most wildfires are not located on federal land and are under state (and/or local) jurisdiction (Figure E-1). Although state and local fires tend to be smaller in size than federal fires, about 47 percent of the total acres burned in 2001 were on non-federal lands (Figure E-2). In addition, it is increasingly recognized that several governmental entities often have important authority and jurisdiction over wildland fires that can span multiple land ownerships and involve various fire organizations, particularly if located near community interface areas. As a result, it is important to consider federal and state wildland fire programs together. Almost all nation's state foresters (48 of 50) have wildland fire under their jurisdiction, and it is the largest program managed by some of them.

Figure E-1. Number of All Reported Wildland Fires in 2001



Source: http://www.nifc.gov/fireinfo/2001/stats.html

Figure E-2. Jurisdictions of Acres Burned by Wildland Fire in 2001



Source: http://www.nifc.gov/fireinfo/2001/stats.html

In addition, the nation's state foresters and their membership organization (NASF) have been active partners with the federal government concerning wildland fire for several decades. NASF's Forest Fire Protection Committee initiated specific efforts in the late 1990s to examine the utilization of resources and rising fire suppression costs. A Fire Resources Utilization Subcommittee was established and concluded that the input of state and federal wildland fire personnel was needed to address this concern. As a result, NASF conducted and published brief nationwide survey of state and federal wildland personnel in 2000.[1]

Methodology

Through discussions with NASF's Forest Fire Protection Committee leadership, the Academy panel and staff agreed that a new survey of state wildland fire personnel was needed. The purpose of the survey was to identify new perspectives, issues and reactions to recent developments, particularly after the large 2000 fire season, implementation of the National Fire Plan, and issuance of the 2001 Federal Wildland Fire Management Policy.

NASF Fire Committee representatives and Academy staff reviewed the former survey and results early in 2002, and prepared a new survey to complement the 2000 one and provide input to the

[1] NASF, *Cost Containment on Large Fires: Efficient Utilization of Wildland Fire Suppression Resources*, July 2000.

Academy study. Each of the five questions in the 2000 survey were included in the new instrument, though with some updates to facilitate compilation of the results. Several additional questions were added to enrich the understanding of state perspectives.

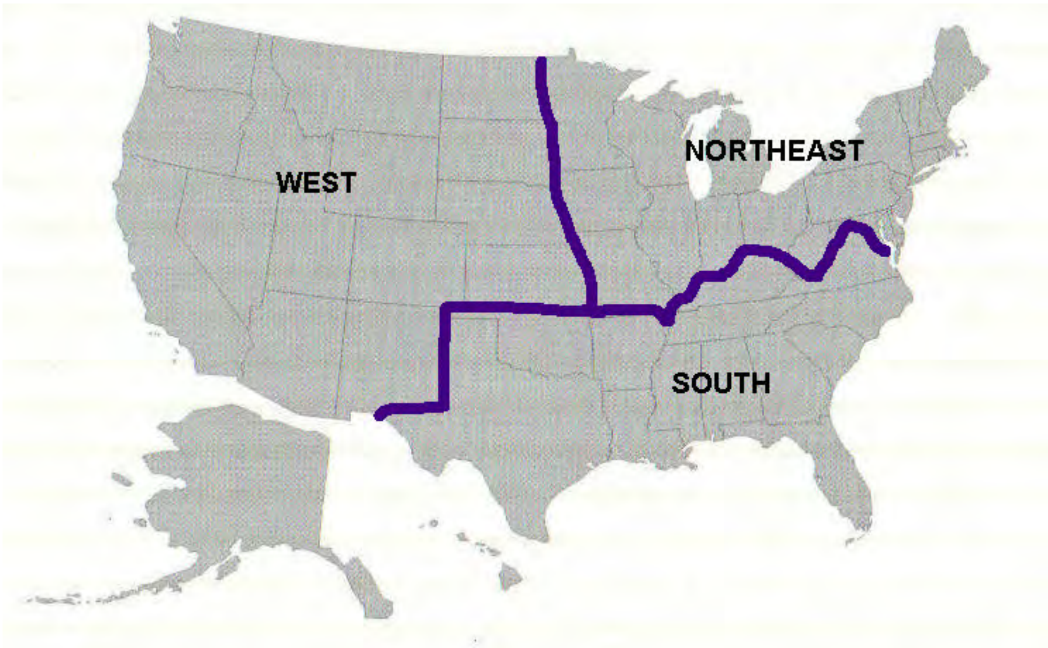
The survey was distributed through NASF to maximize the number of responses. Initial contacts were made with state foresters in the 50 states and seven U.S. territories at the end of March, and the survey went to them in early April, using both e-mail and standard mail. The survey also was distributed to each of the nation's state fire directors. Instructions with the survey requested each state forester and fire director to complete the survey, and also to duplicate it and ask fire line officers and incident commanders to respond. Subsequent emails and phone calls were made by Academy staff and NASF representatives to increase the number of survey responses. Academy staff also made a second mailing of the survey in mid-May. All data collection ceased at the end of May following a final request for responses at the spring NASF Fire Committee meeting.

Each survey response was analyzed using statistical software. SPSS software was used to compile and analyze the quantitative data in response to the first three survey questions, and QSR Nudist software was used for the qualitative data obtained through the open-ended questions. The textual responses were aggregated into categories, and some broad answers were coded into more than one category. Thus, percentages of responses to some questions exceed 100 percent. Although the use of open-ended questions limited the precision of findings, and made comparisons between the findings of the two surveys difficult, it yielded a good understanding of leading state perspectives.

Respondent Profile

The 105 responses received from state officials came from 44 of the 50 states, and were analyzed by NASF's three recognized regions, as well as nationwide. Each of these regions, which has approximately the same number of states, are known as the Northeast, South and West. They are shown in Figure E-3 and listed below. Each regions' leadership aided in gathering survey responses.

Figure E-3. Regions of the National Association of State Foresters



The level of survey response varied by region, and some states in each region provided more responses than others. The South provided the most responses, over half of the national total. Of the 56 southern responses, 19 were received from Florida, 10 from North Carolina, and 7 from Texas. In the Northeast, multiple responses were received from Wisconsin (4 out of the total of 19 in the region). Of the 30 responses in the West, 5 were received from Washington, 4 from Utah, and 3 each from New Mexico and Oregon.

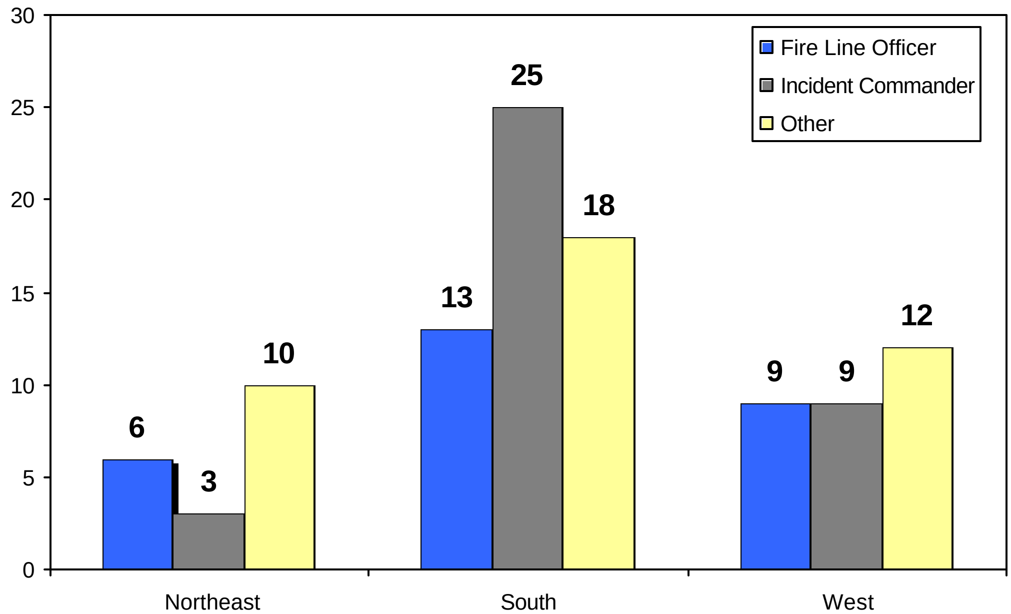
List of States in Each NASF Region

Northeast	South	West
Connecticut	Alabama	Alaska
Delaware	Arkansas	American Samoa
District of Columbia	Florida	Arizona
Illinois	Georgia	California
Indiana	Kentucky	Colorado
Iowa	Louisiana	Federated States of Micronesia
Maine	Mississippi	Guam
Maryland	North Carolina	Hawaii
Massachusetts	Oklahoma	Idaho
Michigan	Puerto Rico	Kansas
Minnesota	South Carolina	Montana
Missouri	Tennessee	Nebraska
New Hampshire	Texas	Nevada
New Jersey	U.S. Virgin Islands	New Mexico
New York	Virginia	North Dakota
Ohio		Northern Mariana Islands
Pennsylvania		Oregon
Rhode Island		Palau
Vermont		Republic of the Marshall Islands
West Virginia		South Dakota
Wisconsin		Utah
		Washington
		Wyoming

Nationwide, incident commanders submitted 38 responses, while fire line officers submitted 27 responses. The remaining 40 responses were received from state foresters, fire directors and other state forestry and fire staff.

A regional analysis of respondents (Figure E-4) shows that within the Northeast, 6 responses were received from fire line officers, 3 from incident commanders and remaining 10 from other forestry or fire officials. Within the South, 25 responses were received from incident commanders, 13 from fire line officers, and 18 from other forestry and fire officials. Within the West, 9 responses were received from fire line officers, 9 from incident commanders, and remaining 12 from other forestry and fire officials. Thus, officials currently active on fires dominated the responses in the South, were a majority in the West, and were about even with others in the Northeast.

Figure E-4. Distribution of Respondent Types by Three NASF Regions



Survey respondents provided valuable information and recommendations that aided the Academy in this study. These findings also will help NASF and others to articulate state perspectives about the rising costs of wildland fire suppression effectively.

SURVEY RESULTS

The survey results were analyzed under the following five topics:

1. Large-Fire Suppression Cost Factors and Barriers to Cost Reduction
2. Recommended Actions to Reduce Fire Suppression Costs
3. Reactions to Recent Fire Efforts and Resources
4. Recommendations for Work In and With Localities
5. Recommendations for Improving Relations with States

The results are summarized below, and complete tabulations of the data are attached at the end of this appendix.

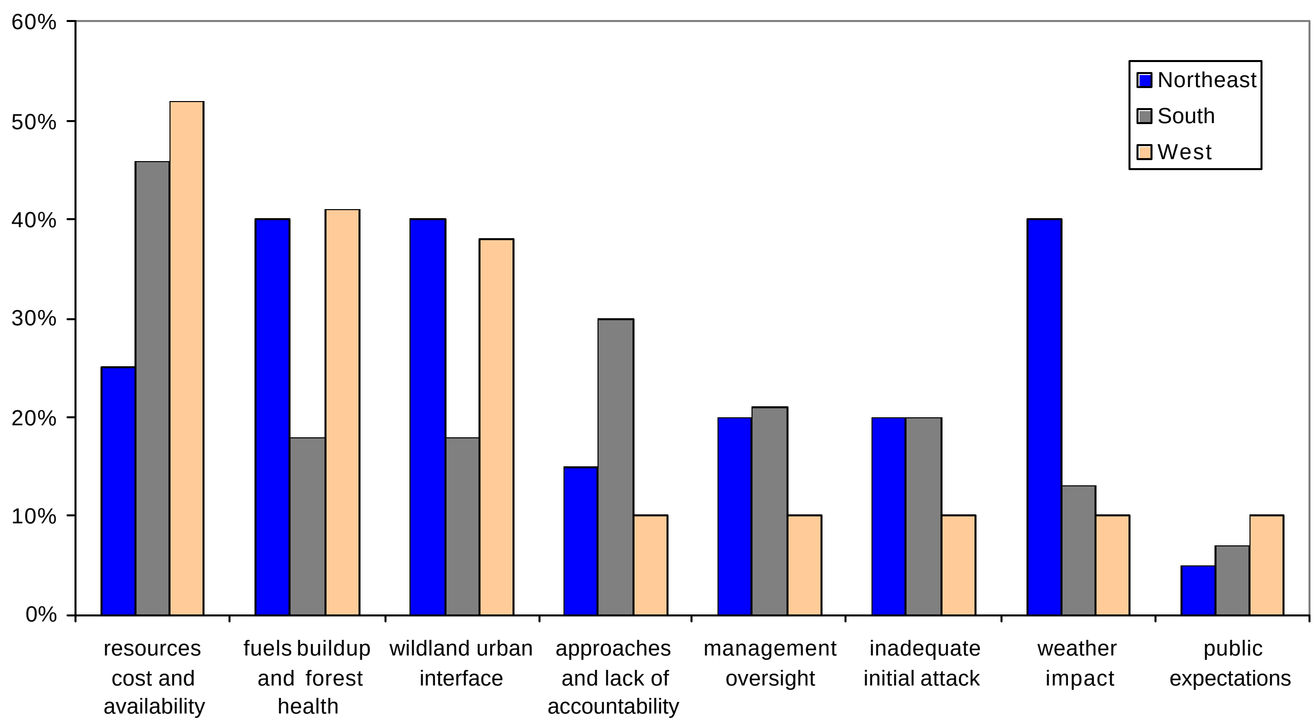
Large-Fire Suppression Cost Factors and Barriers to Cost Reduction

An important purpose of both the 2000 and 2002 surveys was to garner the perspectives of state forestry and fire officials about the factors contributing to escalating large fire suppression costs and the barriers to reducing these costs. Both surveys asked respondents to identify the most significant factors and barriers through two questions. While responses to the two questions (4 and 5) were compiled separately in 2002 and together in 2000, the overall findings from both years were similar.

The three most important factors increasing suppression costs in 2002 were identified as the increasing costs, availability and overuse of firefighting resources (44 percent); fuels build-up and deteriorating forest health (29 percent); and increasing development in wildland areas (28 percent). Comparison of these results with those from the Academy's other research in this study suggests that states place higher significance on the increasing costs, availability and overuse of firefighting resources. Other significant factors identified by respondents were: prevailing beliefs and approaches that contributed to the lack of accountability, motivation and incentives to reduce costs (22 percent); the quality of management control and oversight of decision making that can lead to over-ordering of resources to avert risks (18 percent); and inadequate initial attack (17 percent).

Some differences were revealed by tabulating the results by NASF region (Figure E-5). While the increasing cost and lack of available firefighting resources was the top factor in the West and South (52 percent and 46 percent respectively), only about half (25 percent) as many respondents in the Northeast identified this factor. This difference may be due to the relatively fewer number of large fires in the Northeast as well as a strong reliance on interstate fire compacts and relatively less use of federal resources in this region. In the Northeast, weather, drought and fire behavior topped the list of cost-increasing factors (40 percent), compared to less than a third as many respondents in the other regions.

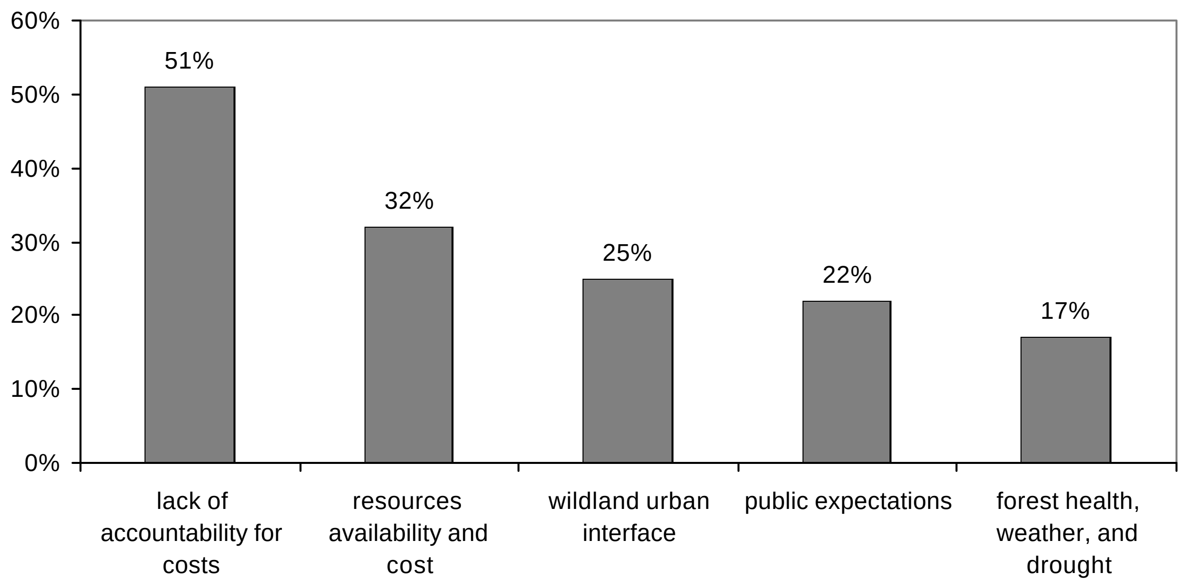
Figure E-5. Factors Contributing to Escalating Large-Fire Suppression Costs



Regional differences also exist concerning the importance of fuels build-up and forest health, as well as increased development in wildland areas. Respondents in the West and Northeast considered these factors to be the two of greatest concern, with approximately 40 percent in both regions citing both factors. However, less than half as many respondents in the South identified these factors (18 percent for both).

When asked about the greatest barriers to containing large-fire suppression costs (Question 5), a majority of respondents indicated that prevailing attitudes and the lack of accountability, motivation and incentives were a leading barrier (51 percent). Several respondents indicated, in response to this and/or other questions, that an "open checkbook" attitude and culture exists in the fire community. In general, this perception seemed more apparent among survey respondents than was found through the Academy's other research in this study.

Figure E-6. Barriers to Reducing Large-Fire Suppression Costs



As shown in Figure E-6, other identified barriers also related to the factors described above. The high cost and overuse of some resources was identified most often (51 percent), followed by resource limitations, particularly at the local level (32 percent). Increasing development and fuels buildup in wildland areas and the costs and complexity of suppressing fires in these areas was another important barrier (25 percent). Expectations and lack of understanding about fire hazards by the public, government leaders, and the media were also mentioned (22 percent), as was forest health, weather and drought conditions (17 percent).

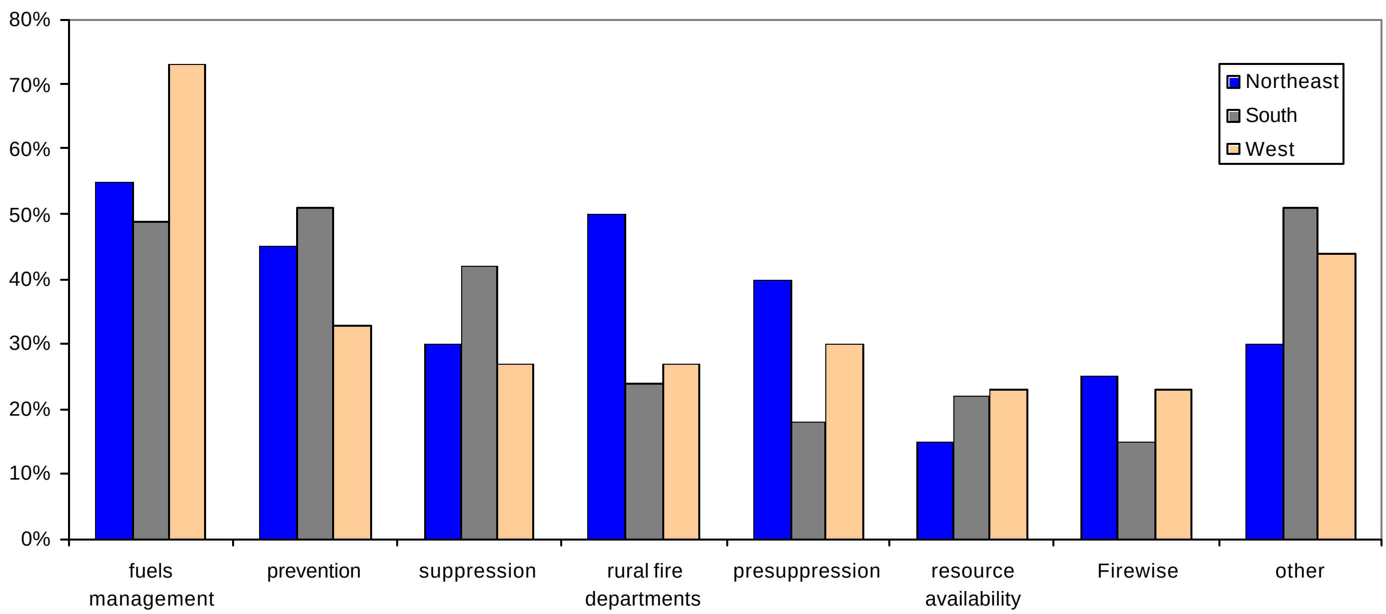
In 2000, the responses to the two questions were analyzed together and the combined factors and barriers were categorized as being administrative (42 percent), operational (41 percent), and cultural or systemic (17 percent). Resources availability, attitudes and accountability, wildland/urban interface (WUI), and fuels management were identified as leading factors and barriers at that time. Comparison between these findings of the two surveys suggest that cost is likely a greater concern in 2002.

Recommended Actions to Reduce Fire Suppression Costs

Both surveys asked for recommend actions to reduce the costs of suppressing large wildfires. The 2002 question provided with a list and asked respondents to rank the top three activities that should be emphasized to reduce suppression costs (Question 1). Nationwide, respondents selected fuels management (57 percent), prevention (45percent), and direct suppression practices (35 percent) as the top recommended activities, while partnering with rural fire departments (30 percent), presuppression (26percent), and several other activities were viewed as less important.

Some regional differences were observed, as shown in Figure E-7. Similar to responses for other questions, fuels management was by far the leading selection in the West (73 percent). It also was the leading choice in the Northeast (58 percent), and was the second strongest choice in the South (49 percent).

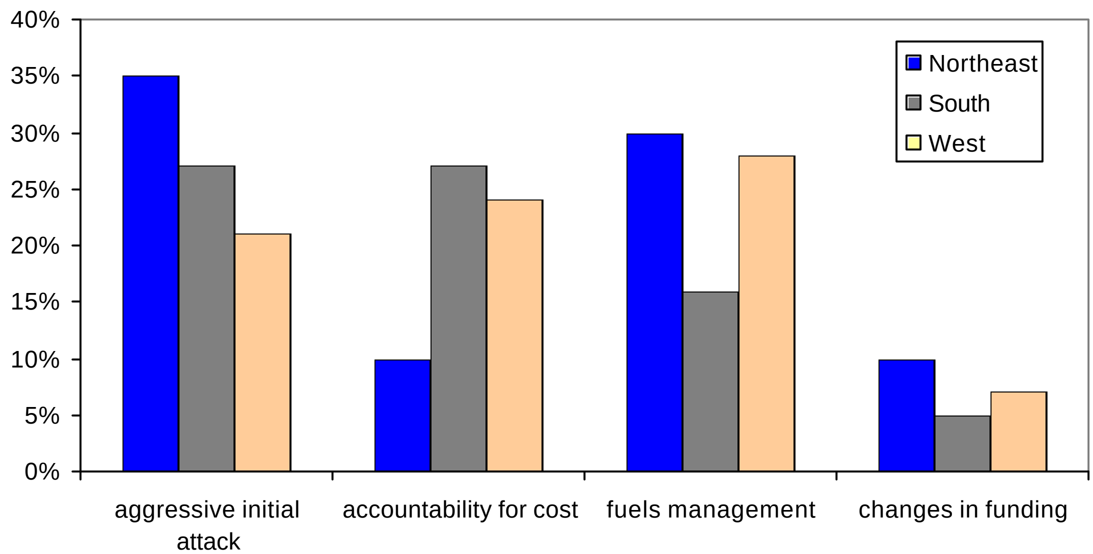
Figure E-7. Suggested Efforts to Reduce Large Wildland Fire Suppression Costs



Prevention was mentioned most frequently in the South (51 percent), while it was second and third in the West and Northeast. Another important difference is that providing assistance to rural fire departments ranked much higher in the Northeast (50 percent) than in the South and West with approximately half as many respondents in these regions mentioning this activity. Presuppression and Firewise were also more frequently identified in the Northeast (40 percent and 25 percent respectively) than in the other regions. Resource availability was indicated less often in the Northeast than in the other two regions. Other responses included training, experience, and fire line officer roles.

Respondents also were asked to recommend the first step they would take to control suppression costs (Question 8). The vast majority of responses in 2002 were to strengthen initial attack, increase accountability, and conduct fuels management. Nationwide, the level of support for these efforts was quite similar, but some regional differences existed. Aggressive initial attack was suggested most frequently by all respondents (27 percent), but it was most strongly indicated in the Northeast (35 percent), as shown in Figure E-8.

Figure E-8. Suggested Steps to Control Large Wildland Fire Suppression Costs



The second most frequent category of responses was to increase accountability, monitoring, and other approaches to contain costs (23 percent), although it was an infrequent choice in the Northeast (10 percent). Recommendations to change funding approaches were least mentioned nationwide (7 percent), but drew a slightly higher response in the Northeast than in the other two regions. Accountability and funding recommendations included greater scrutiny over the use of expensive resources, use of cost containment officers and independent auditors at individual fires, assurance that cost considerations are included at all levels of training and supervision, eliminate "bulk" suppression funding and provide more funds to local levels (field units of federal agencies, states and localities).

Most of the remaining recommendations focused on fuels management, including greater use of prescribed fire and other fuels treatment (22 percent). Fewer respondents in the South (16 percent) provided recommendations in this category, while responses were nearly equally mentioned in the other regions. This difference may reflect the relatively higher incidence of incident commanders among the respondents in the South.

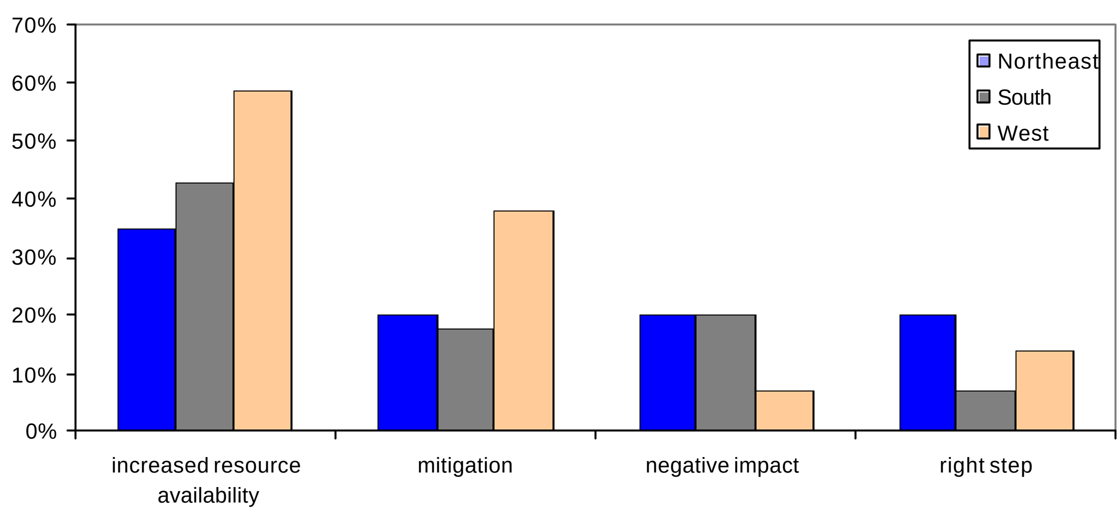
Similar recommendations were made in response to the 2000 survey. Direct comparisons were not possible between the two results due to the differences in overall categories, but strong commonalities exist. Respondents in both years called for increased accountability for cost containment, aggressive initial attack and comprehensive fuels management policies and approaches. Additional recommendations made in 2000 included the development and implementation of clear and firm policies to promote program consistency, efficiency and effectiveness; as well as more efficient use of overall resources and greater use of local resources, which are also reflected in responses to other questions in the 2002 survey.

Reactions to Recent Fire Efforts and Resources

State forestry and fire officials were asked to indicate their perspectives about the impact of the fire community's efforts and additional funding resources available to the federal government over the last two years. In response to Question 2, most respondents indicated that the fire community has strengthened emphasis on activities intended to reduce suppression costs during this time (90 percent). The most frequent activity identified as evidence of this increased emphasis was fuels management (47percent). It was followed by the Firewise program for educating and organizing communities to mitigate wildfire hazards (30 percent) and fire prevention (29 percent). Responses to each of the other categories of activities ranged between 10 percent-15 percent.

Responses to Question 3 about the impact of additional federal funding were generally positive, though some regional differences and mixed results also emerged. The most frequent response was that more federal funding increased resource availability and capacity at the local level, along with stronger initial attack capability (46 percent). As shown in Figure E-9, this reaction was the strongest in the West (59 percent), but weaken in the South and Northeast (43 percent and 35 percent respectively). Nationwide, improvements were also cited (24 percent) for mitigation and preparedness (including fuels management, education, planning and related efforts); the West most frequently cited this improvement (38 percent).

Figure E-9. Impact of Additional Federal Wildland Fire Funding in Past Two Years



Only small numbers of respondents indicated that minimal or negative impacts had occurred as a result of the additional funding (16 percent). However, respondents in the Northeast and South had this reaction more frequently (20 percent in both regions) than those in the West (7 percent). Examples of these results included that the funding was too restrictive and/or had too much "red tape," insufficient funding was provided to localities, cumbersome and lengthy processes existed with state and federal fire grants, inexperienced people were hired, too much funding was applied to fuels management on federal lands or wasted in general, and the new funding did not reduce suppression costs. Finally, a few respondents (11 percent) were more neutral about the additional funding, indicating that it was a step in the right direction but more time would be needed to evaluate impacts.

Question 7 complemented this query about recent approaches and funding by asking about (1) improvements by the fire community in delivering and supporting a clear national message on the importance of fire suppression cost containment over the last two years, and (2) how this message could be improved. To a similar question in 2000, 24 percent of the respondents stated that the message had been adequately presented and supported, and 76 percent disagreed. The 2002 respondents split evenly on this.

Several suggestions were made to improve delivery and support of this message. An overarching theme expressed by respondents was to better articulate the message, show commitment, and be accountable for delivering a consistent message. Sentiments in both years included: "actions speak louder than words," and "organizations must not only 'talk the talk,' but also 'walk the walk'." One respondent to the 2002 survey noted that "before the fire starts I hear about cost control; during the fire, I don't." Responses to this question also reiterated the need for evaluating and holding fire managers accountable for costs. Some suggestions were to offer bonuses or otherwise reward fire managers for saving money rather than for spending it. Some respondents said that the message is strengthening among the fire community, but it is not getting out to the public as well.

Recommendations for Work in and with Localities

While not asked about in the 2000 survey, the 2002 survey sought to understand the perspectives of state officials about how to increase cooperation with local governments in addressing wildfire hazards in wildland areas with increasing development. Respondents provided several suggestions about significant efforts that should be taken by the federal or state governments to increase this cooperation (Question 10). Many responses involved approaches to increase local engagement (45 percent) and local capacity (41 percent), for mitigation, preparedness and suppression efforts.

General suggestions included:

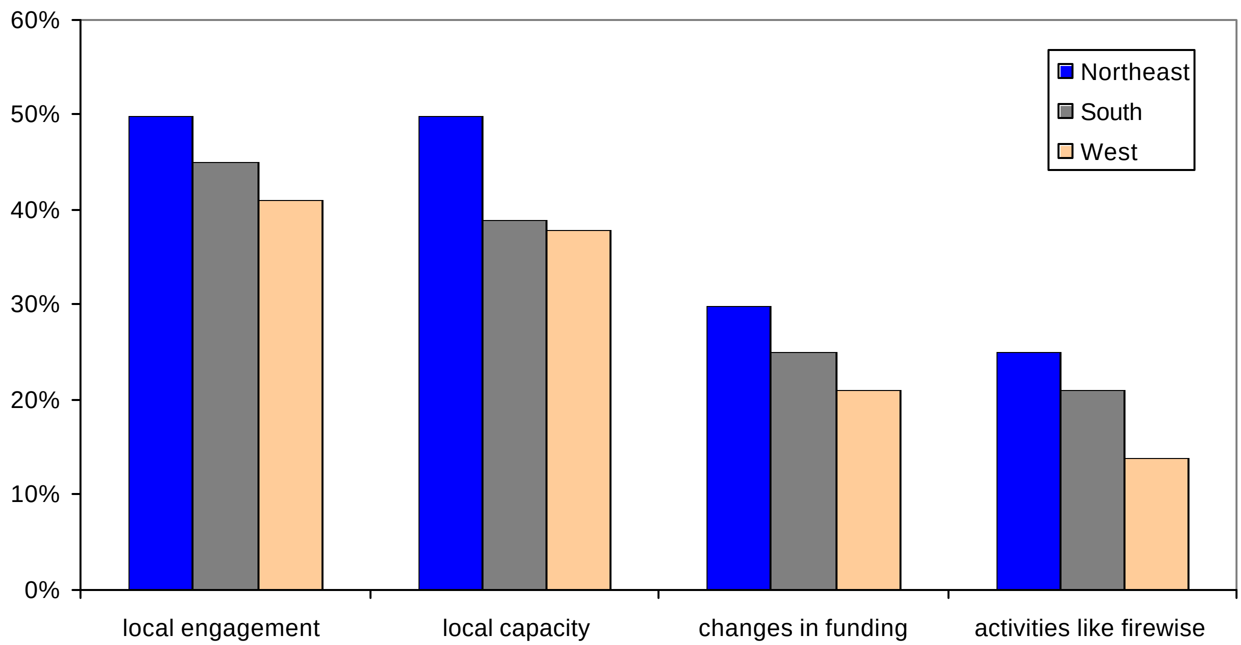
- better and more regular communication and meetings with fire departments and city and county officials (pre and post fire season)
- encouragement, listening to and action based on local ideas
- preplanning and advanced agreements on rules and responsibilities that emphasize safety and efficiency

- regular involvement of localities in Geographic Area Coordination Groups
- coordination of federal and state grant programs and other agency activities directed toward localities

In terms of fire suppression activities, suggestions were to remove barriers to local participation in fires such as restrictive policies, procedures and qualifications; increase use of mutual aid agreements, unified command and joint dispatching; develop and use local overhead teams; synchronize radio communications; and improve and conduct joint training and exercise activities.

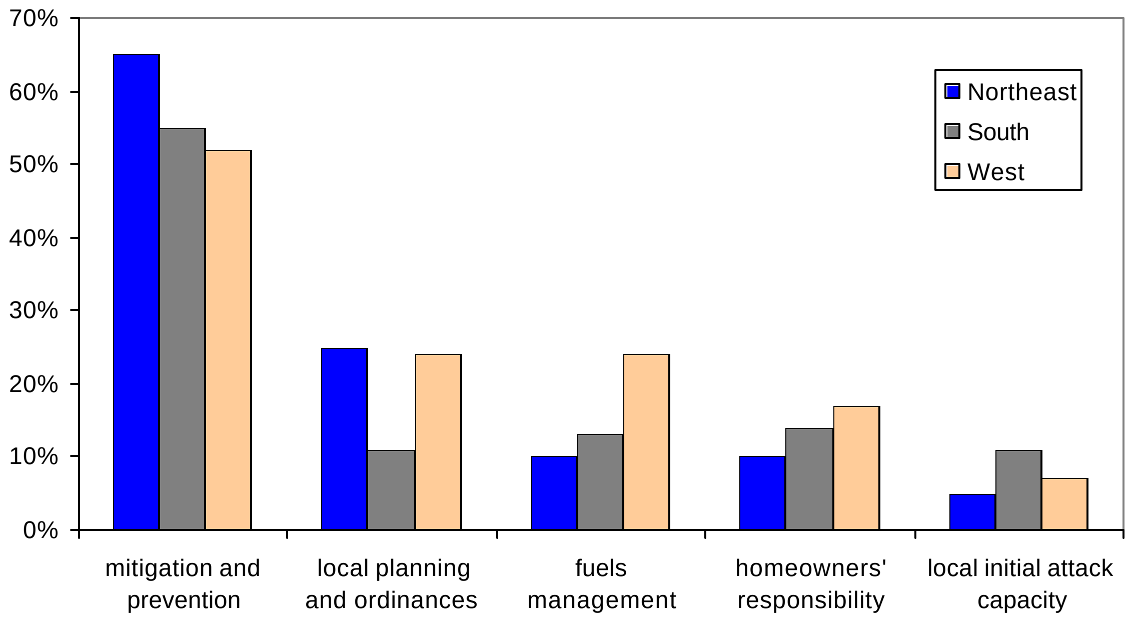
Responses in the other two categories provided related input, including greater participation in planning and mitigation, including programs such as Firewise (22 percent) and changes in funding, such as increasing funds for local governments and fire departments, and giving more flexibility to localities (23 percent). The differences among the three regions for this question were less distinctive than for other questions (Figure E-10). As explained in the methodology, some responses were classified in multiple categories, and the Northeast provided the most suggestions that fit into multiple categories. In comparing the three regions, respondents in the Northeast most frequently indicated that state and federal efforts to strengthen local capacity would help to increase cooperation and control fire suppression costs. Western respondents had the fewest number of suggestions in all four categories.

Figure E-10. Suggested Federal or State Government Actions to Increase Local Cooperation



Question 11 asked respondents to identify additional efforts needed to control fire suppression costs in what is commonly known as the wildland urban interface. The majority of responses called for action before fires start, and many mitigation and prevention efforts were suggested (56 percent). Responses suggested public education, outreach to local planning, zoning and community development entities, planning, Firewise and related programs, and specific suggestions to help suppression efforts such as dry hydrants and permanent fire breaks. As shown in Figure E-11, fire mitigation suggestions were strongest in the Northeast.

Figure E-11. Suggested Efforts in Wildland Urban Interface to Control Fire Suppression Costs



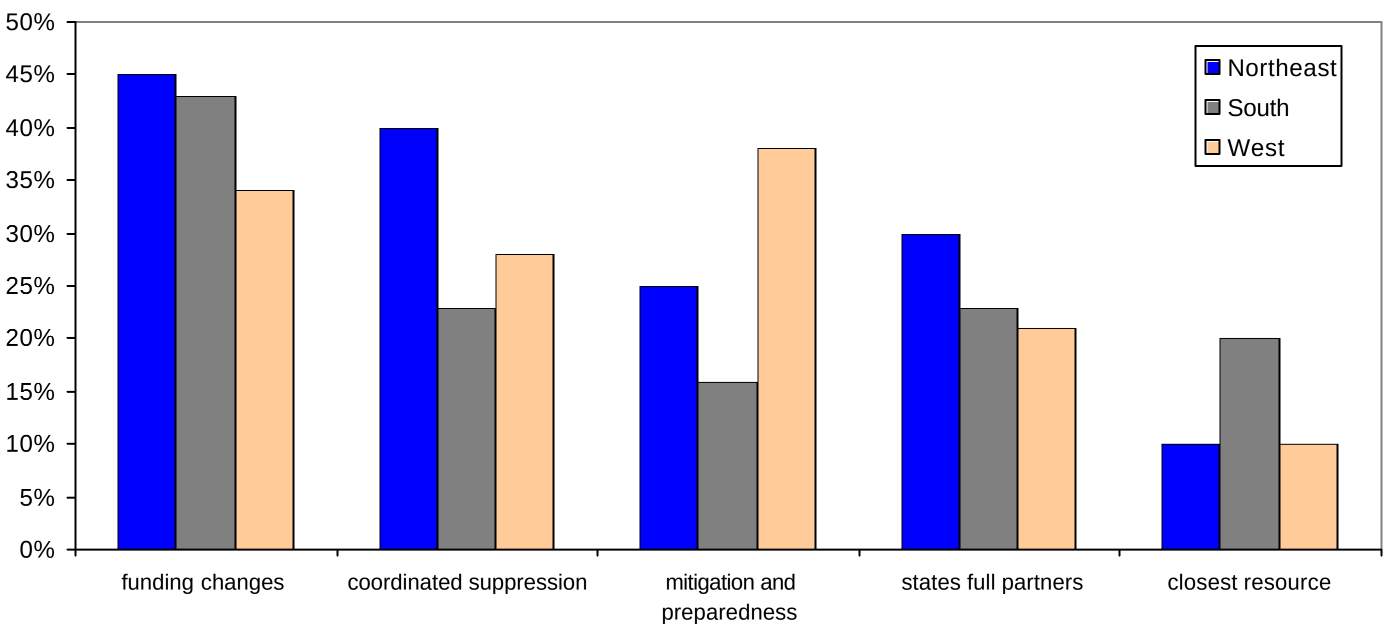
The most distinct suggestion was the need for local planning and ordinances, including zoning and building codes. Repeated suggestions were to conduct planning at state and local levels, develop and enforce local ordinances, restrict development, and require and enforce provisions for "defensible space," firefighter access, and water sources in zoning and building codes. Other suggestions were to establish "fire plain" zoning similar to flood plains, adopt a "national urban interface code," and include forest management in local planning. Respondents in the Northeast and West indicated greater support for these actions (25 percent and 24 percent respectively) than in the South (11 percent). There may be several reasons for this disparity, such as the growth in both development and damaging fires in the West and general acceptance of planning approaches in the Northeast. Another reason may be because there was a relatively higher number of survey respondents in the South who were incident commanders and fire line officers, and they may be less familiar with local planning and ordinances.

Responses were categorized according to three other specific types of actions. Fuels management suggestions were cited by 15 percent of the overall respondents, but were more often mentioned in the West (24 percent) than in the South and Northeast (13 percent and 10 percent respectively). Some respondents indicated that land, home and other property owners should fire proof their properties and exhibit greater responsibility and accountability for their actions, and that insurance rates and incentives should be used to influence such responsibility (14 percent). Specific suggestions included that insurance companies should not write policies or establish higher rates if defensible space and other minimum prevention methods are not used by property owners. More respondents in the West called for such actions than in other regions (17 percent). Increasing local capacity for initial attack was the final category (9 percent), with suggestions including more funding, training, equipment and other resources for local fire departments. Another suggestion in response to this and some other questions was to contract with local governments in wildland-urban interface areas.

Recommendations for Improving Relations with States

The 2002 survey asked for suggestions about how the federal government can increase cooperation with and learn from state governments to help control the costs of fire suppression (Question 9). The most common category of responses was to change and/or increase the funding provided to states for fire programs (41 percent), with several suggestions to fund staffing, training and other capacity building, and to improve existing grant programs. Similar to suggestions for improving local government relationships, these suggestions included mitigation, prevention, and suppression, with particular focus on initial attack.

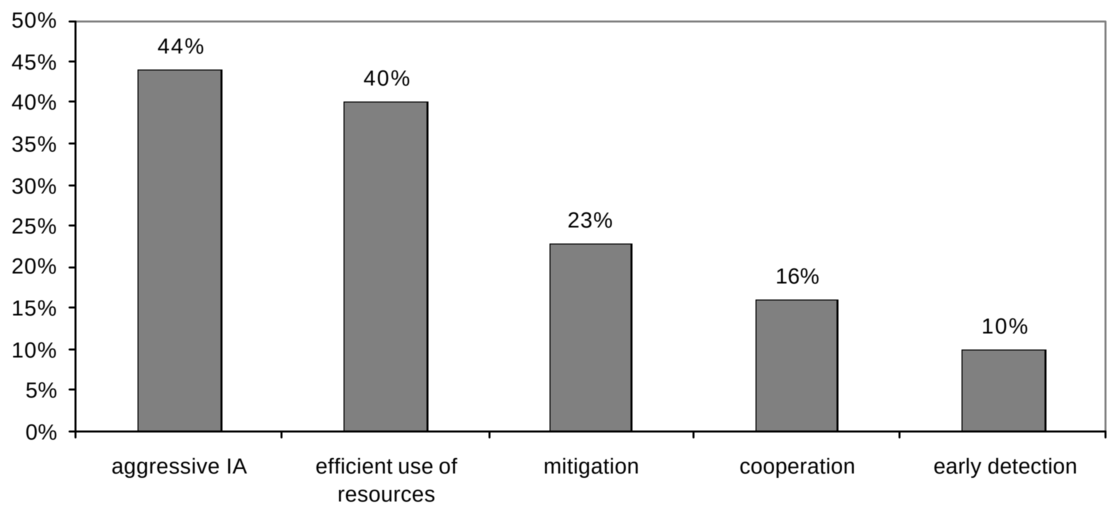
Figure E-12. Suggested Federal Actions to Increase Cooperation with State Governments



Additional suggestions addressed coordinated approaches to suppression (28 percent) and the need to utilize closest forces, particularly state and local resources (15 percent). As shown in Figure E-12, some regional differences were noted in these responses. For example, respondents in the Northeast most frequently suggested coordinated approaches to suppression (40 percent), while those in the South most often called for the federal government to use the closest forces approach (20 percent). Other responses included ideas for more coordinated mitigation and preparedness efforts (24 percent), while others suggested making states full partners (24 percent). Respondents in the West most frequently called for coordinated mitigation and preparedness (38 percent).

Respondents were also asked to identify two of the most cost effective fire suppression techniques used in their state that could be considered "best practices" and could be adopted by the federal government (Question 13). As shown in Figure E-13, aggressive initial attack and prepositioning of resources was identified most frequently (44 percent). This suggestion is consistent with responses to other questions in this and the 2000 survey. Ten percent of the responses identified early detection as a technique supports initial attack.

Figure E-13. Suggested Federal Actions Based on State Fire Suppression "Best Practices"



Efficient use of resources, including having the appropriate equipment and teams to respond to fire conditions, was also strongly indicated (40 percent). Several specific suggestions were made, such as greater use of helicopters, mechanized equipment of various kinds, inexpensive personnel on crews, and using the closest forces. Another suggestion was to adopt a local resource ordering priority system in which the furthest and most expensive resources are ordered last. Various mitigation and prevention efforts were also suggested (23 percent), such as fuels management (including prescribed burning, cattle and other approaches), greater public awareness and planning, accurate monitoring of fire danger, and daily risk assessment and fire prevention team deployment. Use of local and state laws and other programs was also suggested, such as for planning and restrictions on debris burning. Strong cooperative relationships were also suggested, including meeting and training together, establishing unified commands, and making better use of and providing assistance to local fire departments (16 percent).

A particular focus of the Academy study addressed the federal government's use of the Wildland Fire Situation Analysis (WFSA) system that is used to help large fire incident management teams analyze alternative strategies for fighting a fire and ordering the appropriate equipment and personnel necessary to implement the strategy. Thirteen states reported using or (planning to use) a WFSA-type of analysis for selecting firefighting strategies (Question 6).

A final survey question (#12) asked respondents to identify two significant technologies to help control fire suppression costs. Several technologies were identified, most of which would increase intelligence available to firefighters before wildfires are ignited. The largest category was for fire behavior research and weather monitoring and prediction (23 percent). Specific suggestions included more accurate and current weather and fire information and predictions, installation and upgrading of the Remote Automated Weather Stations (RAWS) network nationwide, and fire prediction and risk assessments. A similar level of respondents suggested greater use of geographic information systems (GIS), Global Positioning System (GPS) receivers, and related mapping capabilities (22 percent). Remote sensing, other geographic information technology and cell phones also were specifically mentioned to more quickly and effectively detect fires, and thus be able to put fires out while they are small (18 percent). In addition, various management support systems were identified to monitor and automate financial records, and to track costs (16 percent). Approaches and technologies to conduct rapid initial attack were also suggested (10 percent), including prepositioning of resources and the use of aircraft.

CONCLUSIONS

This survey provided many specific suggestions to help the states work together with federal and local officials, and others, to help contain the costs of suppressing large wildfires. While none are without precedent, many may be worth greater attention as costs continue to increase and government resources become more limited. The incentives for working together rise as budgets shrink.

Almost twice as many state respondents to this survey, compared to the 2000 survey, believe there is now a coherent message calling for cost containment. Yet, it is still true that only half the respondents agree that this message is as clear, consistent, and backed up with action as it should be. So there is still a lot of room for improvement. Many respondents to this survey, not unlike many federal studies, emphasized the need for greater accountability, motivation, and incentives for reducing costs while suppressing wildfires.

Many state forestry and fire officials in this survey favored enhanced roles for local governments, particularly where local communities interface with wildlands. Without engaging local leaders, firefighters, and planning and development officials more fully, wildfire suppression costs will continue rising. Many respondents also recognized needs to increase the capacity of local governments to respond better to these challenges.

These respondents were more focused on the rising costs of firefighting resources than the federal officials whom Academy representatives talked with in preparing case studies of six large federally managed wildfires that burned in the summer of 2001. Most of the federal officials were most concerned with the "predispositions" that are in place before the fire ignites, but inevitably set the fire on a path to high-costs. These predispositions include the heavy fuel loads, nearby communities, numerous natural resource values that must be protected, and other conditions that require use of maximum effort and high-cost firefighting resources. Of course, this is not an either-or proposition, but more one of emphasis. Cost consciousness is needed both on the fire and before it begins.

Some regional differences appeared in analyzing the responses. Overall, Western respondents emphasized the need for fuels treatments while those in the Northeast and South emphasized the need for mitigation and prevention efforts. Once again, regional differences emphasize that conditions, concerns, and expectations differ from one part of the nation to another. Consequently, prescriptions for improvement need the flexibility to adjust to and accommodate different approaches in different places.

To improve relationships between federal and state wildfire activities, significant numbers of respondents called for fuller partnerships, joint activities, and the use of state and local forces before ordering resources from a distance—again strengthening the theme of coordinating with other governments in the part of the nation where the activity is taking place. Federal funding to the states will be most effective if it can adjust to and help address the states' highest priority needs.

DATA TABULATIONS

The following tabulations present all the data from the 2002 survey.

*1. In your opinion, what are the top three activities that should be emphasized to reduce the costs of suppressing large wildfires? **(Please pick __only 3__ – and rank them - with #1 the most important.)***

- FUELS MANAGEMENT **57.1%**
  - most important – 28.6%
  - second most important – 18.1%
  - third most important – 10.5%

- PREVENTION **44.8%**
  - most important –23.8%
  - second most important – 12.4%
  - third most important – 8.6%

- SUPPRESSION **35.2%**
  - most important – 17.1%
  - second most important - 5.7%
  - third most important – 12.4%

- PARTNERING WITH RURAL FDs **29.5%**
  - most important – 8.6%
  - second most important – 10.5%
  - third most important – 10.5%

- PRESUPPRESSION **25.7%**
  - most important – 9.5%
  - second most important – 7.6%
  - third most important – 8.6%

- OTHER - Resource Availability (21.0%), Firewise Communities (19.0%), Training (16.2%), Experience (14.3%), Role of Line Officer (14.3%)

*2. In your opinion, **__over the past two years__** has the interagency fire community strengthened its emphasis on any of the above activities?*

Yes – 89.5%
No – 9.5%

If so, which one(s)?:

- Fuels management **– 46.7%**
- Firewise program **– 29.5%**
- Prevention **– 28.6%**
- Other **-** Presuppression (15.2%), Partnering with Rural Fire Departments (14.3%), Resource Availability (12.4%), Training (11.4%), Suppression (10.5%)

3. In your opinion, what has been the impact, if any, of the additional wildland fire funding available to the federal government ***over the past two years****?*

- increased resource availability, increased capacity at the local level (funds and assistance in personnel, equipment, training, etc.), strong IA capability **– 46%**
- more mitigation activities in high-risk areas (fuel mgmt, Firewise, WUI issues are being addressed, planning) **– 24%**
- negative and minimal impact (red tape, not enough to locals, inexperienced people, no reduction in suppression costs) **– 16%**
- step in the right direction; need to wait to see its impact **– 11%**

4. What are the ***two*** *most significant factors contributing to escalating large fire suppression costs?*

- increasing cost of resources (particularly aviation, personnel, new technology, and contracted resources), limited resources availability (ordering from remote locations), overuse of some expensive resources **– 44%**
- fuels buildup, deteriorating forest health, backlog in fuel and timber management **– 29%**
- increasing development in wildland areas, and poor planning in WUI areas, costs of protecting structures (interface fires are more expensive and cost more) **– 28%**
- beliefs, approaches, no motivation to reduce costs, lack of accountability for costs, lack of incentives to reduce costs **– 22%**
- quality of management oversight, ordering more resources than needed, management and use of expensive resources (like aviation), risk aversion (liability avoidance) **– 18%**
- inadequate initial attack (not sufficient capacity for IA), lack of aggressive firefighter tactics **– 17%**
- weather patterns (especially drought) and fire behavior (higher intensity fires, on larger scale) **– 11%**
- public, political, and agencies' expectations **– 8%**

5. What are the ***two*** *most significant barriers to reducing the costs of large fire suppression activities?*

- team attitudes, "open checkbook attitude", no accountability for costs, lack of motivation (incentives), expensive tactics used **– 51%**

- resource availability and cost, insufficient capacity at the local levels, dispatch system slow to respond, budget constraints– **32%**
- increased WUI and values at risk to be protected, fuels build-up in those areas (suppression more complex and costly)– **25%**
- media, public, political, and agencies' expectations (contain fires, save homes), lack of understanding of fire hazard, opposition against fire management practices (prescribed burning, thinning) – **22%**
- forest health and weather patterns – **17%**

6. *Does your state use any kind of quantified situation analysis as part of your process of suppressing large wildland fires? (perhaps similar to the federal government's Wildland Fire Situation Analysis (WFSA) that is used to help large fire incident management teams to analyze alternative strategies for fighting a fire and order the equipment and personnel necessary to implement the strategy.)*

☐ YES ☐ NO If yes, please name the program: __________________ and the lead contact in your state: _______________ and phone: ______________________

Thirteen states reported using or (planning to use) a WFSA-type of analysis for selecting firefighting strategies, comparable to the federal practice. A contact familiar with WFSA was identified for the following states: Alaska, Arizona, Colorado, Florida, Idaho, Montana, New Mexico, North Carolina, Texas, Utah, Washington, Wisconsin, and Wyoming.

7. Has there been improvement by the interagency fire community in delivering and supporting a clear national message about the importance of fire suppression cost containment?

Yes – 50%
No – 50%

How could this be improved?

- Better articulation, implementation, and promotion – **24%**
- Evaluate and hold fire managers accountable for costs – **14%**

8. *If you were in charge, what is the first step you would take to control the cost of suppressing large wildfires in the U.S.?*

- keep fires small, aggressive initial attack, more research and development – **27%**
- accountability for cost, scrutinize use of high cost resources, monitoring – **23%**
- fire use and other fuels treatments – **22%**
- changes in funding, money from local budget, eliminate bulk funding, more funds for local – **7%**

*9. What are the **two** most significant efforts that should be taken by the federal government to increase cooperation with **State** governments to control the cost of suppressing large wildfires in the U.S.?*

- continue, increase change funding for IA, prevention, state/local – **41%**
- coordinated suppression: implementation, unified command, multiagency incident teams – **28%**
- coordinated mitigation, preparedness and prevention: community fire planning, train together – **24%**
- consider states as full and equal partners – **24%**
- utilize closest resource concept, use more state and local resources – **15%**

*10. What are the **two** most significant efforts that should be taken by the federal or state government to increase cooperation with **local** governments to control the cost of suppressing large wildfires in the U.S.?*

- greater local engagement and coordinated implementation, work and train together, collaboration, coordinated community planning – **45%**
- help build and maintain capacity at the local level – **41%**
- changes in funding, increase funding for local fire departments, give more flexibility to locals – **23%**
- planning, mitigation, preparedness, Firewise and related programs – **22%**

11. What additional effort could help control fire suppression costs in the Wildland Urban Interface (WUI)?

- mitigation, prevention, education, Firewise and related initiatives – **56%**
- local planning, ordinances, zoning, building codes – **17%**
- emphasize fuels treatment and management – **15%**
- put responsibility and accountability with home and property owners, increase insurance rates and incentives – **14%**
- increase local initial attack capacity – **8.6%**

*12. What are **two** most significant technologies to help control fire suppression costs in the U.S.?*

- fire behavior and weather monitoring, prediction, research – **23%**
- geographic information systems (GIS) and Global Positioning System (GPS) receivers, particularly for mapping – **22%**
- early detection technologies, particularly by satellites and other remote sensing – **18%**
- management support systems, including for tracking costs, dispatch, communications – **16%**
- highly effective and new initial attack equipment – **10%**

*13. What are **two** of the most cost effective fire suppression techniques used in your state that could be considered as "best practices" and could be adopted by the federal government?*

- aggressive initial attack and prepositioning of resources **– 44%**
- efficient and effective use of resources (equipment and teams) **– 40%**
- mitigation, prevention, fuels management, local planning **– 23%**
- strong, cooperative relationships with federal and local responders (meet and train together, unified command, providing assistance to local fire departments) **– 16%**
- early detection capabilities **– 10%**

2001 LARGE-FIRE
CASE STUDY REPORTS

CONTENTS

Prepared by
Academy Staff

National Academy of Public Administration
Washington, DC

GREEN KNOLL FIRE CASE STUDY REPORT
Bridger-Teton National Forest, Wyoming
July 22 – August 8, 2001

INTRODUCTION

The Green Knoll Fire provides a case study within a case study. It foretells the future of wildland fires in an urban interface. Federal, state and local interagency partnerships forged prior to the incident provide a model for other land management units. It demonstrates the value of continuing communication between fire fighters and residents. And Green Knoll demonstrates how expensive protection in the community interface can be, even when the fire consumes a small number of acres.

Green Knoll started on Sunday, July 22, 2001, when a campfire escaped. The fire actually began just inside the Targhee National Forest, but that wasn't discovered until days later. Because of its location and believing the fire was on Bridger-Teton Forest (BTF) land, the BTF fire management personnel assumed responsibility. The fire developed into the first large fire of the 2001 season. It was declared controlled on August 8, 2001, 17 days after it started.

Green Knoll burned 4,470 acres of timber within the BTF and adjacent private lands. As the fire was early in the season in the west, resources were abundantly available, and Green Knoll firefighters used resources from all over the nation. One-fourth (10) of the nation's air tankers were on the fire at one point. At the peak of the incident 1,369 personnel were assigned. Suppression forces included 24 Type 1 crews, 17 Type 2 crews, 11 helicopters (including 6 Type 1 helicopters), 59 engines, 8 dozers, and 24 water tenders. Firefighters did not lack for resources.

Initial cost estimates totaled $13.3 million. The academy staff was advised at the time of its field visit that the cost had grown to over $17 million, which is more than $3,800 per acre, and made Green Knoll the most expensive per acre fire in 2001. It cost slightly over $1 million a day. Contrast this with the Moose Fire that cost about $275 per acre.

Green Knoll also presents an interesting issue concerning structure protection. FS policy reads as follows:

> Section 5137—STRUCTURE FIRES. Structure fire protection activities include suppression of wildfires that are threatening improvements. Exterior structure protection measures include actions such as foam or water application, to exterior surfaces of buildings and surrounding fuels, fuel removal, and burning out around buildings.
>
> 5137.1—Structure Fire Protection From Advancing Wildfires. The Forest Service's primary responsibility is to suppress wildfire before it reaches structures. The Forest Service may assist state and local fire departments in exterior structure fire protection when requested under terms of an approved cooperative agreement.

> 5137.2—Structure Fire Suppression. Structure fire suppression, which includes exterior and interior actions on burning structures, is the responsibility of State, tribal, or local fire departments.
>
> Forest Service officials shall avoid giving the appearance that the agency is prepared to serve as a structure fire suppression organization.
>
> Forest Service employees shall limit the suppression actions to exterior structure protection measures as described in section 5137.
>
> 5137.3 – Structure Fire Protection and Suppression for Forest Service Facilities. At those Forest Service administrative sites, outside the jurisdiction of state and local fire departments, limit fire protection measures to prevention, use of fire extinguishers on incipient stage fires (FSH 6709.11, sec. 6-4c), safe evacuation of personnel, containment by exterior attack, and protection of exposed improvements.
>
> At Forest Service administrative sites located within the jurisdiction of state and local structural fire departments, structure fire suppression responsibility must be coordinated with state and local fire departments.[1]

Thus, it appears there is virtually an unlimited responsibility to suppress a wildfire ***before*** it reaches a structure. While not clearly stated, the inference is that the "structures protected" are private lands, as Section 5137.3 covers structural protection for FS facilities.

During the Green Knoll Fire, the FS and the State (representing Teton County) negotiated a cost share agreement. This agreement set the state's share at $2.7 million dollars (against an estimated total fire cost of $13.9 million). The agreement was based on the percentage of total acres burned by ownership (which equated to 15 percent for private ownership burned)[2] plus ½ the daily cost of aviation from July 26 through July 31.

While little of the $17 million spent by the FS on the Green Knoll Fire was for "structural protection," a significant amount was spent to suppress the fire before it reached the structures in the path of the fire. The state paid for "structural protection," that is, the costs associated with direct preventive treatment (such as, sprinkler systems, foam, gel, wrapping buildings, etc.) for individual homeowners and for part of the aviation costs. The FS paid for everything else.

This case demonstrates vividly why rising costs are caused by the wildland-urban interface. This case study should be compared with the Star Fire review[3], where a backfire was utilized—a strategy not considered for Green Knoll because of the location of homes in the path of the fire.

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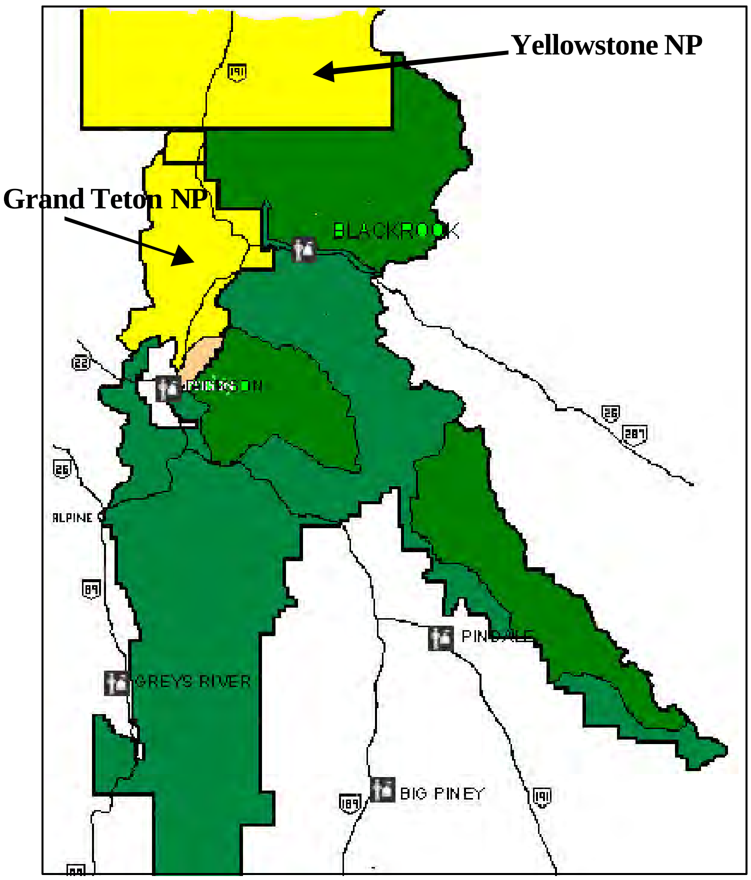
[1] Forest Service Manual, Fire Management (FSM), as amended.

[2] The percentages subsequently were adjusted to about 12% for the state's share. The percentages are not based on the total coat of the fire but on proportionate costs of crews and equipment during an agreed-upon period and on aviation costs, also during a specified time frame.

[3] The Star Fire was the subject of another case study by the Academy team. See the report for details.

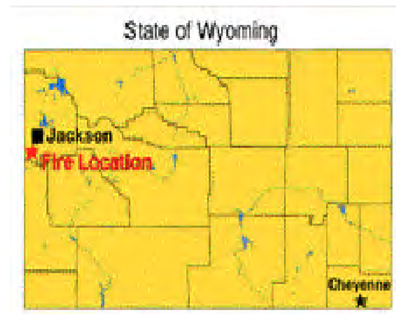
Figure F-1. Green Knoll Fire Map

Bridger-Teton National Forest



Green Knoll, WY

August 2001



Incident summary

- The area experienced a mild winter, early snowmelt, and unseasonably warm weather. This resulted in lower than average fuel moistures levels and early seasonal curing of grass. The Long Term Drought index rated the area as moderate to severe. The fire burned predominately in a timber fuel represented by NFFL fuel models 8 and 10.[4] The timber canopy in and around the fire consisted of subalpine fir, Eaglemann spruce, Douglas fir, lodge pole pine and some scattered aspen stands. Fire control in these fuels and conditions was extremely difficult because of spotting potentials and spotting distances that contributed to the fire spread. Low moisture in both live and dead fuel compounded the spread.

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[4] Fuel models 8 and 10 are classified as a timber fuel type with a moderate to heavy fuel loading of large dead and down material found on the forest floor. There is a high fire intensity in the surface fires, torching of single and multiple trees, long range spotting (.5 miles) and active wind driven crown fires associated with these fuel models.

- The fundamental strategy and tactics used, the Incident Management Teams, and the performance of the people and agencies involved were exceptional, including the Forest Service, National Park Service, and Jackson/Teton County Volunteer Fire Department. While there may have been a chance to suppress the fire had it been located and attacked by the first helicopter recon flight, the fire's remote location, the abundance of fuels, and the wind and weather conditions virtually guaranteed an escaped fire.

- Despite the high cost, the Academy field team's review of available records and interviews with local officials indicated that no significant questionable or inappropriate costs were incurred.

This case study describes how the Green Knoll Fire evolved, how it was managed, how costs were monitored, and the principal factors that drove fire costs. It assesses whether FS policies were followed in the related decision-making and whether firefighting costs could have been reduced without reducing firefighting effectiveness. It also identifies lessons learned that can be used to improve the efficiency and cost effectiveness of firefighting in the future.

Fire Chronology

Table F-1 summarizes the Green Knoll Fire chronology.

Table F-1. Green Knoll Chronology

Date	Activity
7/22/01	Escaped campfire ignites fire southwest of Jackson, WY. Escapes initial attack. 1st WSFA prepared
7/23/01	Joe Carvelho's Type I team assumes command. Fire at 300 to 500 acres; spread primarily east to 1,104 acres by end of day.
7/24/01	Fire not very active; grew to 1,390 acres
7/25/01	Low moisture and high winds; spread north across Mosquito Creek and east to 1,900 acres. 2nd WFSA prepared. Evacuated 6 subdivisions displacing 400 people.
7/26/01	Established unified command with Teton County. Established a structure protection branch (which was disbanded Aug 3). Winds and weather caused fire to blow out to 3,060 acres
7/27/01	Moderate fire activity; grew to 3,271 acres. Winds caused spotting
7/28-8/2/01	Significant runs in afternoons, more spotting. Grew to 4,470 acres. Declared fire contained on Aug. 2. All residents allowed back to their homes.
8/2-4/01	Mop up, improve fire lines, begin rehab, continue to fight spotting and fire in burned areas.
8/5/01	Transition to Jim Shell's Type II IMT. 3rd WFSA prepared
8/6/01	Bieyer Fire, lightning caused, also on the Bridger-Teton assigned to Shell's team. Utilized same Incident Command Post and resources.
8/8/01	Green Knoll Fire declared controlled.
8/11/01	Bieyer Fire declared controlled; both returned to BTF for management & rehab.

CONTEXT AND PRECONDITIONS FOR THE FIRE

The Green Knoll Fire started from an escaped campfire in the morning of Sunday, July 22, 2001. It was located about 5 miles southwest of Jackson, WY, and south of the unincorporated community of Wilson, on the Bridger-Teton National Forest (actually, the fire started on the Targhee National Forest but that wasn't known until a later investigation to determine the cause). Green Knoll burned 4,470 acres of timber within the forest and on adjacent private lands. It was a "poster child" wildland-urban interface fire that burned into two subdivisions and threatened several others, causing an evacuation and displacement of 400 people. No structures were lost in the fire. Total fire costs are estimated, as of April 2002, at more than $17 million.

Bridger-Teton averages 67 fires per year. In 2001 they had 120. Approximately 35% of the fires are person caused, and 65% lightning or nature caused. Fire season generally runs from late June to September and occasionally into October. They had several years of moderate to severe drought prior to this fire. Almost 100 years of inadequate forest management, including a history of fire suppression, led to a buildup of fuels. The steep terrain and limited access in some areas affected firefighting strategy and tactics. For Green Knoll, however, the wildland-urban interface dictated full suppression and eliminated any options for fire use or management since the presence of homes precluded the option of allowing the fire to burn.

Features of the Land Affected by the Fire

The Green Knoll fire started on an isolated area near the border of the Bridger-Teton and the Targhee National Forests. It was in an area used occasionally by mountain bikers and not far from an outfitters fishing and hunting camp. There is a "timber" road near the origin but it was washed out about 2 miles below the fire site. The fire started in a small grove of trees, and quickly began spotting across the road into a previous clear-cut timber area that had a stand of trees along one side. There was minimum fire in the clear-cut area, but the tree stand proved to be a "wick" for the fire to move to more heavily wooded terrain.

The combination of the location, with its access initially only by helicopter, the terrain, the fuels, weather and wind conditions constituted a recipe for an escaped wildland fire.

Initial attack quickly progressed to a Type III organization due to the complexity of having multiple resources on the fire including engines (after the road washout was repaired during the night of July 22), smokejumpers, air tankers and helicopters. Because of the unusually dry fuel conditions, nature of fire behavior, anticipated weather, and the private structures at risk, the BTF fire management staff quickly recommended and the Forest Supervisor approved requesting a Type I Incident Management Team.

There were several subdivisions in the potential path of the fire. These included Indian Paintbrush, Crescent H, Burcher Road, Rivermeadows, Aspen Cove, Wooded Hill and Deep Powder. The average home sold in some of these subdivisions in 2000 for $1.2 million, and the median price of all homes was $625,000. Firefighters insisted that the value of the homes was immaterial in determining strategy. But they took pride in ensuring that no structures were lost because of the fire.

Fire-Related Geographic Conditions

The rugged and heavily forested mountainous terrain where the Green Knoll Fire occurred had not had a fire in several decades. It burned on fuel model 8 and 10[5]. There was limited access, with steep slopes and generally rocky soil. The terrain, weather and lack of safety zones inhibited direct attack by ground crews. The firefighters selected an anchor and flank strategy, with primary dependence on air attack of water and retardants. They subsequently were able to utilize dozers to cut some of the lines in support of the ground crews.

Local Demographic And Economic Characteristics

The 3.4 million acre Bridger-Teton National Forest is one of the largest forests in the continental U.S. More than 1.2 million acres are designated as wilderness. It borders the Grand Teton National Park on three sides, and has mountain ranges that reach from 5,900 to over 13,000 feet. It is part of the Greater Yellowstone Ecosystem. Recreation (camping, mountain biking, fishing and hunting), wildlife habitat, beautiful vistas, and tourism are its primary purposes. Jackson is the largest city in the Forest.

Fire management in this area has become an interagency multi-jurisdictional partnership covering nearly 5 million acres. Since many public and private buildings are surrounded by or adjacent to large tracts of public land, firefighters from the Bridger-Teton NF, Grand Teton National Park, the National Elk Range, and the Jackson/Teton County Fire Departments ignore established boundaries to jointly manage wildland fires. Interagency and community-based firefighters train together each spring and early summer and work together to develop joint annual operating plans. Their effort to draft an emergency operations/mutual-aid plan in early 2001 should be credited with improving the management of the Green Knoll Fire and preventing the suppression costs from being even higher. The Academy team was told repeatedly that this partnership performed almost seamlessly during the incident.

Local prevention and mitigation efforts

Prevention or mitigation efforts did not affect the Green Knoll Fire. Nor did they influence suppression strategy or tactics. Neither the FS nor the state had completed any recent mitigation efforts in the general area of the fire. The interagency partnership, referred to above, had been actively attempting to better educate the public, and during the fire spent a significant amount of time and effort on encouraging residents to take independent action. The FS and NPS previously began sharing some fire management positions including a fire prevention officer and an education and information specialist among others. Homeowners in the path of the fire, with a few exceptions, had not taken extensive measures to make their properties resistant to wildland fire despite the agencies' prevention efforts. Protecting those homes significantly added to the total cost of the fire.

[5] See footnote 4.

Land unit plans and policies

The Bridger-Teton Land Management Plan was prepared in 1989. While it is not as current as perhaps it should be, it did provide for fire use in the three wilderness zones and contained a more than adequate framework for managing the Green Knoll Fire. However, because of the threat to homes, the LMP actually had little or no impact on the strategy or tactics. Therefore, it had no effect on reducing or increasing costs. It was known from the outset that the fire was not lightning caused and was near a populated area. FS policy mandated all out suppression.

The BTF Fire Management Plan has been updated each year since 1995. At least one plan identified the area near the fire location as a "community at risk," and included a fuels treatment project there. As this was not the highest forest priority, the fuels treatment project had not been completed. A new interagency fire management plan was being drafted during the time of the NAPA site visit. This is aimed at making management objectives more compatible by authorizing simultaneous management of fires on different jurisdictions without concern for agency boundaries. This effort, involving the FS, NPS, F&WS, and Teton County should allow the agencies to manage fires and resources more effectively, plan and monitor fire activity for resource benefit more efficiently and study the aftermath of fires through a fire effects monitoring team more thoroughly. Having said all this, the fact is the BTF FMP had no effect on the costs of the Green Knoll Fire. It was a full suppression effort from the outset.

KEY MANAGEMENT DECISIONS AND ACTIONS AFFECTING FIRE COSTS

The Green Knoll Fire was the first in decades in this part of the Bridger-Teton NF, and the first large fire of the 2001 season. It tested interagency plans, agreements and working relationships of the BTF, Grand Teton NP, and Jackson County authorities. It also challenged BTF fire managers who responded quickly by completing a timely initial Wildland Fire Situation Analysis (WFSA), immediately calling in a Type I Incident Management Team (IMT), and ordering firefighting resources. While the first WFSA included only one alternative, the second was untimely prepared, and the third described the fire location incorrectly, these deficiencies affected neither strategy nor costs.

Local interagency fire staff continued to provide support and resources throughout the duration of Green Knoll. Previously established mutual-aid and operations plans and agreements were executed. Forest managers, directly involved from the outset, worked closely and cooperatively with the two IMTs on the fire. Federal, state and local officials unanimously praised the professionalism of all the parties involved.

Initial and Extended Attack

An interagency helicopter was dispatched mid-morning Sunday, July 22, based on a report from the Teton County Sheriff's office that smoke had been spotted in a canyon near Mosquito Road south of Wilson. The recon flight failed to locate a fire and returned to base at the Jackson Airport. BTF fire management personnel could only speculate that had the fire been discovered then, initial attack might have extinguished it at that stage. Shortly before noon, the interagency dispatch center began receiving other reports of smoke in the same location. This time the recon flight found the fire. By then, the fire had grown to about a half acre in size and conditions were such that there was little hope for containment.

Within the hour, an interagency initial attack crew, the “Teton Crew,” arrived and began holding the fire until more resources could be assembled. Smokejumpers joined the initial attack crew as the fire began to spread with brisk winds. With isolated homes and subdivisions threatened, federal and county firefighters also organized structural protection in coordination with wildland fire resources. The initial attack forces were under the command of the BTF fire management staff. Personnel had to be airlifted by helicopter to the fire site because a nearby road had been washed out about 2 miles from the scene. This prevented engines and dozers from arriving until the next morning after the road was repaired during the night.

The IA commander recognized that the existing wind, fuel and terrain conditions made it only a matter of time before the fire escaped. It began spotting across the road and into a tree stand. Air tanker and helicopter water and retardant drops may have temporarily slowed progress but did not stop the fire advance. He essentially moved to extended attack early in the afternoon and began planning strategy. He chose an anchor and flank approach and was reluctant to put firefighters out in front of the fire because of the steep terrain, lack of safety zones, wind and fire behavior. Those on the scene were having limited success with the fire.

BTF fire management staff discussed the situation, recognized what they were dealing with, prepared an initial WFSA, and requested a Type I IMT.

WFSA preparation

According to the participants, which included the BTF district ranger, the FMO, and “a couple of other” line officials, the assistance of the forest’s “roving WFSA ranger” was requested to facilitate the preparation of the first WFSA. They began working on it around 10:00 p.m. the first evening of the fire. Firefighter and public safety was the number one priority. They decided there was only one alternative – to protect the structures in the community interface – which was to minimize the acres burned. They also knew at the outset that there were no other large fires on the national scene and that resources, such as a Type I IMT, would be readily available. It’s not surprising that the complexity analysis supported the decision to request a Type I Team. The target outcome was to keep the fire south of Mosquito Creek, north of Cottonwood Creek and west of the ridge between Mosquito and Cottonwood Creeks. This had an estimated success probability of 80% with a fire size of 1,600 acres, 5 days to contain and 10 days to control. The worst case was 12,000 acres and 20 days to control. Estimated cost of the target outcome was slightly over $2 million.

For clarity rather than chronology, the following describes the 2nd and 3rd WFSAs.

WFSA number 2 was prepared on July 25 after the fire grew and crossed some of the boundaries established in the first WFSA. It again included only one alternative, revised the estimated outcome to 6,000 acres and cost to $9.4 million, also with a success probability of 80%. The worst case stayed at the same 12,000 acres but 35 days to control.

Participants were unclear why WFSA No. 3 was prepared on August 5. This was the same day the Type II IMT took command of the fire, but preparation of the WFSA did not appear to have any connection with the transition in fire management. Those involved said they believed this WFSA was required because it was clear that costs would exceed earlier estimates.

WFSA No. 3 again included the same boundary alternatives (which at this point made no sense since the fire had moved north rather than east), dropped the fire size to 5,000 acres, with 13 days to control, and estimated costs at $14 million. While this WFSA had the fire located incorrectly, BTF fire management personnel seemed pleased that the estimated fire size (4,070 acres) and cost ($13.3 million), at that time, were reasonably accurate. They expressed surprise when the NAPA team informed them that costs had exceeded $17 million as of April 2002. This disparity can be largely credited to the inability of ICARS to reflect actual costs and to a subsequent review by the Regional Office financial personnel that included contacting participating federal agencies to obtain information orally about their charges to the fire code. This is not general practice in determining total fire costs. The Academy team did not obtain a breakout of the additional almost $4 million.

Incident Management Phase

Joe Carvelho's Type I IMT assumed command on July 23, the second day of the Green Knoll Fire. The fire had grown to approximately 1,104 acres shortly after the team transitioned in. The transition went smoothly. The Incident Base had been established with all the necessary facilities including power and phone lines near the Wilson School. The initial briefing provided Carvelho's team the needed information, including GIS data on the forest and the detailed structure protection plans previously developed jointly by BTF and Teton County staffs.

The IMT, utilizing data provided and its own assessment of the situation, developed what was primarily a direct attack strategy and tactics. They began ordering resources. At its high point, there were almost 1,400 personnel on the fire. The air attack was considered among the highlights, especially as no major accidents occurred (a minor miracle considering the limited air space and terrain). Resources were available due to the National Fire Plan additions and the lack of other large fires elsewhere.

Carvelho's team was highly effective in developing strategy and tactics, establishing and implementing the unified command with Teton County, and containing a fire that seriously threatened but was prevented from burning any structures. In fact, all the firefighters, and Carvelho in particular, became cult heroes to the residents of Jackson Hole. They commented about people cheering them on the streets, bringing food to the incident base, and offering other forms of support and assistance. Local residents will dedicate a memorial to the Green Knoll firefighters in July 2002.

Jim Shell's Type II IMT replaced Carvelho's after 14 days to complete mop-up, rehabilitation and demobilization. Shell described the transition as smooth, the initial briefing as thorough and complete, and the handoff of resources effective. Shell's team was in command only a few days before returning the controlled fire on August 8. It should be noted that the Bieyer Fire, also on the Bridger-Teton, was managed by Shell's team from August 6 and used the same command post and resources as Green Knoll. The Bieyer Fire was managed as a division of the Green Knoll incident and declared controlled on August 11. This may explain some of the additional charges to the Green Knoll Fire.

Neither team encountered any difficulty in obtaining requested resources, nor reported any significant concerns about the performance or conduct of crews on the fire. Both teams:
were amazed and pleased by the public reception and support truly believed the large utilization of air resources was justified and essential to fight the fire indicated a concern for controlling costs but said that firefighter and public safety was first, protection of the structures and other resources second addressed costs primarily at the demobilization stage by releasing resources on a timely basis and attempting where possible to release more costly items (aircraft or crews) first.

Also, toward the later stages of Green Knoll and during the demobilization phase, resources began to be diverted to the Arthur Fire, a lightning-caused fire near the eastern entrance of the Yellowstone National Park. Competitions for resources did not affect Green Knoll. They came late, after the fire was controlled.

The entire IMT phase was exemplified by a high level of federal, state and local interagency cooperation, by the successful attack operations, and by the overall management of the various resources – human and mechanical.

Several reviews of the Green Knoll Fire have ranged from an informal local "lessons learned" session to studies from national groups to this Academy effort. These reviews, according to the copies provided to the Academy team, have uniformly praised the efforts of the IMTs and the agencies involved, and none has reported any major concerns with any phase of the management or the operations. We found nothing to contradict earlier reports.

There were minor issues, such as an accident where one helicopter lowered its water bucket into the rotor of another helicopter as both were attempting to reload. No injuries resulted, no lives were lost, and there were no truly serious injuries (one firefighter injured her eye).

Emergency Stabilization and Rehabilitation

The Carvelho IMT began rehab several days before it rotated off. They began repairing the dozer and hand lines along the perimeter of the fire, and assisted the county in removing foam, gel and retardant from some of the houses protected. Several homeowners did not wait for FS rehab. They acted independently and hired contractors to clean their homes and, in some cases, went farther and cleared trees and brush from near their houses. One homeowner clear-cut his entire property, about 8 acres.

There were few rehab issues at Green Knoll, primarily because there were few natural resources at risk. One retardant spill into a creek necessitated a temporary dam to allow the retardant to dissipate. This reportedly was at minimal cost.

Adequate resources were available to perform the rehab work that began about 5 or 6 days into the fire. The effort “continued smoothly” through the transition to the Type II IMT, again with adequate resources and attention.

The BTF established an interdisciplinary team to develop a plan for BAER. There were no reported conflicts between rehab and BAER.

Local Participation in Fire Suppression and Structural Protection

Prior sections of this report have mentioned the initial and continuing participation of the Teton County Fire Department (TCFD) on Green Knoll. They responded very early in the initial attack phase and assumed responsibility for protecting the private property in the surrounding subdivisions. This did not vary.

The Carvelho team joined with the county in establishing a unified command. The TCFD Chief stated that two factors made a significant difference on Green Knoll. The first was that prior to the fire the county and the forest had jointly developed a structure protection and emergency evacuation plan. He credited the mutual trust and cooperative relationships between the county and the forest personnel as the second factor. He believed these things assisted Carvelho’s team, saved “2 or 3” days by already having the plans in place, and helped contain total fire costs.

Carvelho and Shell included the county in planning sessions, developing operating plans and discussing strategies and tactics. “We were involved at 15 acres rather than at 1,500 acres” was how the Chief described it.

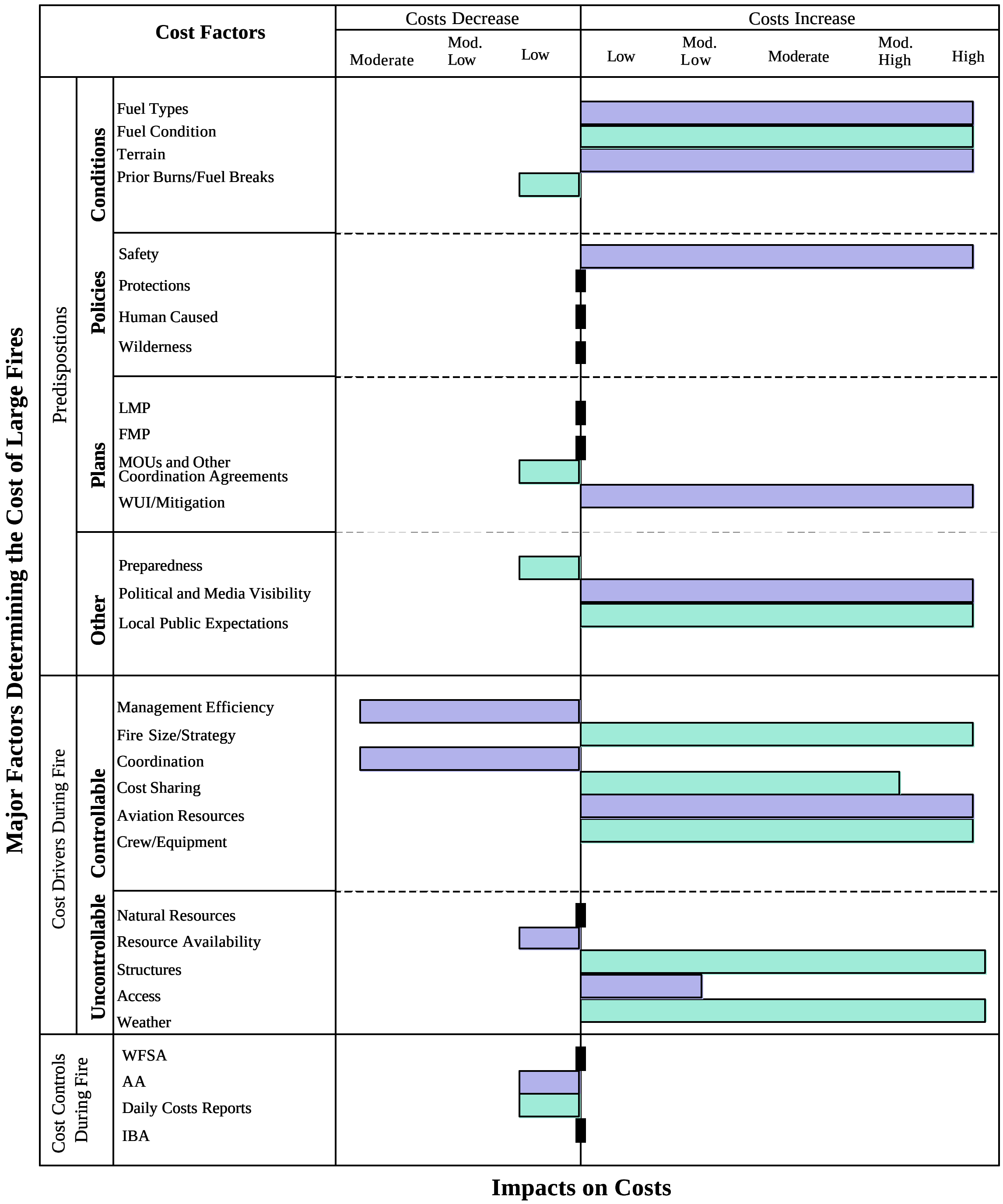
TCFD personnel focused on structure protection and meeting with each homeowner in the threatened subdivisions. They believed having a local face and a known individual are essential to providing the kinds of information residents want and need. They actively participated in the numerous public meetings conducted by both IMTs and the forest. Residents applauded the time and attention given to these public meetings and the work of the information center.

PRINCIPAL COST DRIVERS

The build up of fuels, large number of residences in the path of the fire, and extended drought and weather conditions were the most significant factors contributing to the cost of the Green Knoll Fire. The Academy team identified several other factors, based on interviews and a review of the records. The chart below identifies these factors and their estimated qualitative impacts on total costs. It illustrates “increases” and “decreases” for the various factors.

Figure F-2. Generalized Relative Influences of Various Factors on the Cost of a Wildland Fire*

GREEN KNOLL, Bridger-Teton NF, Jackson Hole, WY, 07/23/01-08/08/01



* The relative cost impacts of any given factor on a particular fire were judged qualitatively by the site visit team sometimes in consultation with personnel involved in fighting the fire. Some factors had different impacts during different stages of the fire. The case study write-up should be consulted for a more detailed description of each factor.

Predisposition—Uncontrollable

Structural protection needs, resource availability during the fire, drought and wind/weather conditions, access/location, and terrain have previously been described as establishing the uncontrollable factors influencing the cost of the Green Knoll Fire. They won't be repeated here. But it is important to keep them in mind.

Cost Factors During the Fire—Controllable

First are those management efficiencies that directly affect fire costs.

Initial attack—Our study surfaced several reasons to commend the Bridger-Teton fire management staff and forest managers in general. They acted quickly, effectively and efficiently in response to the fire discovery. Their prior planning with the Grand Teton NP, and the state and local agencies, plus their staffing at 100 percent of MEL enabled them to do what needed to be done. Perhaps the fire could have been squelched had it been found by the first recon flight. But it wasn't. After that, forest management took the appropriate actions. Particularly commendable was the recognition of the complexity and conditions of the fire and the immediate decision to request a Type I IMT. Preparation of the WFSA with only one alternative may not be the best action they took. How much this helped control costs is conjecture, but the Academy team believes that quickly requesting a Type I IMT was economically wise.

IMT phase—The WFSAs, despite their deficiencies, and the delegations of authority contained essential information for both Incident Management Teams to plan and develop effective strategy and tactics. Team transitions were accomplished smoothly. Prior establishment and supplying of the Incident Command Post (camp) saved time and funds. The prior mutual-aid agreements, addressed below, ensured cooperation. Consistent involvement by BTF managers in the IMTs' daily planning sessions, readily available support, and timely responsiveness eased operations throughout the fire.

Particularly significant were the BTF's financial operating guidelines for the business conduct during the fire. Dollar savings may have been relatively small when measured against the total fire cost, but unquestionably these guidelines served the forest and the taxpayer well.

The BTF provided the Type I team with adequate GIS data (Carvelho's team brought its own GIS specialist who worked with forest personnel and left necessary maps and forest layer information for Shell's Type II team). The Buying Team received timely and efficient support from BTF budget and finance staff. The IBAs were included in planning meetings and their advice solicited. No significant issues arose. Requested supplies and equipment were provided appropriately. (The IMT did not get a state of the art copy machine with all the whistles and bells merely because one was requested.) There was limited use of contractors on the Green Knoll Fire, and for those few that were used, there were no difficulties.

Strategy selection—It was known from the outset that in all likelihood this was a person caused fire. Several isolated structures and subdivisions were in the anticipated path of the fire. Forest

Service policy mandates a full suppression strategy in such cases. Carvelho's team took this strategy to a higher degree. They did this in part because the resources were available, but primarily because they accurately assessed the combination of conditions and climate. Everyone has consistently praised his team's actions. The NAPA team's assessment is that the strategy was on target and deserves credit for the relative small size of the fire, for preventing any structures from burning, and for protecting the safety of firefighters and the public. The overall safety record is exceptional for a fire of this size and with this volume of resources.

Coordination—The Bridger-Teton, Grand Teton NP, state, county and local mutual-aid and emergency planning agreements developed prior to the Green Knoll Fire, along with several years of joint training and group exercises, are a model for other agencies to emulate. Further, the forest and the park partnership pave the way for future developments. They currently are sharing management and staffing of an excellent dispatch center, on-site aircraft operations (two helicopters), and several fire-related positions: among them are an interagency fire planner, a fire prevention officer, a GIS coordinator, and an education and information specialist. They are drafting an Interagency Fire Management Plan, and mutually fund three 10-person initial attack crews. The BTF and the GTNP participated with the state and county in identifying and prioritizing the communities at risk, and have planned fuels treatment projects that complement each other. The forest and the park also provide advisory assistance to the state and county to prepare grant requests for NFP funds. In sum, they spell coordination and cooperation with capital letters.

Cost Share Agreement

The most controversial issue from the Green Knoll Fire concerns the cost share agreement. Such agreements generally are based on two factors: (1) ownership of acres burned, or (2) level of firefighting effort.

BTF officials including the Forest Supervisor, the Wyoming State official involved, and Teton County personnel said they believed the final negotiated agreement was fair to all parties. However, the regional finance staff, the two Incident Business Advisors, members of Carvelho's Finance Section, the cost apportionment team, and allegedly the Regional Forester "were not comfortable" with the final agreement.

An early version of the agreement set the FS portion at 85 per cent and the state at 15 per cent of total costs. The final agreement split the costs between the FS and the state at 88 to 12 percent based on a total cost estimate of $13.3 million. However, the state actually paid $2.7 million, but it was reimbursed by FEMA. The percentages and dollar amounts are based on the ownership of total acres burned and ½ the daily cost of aviation during an agreed upon five days during the fire, not on the total estimated cost of the fire.

The state forester involved in negotiating the agreement stated that he was willing to "go back to the Governor for additional funds" if evidence proved a larger share appropriate. It appears no one has any intention to pursue this.

The state's "fair share" ranges from the final 12 percent up to 80 percent or $13.6 million depending on whom is asked. The Academy staff concluded that the FS paid more than the estimated cost data would indicate they should pay. However, the team did not attempt to determine the appropriate percentages. The questions raised clearly indicate material weaknesses with this Green Knoll process.

> First, the parties depended on ICARS cost totals.[6] ICARS does not measure actual costs, it provides estimates. Large fire actual costs rarely are available until as long as two years later. This understandably complicates establishing timely cost share agreements.
>
> Wyoming needed "final" figures quickly because of its fire suppression budget process. The Governor needed to act within the fiscal year to close out accounts. They could not wait indefinitely. The state suppression budget for 2001 totaled only $600,000. FEMA saved them.
>
> All parties agreed that while there is some guidance on responsibilities relating to cost share agreements, inadequate guidelines exist to facilitate negotiating the details of such documents. As a result, cost share agreements vary from region to region and forest to forest. Certainly, no one size fits all. But clearly better national direction is needed.
>
> The value of strengthening and maintaining the close organizational relationships between the BTF and state and local cooperators cannot be quantified. Available information indicates these relationships benefited all parties and will continue to do so. Risking these relationships over determining a "fair share" of the costs of one fire may be counterproductive. After all, what is a "fair share?" And what should it be based on? This is not to undermine the importance of developing an understanding by all parties of the principles behind equitable cost-share agreements.

In sum, this is clearly one issue the FS should address. The Academy team was advised that there had been an effort under way "for a couple of years" to provide model agreements and better guidance.

<u>Aviation Resources</u>—Green Knoll demonstrates the cost and the value of utilizing aviation resources to fight forest fires in a community-interface environment. Aviation consumed approximately 41 percent of the estimated total costs of the fire. Everyone the Academy staff interviewed firmly believed the return was well worth this cost. No one expressed a view that the threatened subdivisions would have been protected without the large air attack. A few stated that had the fire not been contained when and where it was the loss would have been extremely high, not because of the expensive homes immediately threatened but because the fire probably would have run to and through Teton Village. One thing is clear: should the BTF and the IMTs follow the California approach and include estimates of the private values saved, the cost of the fire would be picayune compared to the savings. Large credit should be given to the use of aviation resources.

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[6] ICARS is part of ISUITE, the FS accounting software system. The NAPA team heard complaints about ISUITE at each of the three FS fires reviewed. Most of the comments were directed at implementation without adequate training.

Emergency stabilization and rehabilitation—There were no major issues and no inappropriate costs for this purpose.

The bottom line for uncontrollable and controllable cost factors is that the Academy staff found no major questionable or inappropriate costs incurred. Our findings are consistent with those of the Region 4 "Regional Large Fire Activity Review" of the Green Knoll Fire conducted in August 2001.

CONCLUSIONS

Effective Cost Containment

Green Knoll at 4,470 acres was a relatively small wildland fire. It cost over $17 million. That's about $3,800 per acre compared to the $275 for the Moose Fire. Therefore, it's somewhat difficult to state that costs were contained. However, everyone agrees that the fast action by BTF management to call in a Type I IMT, the strategy and tactics utilized by both the Type I and Type II IMTs, and the heavy reliance on costly aircraft resources were factors that did in fact contain costs. Had these actions not been taken in such a timely, efficient and effective manner, total costs most likely would have been much higher. Certainly, some of the values at risk—those residences in the threatened subdivisions – would have been destroyed.

On a much smaller scale, but still evidence of cost containment are additional factors:

1. The Bridger-Teton Forest's administrative operations plan that laid out budget and finance requirements in advance for the IMTs. There is no way to accurately measure the savings achieved, but they are there.
2. Both IMTs' use of daily cost reports assisted in determining the order of resources to release during demobilization.
3. Both Incident Commanders encouraged their staffs to be sensitive to costs, while keeping firefighter and public safety first. Evidence of this can be measured more by what wasn't ordered or requested. The Buying Team, working with the IBA, analyzed costs against wants/needs -- for example, the type of ground coverings to control dust and protect electronic equipment.
4. BTF's location and establishment of the Incident Command Post prior to the arrival of the Type I IMT, including provision of power and phone lines, saved transition and start up time.
5. According to the Type I IC, prior negotiation of emergency preparedness plans between the Forest and Teton County saved the IMT "2 or 3 days."
6. The close and cooperative working relationships among the various federal, state and local agencies at Jackson Hole avoided any loss of time in bickering over roles and responsibilities such as occurred at the Moose Fire in Montana.

Management Issues

Management and managers performed at an exceptional level. This included Bridger-Teton NF, Grand Teton NP, State of Wyoming, elected and appointed officials of Teton County, and Incident Commanders, and IMT members of the Type I and Type II teams. One can quibble over the preparation of the 3 WFSAs that included only one alternative rather than the two or more generally expected, that the final WFSA had the fire located in the wrong place, and that the final result of the Cost Share Agreement may appear inequitable. But without exception, other review teams studying the Green Knoll Fire have given the managers involved high marks. The Academy staff agrees that they (all of the Green Knoll managers involved) consistently did the right thing at the right time.

Further, no obstacles were placed in the way of using available decision-making tools, such as GIS. No issues were raised about questionable crew performance or conduct.

Issues were raised about (1) currency of Land Management Plans; (2) guidance on preparation of the WFSA; (3) policy on structures protection; and (4) guidance on cost-share agreements. The FS advises each of these issues is being reviewed to determine appropriate improvements.

Lessons Learned

First, Green Knoll illustrates that wildland fire suppression costs will continue to rise as long as location of homes in the forests continues to increase. Green Knoll epitomized the costs of the Wildland-Urban Interface, and the actions firefighters have to take to protect people and property. There are no simple solutions, no magic bullets.

Green Knoll also demonstrated that once a fire starts there are few opportunities to significantly reduce suppression costs. Actions taken prior to the fire, such as fuels treatment, fire prevention, and preparedness will have a greater payoff in the long run. There are no short-term solutions to these long-term problems.

However, Green Knoll showed that use of daily cost reports can facilitate at least some savings, especially when demobilization begins. Timely release of more costly resources, without endangering firefighter or public safety, reduces total fire costs.

The value of cooperative working relationships between federal, state and local agencies could not be more profoundly demonstrated than those at Jackson Hole. They have developed a model for other locales and land units. These relationships range from annual picnics and joint training exercises to sharing the cost of people and equipment for helicopters, a dispatch center, Initial Attack crews, and more. Especially significant were the joint emergency action plans, which may be worth emulating nationally.

Green Knoll illustrated the value of providing complete, timely and responsive communications and information to area residents. Jackson area citizens were so taken with and appreciative of the firefighters that they are dedicating a memorial in 2002. This is not to suggest that good relations should be fostered in order to garner memorials, but it is clear that good communications suppress bad opinions.

Having sound written guidelines on administrative budget and finance practices in place ahead of time proved worthwhile for the Bridger-Teton staff and the IMTs. Other forests and other land management agencies should adopt this practice to improve cost-consciousness.

Green Knoll demonstrated that much needs to be done to improve the WFSA. The Academy staff noted similar problems at all three of the FS fires studied.

Forest Service personnel need better guidance for negotiation and preparation of cost- share agreements. One solution may be establishing more national or regional cost-share teams and providing them more authority. Some action is definitely needed.

Somewhat associated with cost-share agreements is the fundamental need to establish who should be responsible and accountable for wildland fire suppression costs. This involves:
land management agencies that have allowed hazardous fuels to build up,

- state and local governments who neither restrict houses from being built among the trees nor require fire-safe building codes,
- homeowners who do not take basic fire prevention actions and continue to insist on having cedar shake roofs, stack firewood near their structures, and complain if attempts are made to reduce fuels near their property,
- environmental groups who oppose the prescribed burns and mechanical treatments needed to reduce hazardous levels of fuels.

Box F-1. Contacts-Green Knoll

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ARTHUR FIRE CASE STUDY REPORT
Yellowstone National Park
July 29 – August 11, 2001

The Arthur Fire was reported on July 29, 2001 in Yellowstone National Park about three miles west of the Park's east gate entrance. It is believed that lightning started the fire on July 28 near the top of a ridge at 9,000 feet. This area was in an old growth forest where there were heavy accumulations of dead and down woody fuels that were dry due to continued drought conditions. The winds were high, pushing the fire into the tree crowns where it spread rapidly. The area within the fire perimeter was steep, remote and rugged, requiring significant use of aerial resources until the fire was contained on August 11, 2001 (day 15). Total suppression costs were estimated to be about $6.3 million at the time the incident management team demobilized and returned the fire to the Park to complete mop-up. In total, 2800 acres burned.

Just outside Yellowstone's east gate are about 70 residences, several lodges and other businesses, and a power grid that the Arthur Fire threatened. One of the lodges, the Pahaska Lodge, has historic significance as Buffalo Bill Cody's personal hunting lodge. The closest gateway town is Cody, Wyoming (located about 50 miles from the east gate). Yellowstone is a prominent feature in the social and economic life of the surrounding areas. The communities and their businesses receive significant income by providing goods and services to Park visitors and they also benefit from National Park Service (NPS) and concessionaire expenditures for salaries, goods, and services.

Yellowstone encompasses 2.2 million acres (3.4 thousand square miles) and is located primarily in the northwest corner of Wyoming, with portions extending into southwestern Montana and southeastern Idaho. Approximately 95 percent of Yellowstone is a proposed Wilderness area and is managed as such to maintain its Wilderness characteristics. Land ownership around Yellowstone is primarily under the jurisdiction of the Forest Service and NPS. The Shoshone National Forest borders Yellowstone in the area of the Arthur Fire and some of the threatened residences and businesses were located in that forest.

YELLOWSTONE FIRE HISTORY

Natural fire is considered a significant part of Yellowstone's ecosystem. Vegetation covers 95 percent of the Park, of which 81 percent is forested. The forested areas are dominated by coniferous species, while sagebrush and grasslands cover 14 percent. Lodgepole pine is the prevalent forest species, accounting for 76 percent of the forested acres. This is a fire-dependent species that reproduces more abundantly after fire, and where certain birds, flowers, insects, and mammals thrive in recently burned areas.

In an average year, about 32 fires occur in Yellowstone—about 24 of which are caused by lightning. Most of Yellowstone's fires are small—on average, less than 2,250 acres burn from all fires in any given year. [7] The typical lightning-caused fire will burn less than 10 acres. Most often, these fires involve single snags and are extinguished naturally. The vast majority of Yellowstone's fires remain small because the volume of woody fuels on the forest floor is too low to sustain a surface fire in years with normal moisture levels.

Large fires are part of Yellowstone's history. They replace large stands of trees approximately every 250-300 years.[8] When they occur, they can engulf major portions of the Park. In 1988, the most active fire season since 1870 (when the Park began to keep fire records), 794,000 acres burned: 45 fires originating within Yellowstone burned about 302,000 acres, and 5 additional fires originating outside the Park burned about 492,000 acres within the Park. The 406,000-acre North Fork Fire was the largest. It was human-caused and began on the Targhee National Forest.[9] Table F-2 places the 1988 fires in perspective.

Table F-2. Fire history of Yellowstone, 1972-1988**

Year	Total no. of fires	No. of Lightning-caused fires	Total Area Burned Acres	% Normal Precipitation
1972	21	15	5	155
1973	33	24	146	103
1974	38	28	1307	60
1975	26	18	5	75
1976	30	19	1604	166
1977	29	18	67	119
1978	24	12	15	65
1979	54	29	11233	73
1980	25	21	5	122
1981	64	57	20596	77
1982	20	13	2	118
1983	7	4	2	137
1984	11	11	2	138
1985	53	43	32	90
1986	33	27	2	114
1987	35	29	964	117
1988	45	39	793883	32
Total	**548**	**407**	**829721**	
Averages	**32**	**24**	**2249** *	

*Average excludes 1988 fires
**Source: Table 1, Renkin, R. A., and Despain, D. G., 1992.
Fuel moisture, forest type, and lightning-caused fire in Yellowstone National, Park, Can. J. For. Res. 22: 37-45.

Larger fires tend to occur during extended periods of little or no rainfall. As shown in Table 1, 1988 had the lowest level of precipitation over the prior 16 years studied. Other conditions normally present for large fires include a dense understory of trees that provide "ladder" fuels and high winds to carry the fire into the forest overstory. These conditions can sustain an independent crown fire that rapidly increases the fire's size. Because the majority of the Park is on a high plateau with few natural barriers, these fires tend to spread until the wind dies down.

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[7] Renkin, R. A., and Despain, D. G., 1992. Fuel moisture, forest type, and lightning-caused fire in Yellowstone National, Park, Can. J. For. Res. 22: 37-45. Reported data cover period 1972-1988.
[8] Yellowstone National Park Wildland Fire Management Plan, p. 26
[9] Yellowstone National Park Wildland Fire Management Plan, p. 21

ARTHUR FIRE CHRONOLOGY

In virtually all respects, the conditions conducive to having a large fire were present during the Arthur Fire—the fire occurred in a forest that had not been burned in more than 200 years, ladder fuels were dense, and winds were high periodically through day 5 of the fire. These factors caused the fire to spread, and the spreading abated only after the winds died down. The following box provides a brief chronology of the fire and how it was fought.

Table F-3. Arthur Fire Chronology

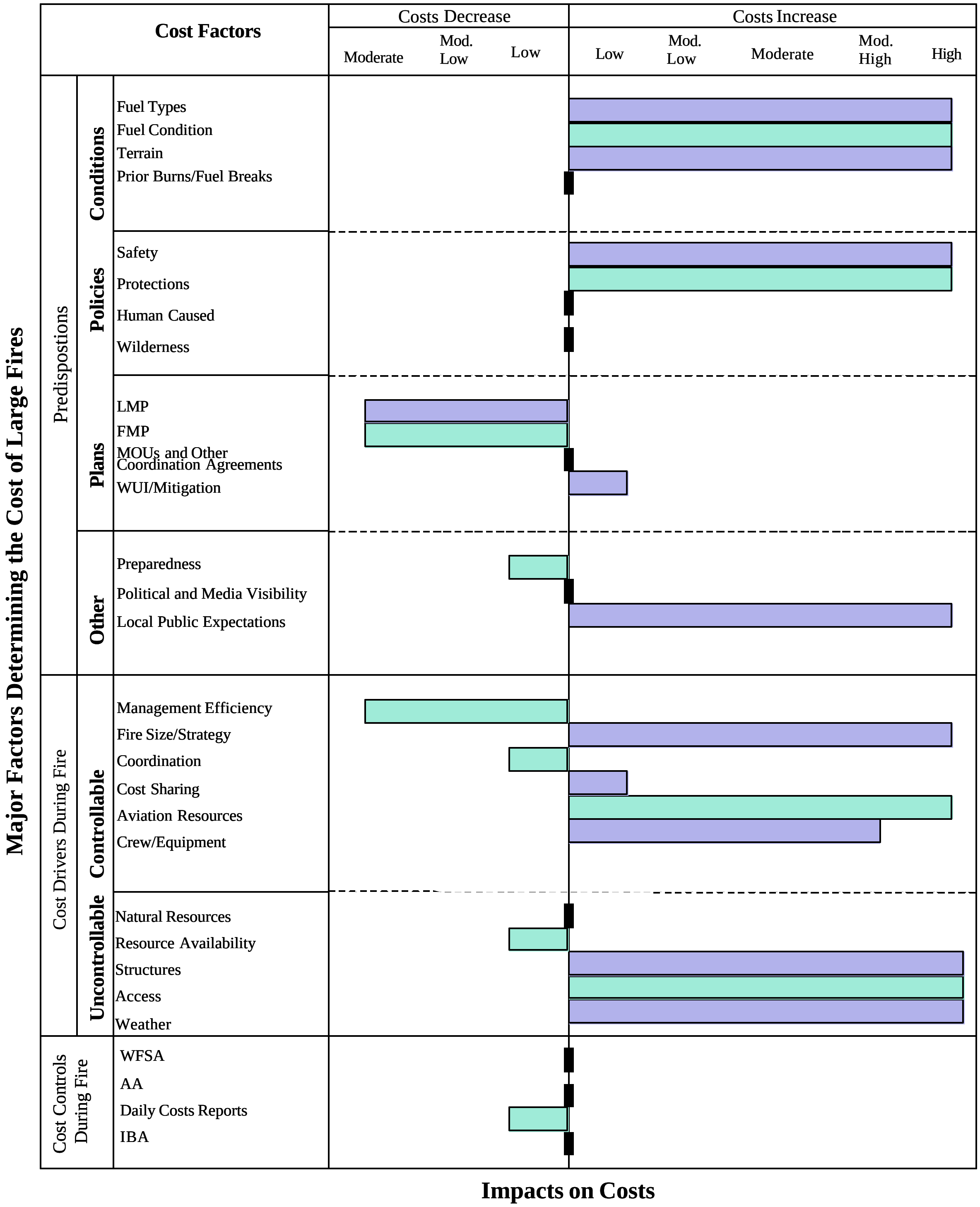
Dates	Activity
7/29-30/01 Days 1-2	The fire was reported at 12:45 p.m. Yellowstone assigned about 60 people who operated in conjunction with the Shoshone National Forest. Crews focused on structural fire protection at the Park's east entrance and evacuation of Park staff and their families. On day one, the Park closed its east entrance. The Type 3 incident commander (IC) did not place ground crews on the fire line during initial attack because of safety concerns created by the steep terrain, high winds, and extreme fire behavior. Winds also precluded effective use of aircraft. Weather was generally adverse, with wind gusts to 40 mph, high temperatures, and low humidity. When reported, the fire covered about 30 acres; by the end of day 2 it covered about 900 acres.
7/31/01 Day 3	A Type 1, incident management team (IMT) assumed management responsibility at 8 a.m. Crews were not totally assigned to line. This was a day for reconnaissance, safety, and mitigation measures to prepare for the next operational period. There was limited use of air resources. The weather was favorable, with cooler temperatures and some light rain. The fire covered about 1,000 acres and costs totaled about $250,000.
8/1-2/01 Days 4-5	Buildup of resources continued. Fire conditions prevented safe access to many portions of the fire. The southeast flank flared-up, throwing sparks across the ridgeline between Yellowstone and the Shoshone. Intense crowning occurred, with spotting up to ½ mile and some spot fires carrying onto the Shoshone. These spots posed a threat to the highway, east gate, and Pahaska Lodge, but could not safely be attacked on the ground. Trigger points were established for initiating evacuations. The Type 1 IC decided not to assign Type 2 crews to lines as a safety precaution because of the steep, rugged terrain and fire behavior. The weather was generally adverse—moderate winds, high temperatures, and low humidity. The fire covered about 2,800 acres and costs totaled about $1.6 million.
8/3-6/01 Days 6-9	No growth in the fire. On day six, four crews were sent to remote camps to remain on the fire for several days at a time. Many loads of retardant (about 63,000 gallons) were dropped from fixed wing air tankers. Heavy helicopters were used to support line firefighters, prevent any significant runs on unmanned stretches of line, and to cool spots in high rugged terrain northeast of the main fire perimeter. Crews made significant progress securing their lines. By day nine, crews had completed lines around the fire and were beginning line improvement and mop-up. Weather was generally favorable, with lower temperatures, humidity, and winds throughout much of the period. The fire was estimated to be about 35 percent contained. Fire costs totaled about $3.5 million.
8/7-8/01 Days 10-11	No growth in the fire. On day 10, the Park opened its east gate during limited periods. On day 11, evacuated Park staff and their families were allowed to return to their homes. The fire was estimated to be about 50 percent contained. Fire costs totaled about $4.3 million.
8/9-10/01 Days 12-14	No growth in the fire. Crews had the entire fire perimeter lined or cold trailed, and infrared devices were being used to identify and address hot spots. Rehab work was begun. On day 14, the structure protection group was demobilized. The fire was estimated to be about 75 percent contained. Fire costs totaled about $5.7 million
8/11-13/01 Days 15-17	The IMT designated the fire contained on day 15. Remaining work for the Type 1 team focused on continuing mop-up operations, demobilizing resources, and preparing a transition plan to return the incident back to the Park and its local Type 3 IMT. Fire costs totaled about $6.3 million.

COST OVERVIEW

Many factors affected the costs of the Arthur Fire. Some, like the weather, topography, and the presence of private structures, predisposed the fire to be costly regardless of fire managers' efforts. Others, such as readiness levels, planning, and management philosophy affected costs by influencing fire suppression strategies and tactics, and these factors are subject to management control. Likewise, costs are affected by the controls and systems that an IMT uses to manage its complex operations and these are largely independent of the IMT's suppression strategies and tactics. The costs of the Arthur Fire, as generalized in the chart below, appeared to have been driven in large measure by conditions and other matters largely outside management control. In those areas where managers had better control—such as planning, preparedness, and the application of management tools—Park and IMT managers tended to act in ways that moderated costs.

Figure F-3. Generalized Relative Influences of Various Factors on the Cost of a Wildland Fire*

ARTHUR FIRE, Yellowstone National Park, WY, 7/29/01 – 8/13/01



* The relative cost impacts of any given factor on a particular fire were judged qualitatively by the site visit team sometimes in consultation with personnel involved in fighting the fire. Some factors had different impacts during different stages of the fire. The case study write-up should be consulted for a more detailed description of each factor.

PRE-EXISTING CONDITIONS THAT AFFECTED THE COST OF THE FIRE

The Arthur Fire occurred early in the fire season and the Park was at a high state of preparedness. Despite the Park's level of readiness, the fire was destined to be a costly, aggressive suppression effort because of the high winds, heavy fuel loads, topography, risks to private structures, and its significant and immediate adverse economic impacts on the local economy. The provisions in the fire management plan (FMP) that allow the Park to manage wildland fires for resource purposes using less aggressive suppression tactics could not be used due to these conditions.

These pre-existing conditions drove costs by increasing the intensity of the fire, requiring that it be kept to minimum size, and significantly constraining the fire-fighting options available to the IMT. Table F-4 summarizes the Arthur Fire's resulting cost structure.

Table F-4. Arthur Fire Cost Summary[10]

	Costs	Percent
Aircraft	$2,120,672	36%
Personnel	1,220,095	21%
Crews	1,164,160	20%
Camp Support	720,712	12%
Equipment	471,146	8%
Supplies	211,600	4%
Total Costs	**$5,908,385**	

Fire Management Plan

The fire management policy for the Park's first 100 years was one of total fire suppression. In the early 1970s, NPS changed its fire suppression policies to more closely mimic nature by allowing the use of lightning-caused fire in the management of its parks and only requiring full suppression on human-caused fires. In 1972, Yellowstone adopted its first natural FMP, which designated a few backcountry areas as fire zones where lightning fires would be allowed to burn for ecological reasons. The current FMP designates most of the Park's areas as natural fire zones except those areas where fire could endanger people, property, or resource values, or those near common boundaries with national forests.[11] Consequently, in most of the Park, fire is allowed to play its ecological role under specified conditions based on factors such as current and forecasted

[10] Costs were obtained from ICARS data prepared by the IMT. The data inadvertently excluded the last several days of the IMT's assignment. Consequently, the reported total costs of $5.9 million are less than the IMT's estimated total costs of $6.3 million for the fire.

[11] The Park divides Yellowstone into three fire management zones: Suppression, Conditional, and Wildland Fire Use (Zones) In the Suppression Zones, personal safety and protection of property is of primary importance. In the Conditional Zones, natural fires can be allowed to burn within certain prescriptions and safety conditions. In the Wildland Fire Use Zones, fire is allowed take its natural course.

weather and wind conditions, fuel moisture levels, site location, and sufficient resources to safely oversee the fire. The Park has a performance goal to allow over 90 percent of its lightning-caused fires to remain natural, with monitoring and appropriate readiness but no active suppression.

The FMP provides criteria for determining whether the Park will suppress a fire or allow it to burn naturally. Applying the FMP criteria required full suppression from the outset on the Arthur Fire for several reasons: it occurred in a high fuel area when weather was adverse; it would likely have expanded beyond Park boundaries; and, it threatened private structures. Fires with any one of these conditions require full suppression under the FMP.

During the Arthur Fire, the Park was managing three other wildland fires for resource purposes. As part of its wildland fire use strategy, the Park uses interagency fire use management teams, which are specially trained for these purposes. One of the fires, the Sulphur, burned a total of 3,750 acres before fall snows extinguished it on November 12, 2001.

Fuels, Weather, and Topography are Dominant Cost Factors

Heavy fuels combined with low moisture levels added to the adverse burning conditions that produce large fires. Heavy fuels comprised between 80 to 90 percent of the area within the fire perimeter. The fire started in a mixed conifer stand composed of subalpine fir and lodgepole pine with moderate to heavy loadings of downed fuels. This fuel type readily leads to torching and crowning with rapid spread rates. Bores taken from similar stands near the Arthur Fire showed the lodgepole pine was over 200 years old. Due to a beetle infestation, the stand included many dead trees.

Precipitation amounts for the year were below normal. Some areas had received only about 50% of the normal snow pack from the prior winter. It was the third year of below-normal precipitation. This resulted in fuel moistures in the 12-14 percent range for the larger fuels (referred to as 1,000-hour fuels). These fuel moisture ranges were dry for the time of year and elevation. With moisture levels at or below 13 percent in Yellowstone, lightning ignitions quickly result in observable smoke columns and fires are likely to spread.[12] Low precipitation amounts also led to dry tree crowns, making them more vulnerable to torching and crowning. The fire began following about two weeks without measurable precipitation.

The Ink Spot Fire, a three-acre human-caused fire that occurred in Yellowstone several days before the Arthur Fire (on July 26), provided a prelude to the difficult fuel conditions Arthur would pose. The Park contained the Ink Spot fire quickly, but the organic material on the forest surface, referred to as duff, was abnormally dry and very difficult to extinguish. There was persistent burning and a rapid rate of spread. These fuel conditions influenced early decisions on the Arthur Fire to use aggressive tactics and order a Type 1 team.

High winds also adversely affected the fire. Strong southwest winds pushed the fire to the northeast on July 29. Wind speeds were reported to he steady at 15-20 mph with gusts of 30—40 mph. These strong winds continued for several days after the start of the fire. At the same

[12] Renkin and Despain.

time, temperatures were high, in the 70s and 80s, and humidity low—between 10-20 percent. With this combination of factors, fires climb ladder fuels more easily, resulting in torching and crowning. Spot fires start more readily with ignition potential being very high.

Weather conditions moderated after August 2nd, characterized by lighter winds, cooler temperatures, and higher humidity. At this point, the progression of the fire essentially stopped after having burned about 2,800 acres. Thunderstorms came through the area, dropping up to .10 inch on the night of August 4th and .05 inch on the night of August 8th. The moisture further aided in suppression efforts.

The high altitude, steep slopes, and lack of barriers (such as roads and other manmade or natural fire breaks) within the fire's perimeter, limited suppression options and added significantly to its suppression costs. Much of the fire area included steep terrain (60-70 percent slopes). The elevations where the Arthur Fire burned ran from 6,951 feet at the East Entrance Station to 10,353 feet at the summit of Canfield Peak, the high point where the fire crested the ridge and burned 15 acres onto the Shoshone National Forest. The total elevation gain was 3,402 feet. Deep drainage areas ran off the mountain parallel to the prevailing winds, providing an avenue for the winds to push the fire northeast toward a 30-40 mile expanse of old-growth forest and the private residences and properties on the Shoshone National Forest. The drainage also runs parallel to the prevailing winds in the area.

In these circumstances, containing the fire within Park boundaries required aircraft to support ground crews. Constructing fire lines in such areas was slow and shuttling crews required the use of helicopters. Holding lines and preparing areas to begin constructing lines also required significant use of helicopters for water drops. Because of the altitude, heavy Type 1 helicopters were needed for this purpose, which accounted for over half of the total aircraft operations costs, shown in Table F-5.

Table F-5. Arthur Aviation Costs

Heavy helicopters	$1, 382,344
Medium helicopters	262,302
Air Tankers	174,259
Light Helicopters	129,246
Fixed Wing Aircraft	99,146
Other Helicopters	73,374
Total Aircraft Costs	$2,120,672

Preparedness

Initial attack resources were at full strength before the fire occurred. At the time the Park received notice of the fire, the Park's fire management officer (FMO), assistant FMO, and its acting superintendent were available to plan and oversee the suppression effort. The Park's wildland fire management staff is relatively small, but the Park has a substantial number of employees who are red carded and also has a Type 3 IMT. The Park has exclusive use of a Type 3 helicopter and also has a structural fire department (with two full time employees and Park service volunteers who are qualified for structural fire fighting).[13] The wildland and structural fire units are located in adjoining offices and they work collaboratively as a cohesive fire and emergency response unit. Also, nationally available resources are located just outside the Park—a smokejumper unit, an air tanker unit, and a fire use management team with which the fire units cooperate.

The Park has mutual aid agreements with the volunteer fire districts (VFDs) in its area. In the Park County District, all VFD firefighters have red cards issued through the state. They also receive structural training using state or federal standards. The relationships between the Park and its local cooperators—the Shoshone National Forest and Park County Volunteer Fire Department—functioned effectively.

Fuels Reduction Measures

There are a number of areas in the Park where risks of fire and values at risk are high enough to warrant preemptive measures to reduce fuel loads by thinning or prescribed burning. There is internal debate within the Park, however, over whether and how this should be accomplished. The effect has been a temporary stalemate—lasting over the past several years—where no substantial fuels reduction actions have been undertaken. This problem is still being worked through, but it is useful to illustrate the difficulties that agencies will likely encounter throughout the federal government as the agencies attempt to become more proactive with fuel treatment programs.

Fuels treatment projects recommended in 1998, which included thinning and/or prescribed burning in the area affected by the Arthur Fire and nine other areas identified as high fire risks, were never authorized by the Park acting superintendent and never undertaken. Several factors have contributed to this lack of fuels treatment activity since that time:

The Yellowstone Center for Resources (YCR), established in the early 1990s, is responsible for science and research at the Park, and there are questions about fire management that YCR raised that are still being worked through. For example, YCR staff raised questions about the effectiveness of the proposed treatments, the effects of treatments on both natural and cultural resources, compliance needs, and the necessity of some of the larger proposed prescribed fires (the largest proposal was to burn 8,000 acres). Discussions were ongoing until the Cerro Grande Fire; after that, discussions about prescribed fire were tabled until the summer of 2002.

NPS Director Order #12, issued in January 2001, requires more stringent environmental reviews than in the past for any projects that impact resources. While the full implications of the Order are still being debated, the near term effect at Yellowstone is to require environmental assessments (EAs) on all proposed fuels treatment projects. (Currently planned projects awaiting EAs are all considered to be modest, e.g., thinning trees around historic cabins).

Since the Cerro Grande Fire, DOI requirements for undertaking prescribed burns have made many in the fire community reluctant to use the technique.

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[13] The Park has exclusive jurisdiction for protecting structures within park boundaries but maintains mutual aid agreements to receive and provide assistance from surrounding communities.

KEY MANAGEMENT DECISIONS AND FACTORS AFFECTING COSTS OF THE FIRE

The Arthur Fire occurred when fire activity was low in the Park and nationwide. The availability of firefighting resources had a generally positive influence on containing the fire within the Park's boundaries and, therefore, avoiding additional suppression costs. The relationships between the Park and its local cooperators—the Shoshone National Forest and Park County Volunteer Fire Department—functioned effectively. Senior Park management involvement was substantial and supportive, leading to thorough preparation for the Type 1 IMT's arrival. Moreover, the Park's fire management team and the Type 1 IC had previous working relationships and were very knowledgeable of each others' operational practices as well as the unique characteristics of the Park's terrain and fuel types. This made transitions from the Park to the IMT and back essentially seamless and less costly than would normally have been expected.

Initial Attack

Initial attack resources were at full strength before the fire occurred. The assistant FMO, who is a Type 3 IC, was responsible for initial attack on the fire. On day one, after the FMO completed a reconnaissance flight over the fire, the initial attack team obtained the acting superintendent's approval to close the Park's east gate and impose flight restrictions in the airspace over the area. Both actions were viewed as essential to safely support the aggressive suppression strategy they planned, but were also controversial. Because there is only one road from Cody into the Park at the east gate, the closure had a major impact on the local economy's tourist revenues and other Park-related businesses. Moreover, the Sylvan Pass is the lowest point in the mountain chain for 100 miles and the flight restrictions closed the pass to private air traffic. Small aircraft cannot get over the mountains in that area, except through the pass, so local businesses depending on small aircraft were also adversely affected.

Because of the terrain and weather, the assistant FMO and FMO did not use ground crews during initial attack. Standard practice would have been to locate a helicopter landing spot near the heel of the fire in a safe area and call dispatch for shuttles of local crews. Firefighter safety precluded such actions. The FMO considered using smokejumpers, but winds were too high. Air tankers made a couple of drops, but then it got too windy for them as well. Given the fuels and weather situation, the FMO and assistant FMO did not believe that they could accomplish meaningful fire objectives, and personnel safety was paramount.

Instead of conducting a traditional initial attack, Park management in conjunction with the Shoshone FMO focused on preparing for the Type I team and setting up their structure protection. More specifically:

- The FMO placed the initial resource orders to support the Type 1 team. The FMO was a qualified Type 2 team IC and also a Type 1 team Operations Section Chief and, therefore, had the knowledge and experience to anticipate requirements. He also expected that a specific team, the Northern Rockies IMT, would be assigned to the fire. The FMO served as Operations Section Chief on that team so he was intimately familiar with it. With that as a backdrop, the FMO ordered five Type 1, six Type 2, and five Type 3 helicopters and 12 Type I crews. Arthur was an early season fire, so national resources were still generally available. Also, a large nearby Forest Service fire, (the Green Knoll Fire) was winding down and releasing resources in the area. The FMO received what he requested, plus several additional Type I crews.
- Yellowstone crews set up the incident base; established communications (extra phones in the base facilities and repeaters to minimize radio dead spots); and activated and prepared helicopter-landing spots.
- The Yellowstone Fire Chief and the Park County Fire Protection District jointly established structural fire protection around the east gate, and the Fire Chief placed resource orders for structural protection. On the first day, the Park County VFDs stayed in the Park setting up a protection system for the NPS structures at the east entrance. By noon on the second day, the fire took off again and Park County assigned five trucks, a county dozer, and a lowboy to structure protection in Pahaska and the Shoshone Lodge. They took initial actions to reduce the fuels around properties and lay out water lines and sprinklers.

Late in the evening on July 29, the Park completed its WFSA. The document was thoughtfully prepared by the Yellowstone and Shoshone FMOs, who sought input from the Yellowstone assistant FMO, deputy chief ranger, and other Park staff who are on national IMTs. The Yellowstone FMO, who is a fire behavior analyst, did a quick calculation that showed it would take two days before the fire would get to the east entrance. He expected it would take 7-10 days to contain the fire if they obtained the resources ordered.

The WFSA included three alternatives: full suppression, protection of high value areas, and modified suppression (using fewer resources and natural boundaries to keep suppression costs relatively low). Preparing a full range of options for the acting superintendent's consideration was in keeping with Park policy to intervene as little as possible with the natural processes of fire. Confinement or containment options that are less aggressive than full suppression when safety or property is not at risk are always on the table.[14] However, those options were not considered appropriate given the circumstances of the Arthur Fire. Both the FMO and assistant FMO viewed full suppression as the likely alternative from the outset.

[14] Yellowstone uses three suppression strategies. Confinement strategies allow a fire to burn naturally as long as it remains or is predicted to remain within predetermined natural boundaries until it is out. Containment strategies use natural or constructed barriers to stop the fires spread. The control strategy involves aggressive suppression, such as that used in the Arthur fire, to establish fire lines around a fire to halt its spread and to extinguish all hotspots until it is out.

Incident Management Team Phase

At 8:10 a.m. on August 30th, the FMO called dispatch and officially ordered a Type 1 IMT.[15] The Park was assigned the Northern Rockies IMT, as expected, and the team arrived by early in the afternoon of the 30th. Because this was expected, Yellowstone fire management staff began consulting with the team's IC and other IMT command staff on the 29th.

By the morning of the 30th, the FMO was coordinating tactical decisions with IMT command staff. As with the FMO, the assistant FMO also served as a member of the Northern Rockies team in previous fire seasons. In essence, the Yellowstone fire staff and IMT functioned like a single unit because of their prior history working together. This relationship was enhanced because the Type 1 IC also very familiar with Yellowstone. He was a former district ranger and deputy chief ranger at Yellowstone, and had extensive fire experience at that Park. In addition, all three—the IC, FMO, and assistant FMO—were involved in the 1988 Yellowstone fires. Consequently, learning curve and ramp-up issues common to transitions were avoided.

On the morning of the 31st, the Park's acting superintendent the forest supervisor of the Shoshone National Forest met with the IC, who briefed them, and they both signed the delegation granting the IC authority to manage the fire. The delegation tied in closely with the WFSA and provided the IC with the authorities needed to meet Park objectives. Senior Park managers—either the acting superintendent or the deputy chief ranger—participated in the morning and evening briefings with the IMT. The acting superintendent also had significant experience with fire as the former superintendent of the Saguaro National Park, Arizona, where lightning fires occur frequently in close proximity to urban areas.

The IC and acting superintendent collaborated in keeping the public and local cooperators informed and engaged in the operation. For example, they had several public meetings with local residents and business people that helped diffuse the controversy surrounding the closure of the Park's east gate and air space restrictions. Moreover, local cooperators felt they were effectively used and appropriately involved in decisions impacting their interests.

In addition to unique knowledge of Yellowstone and its fire management practices, the team brought considerable expertise with them to assist in decision making. The team included a fire behavior analyst, an incident meteorologist, computer specialist, and a GIS specialist. As a result, the team had a full range of decision-making tools and practitioners readily available to use as required. The team also included additional safety officers to help minimize the risks associated with steep terrain and grizzly bear habitat, and a fully staffed aviation function to manage the substantial aircraft operation.

Mop-up operations reverted directly from the Type 1 team to the Park avoiding what would typically have involved an intermediate transition to a Type 2 or 3 team. The availability of a Type 3 Park team (under the assistant FMO's direction) made this possible.

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[15] Under the rotation policies for dispatching IMTs, the Northern Rockies IMT became eligible for dispatch at 8:00 a.m.

Business Management

Cost issues were not at the forefront of decision making by the IMT. Nevertheless, operating efficiently seems to be part of the corporate culture and a point of pride. The WFSA process forces a daily reevaluation of likely costs, and is one vehicle that brings the IC, agency administrator, and finance section chief together each day to consider costs in relation to strategy. The IC considered the WFSA important for this reason, and also because its stipulated objectives drive fire suppression strategy and thus costs. Costs also factor prominently (though not exclusively) into demobilization decisions, and all things being equal, attempts are made to demobilize the most expensive equipment, such as aircraft, first.

The Arthur Fire brought close to 1,000 people and millions of dollars of equipment together for a two-week project in a remote location. Automated management systems and specialized business expertise are important in these kinds of situations to keep track of the many details that could give rise to inefficiencies and other unnecessary costs.

The Arthur Fire was the first incident where this IMT used the complete I-Suite package to keep track of resources, prepare invoices, and produce daily management reports. I-Suite allowed the IMT to automate time, resource, and cost information, and to automatically share the data between its various databases to print out time sheets, equipment invoices, and management reports. A team member with computer expertise accomplished some software debugging and other work-arounds to enable this. The Finance Section Chief believes that I-Suite provided the team with superior data management and billing tools and she continued to build team expertise with the software by using it on all incidents since Arthur.

The Finance Section Chief illustrated the difficulties the teams face in implementing the software and the personal dedication that finance chiefs must have to overcome the learning curve, poor software documentation, and lack of national direction regarding business software. Nevertheless, this software allowed the team to have real time information on the usage and costs of all resources on site; the capability to analyze and project costs of current and alternative strategies; and management reports that the IMT planners and operations personnel need to keep tabs on resources across the various units on the fire.

The IMT also disseminated its daily Incident Status Summary reports (referred to as 209's) using the Internet. The 209s are a key vehicle that IMTs use to advise dispatch units throughout the country, and state, county, and federal program administrators and legislators with current information regarding the fire. Using the Internet provided a means for prompt and thorough dissemination of the reports.

The use of an incident business advisor (IBA) on the Arthur Fire also enhanced the IMT's attention to costs and adherence to policies, procedures, and internal controls. IBAs are a bridge between the administrative organization and the IMT. On Arthur, the IBA reported directly to the acting superintendent, who requested that the function be staffed. But the IBA believed that it was equally important to coordinate with the IC. His emphasis was on helping ensure appropriate attention was given to good business management practices on the incident.

CONCLUSIONS/LESSONS LEARNED

Many factors, which for the most part are not subject to management control, predisposed the Arthur Fire to be costly. That notwithstanding, the knowledge and experience of the Park's fire management staff, coupled with the low fire activity at the time of the Arthur Fire, resulted in a high level of expertise and resource availability that is not generally present on land units throughout the fire season. Park and IMT management acted to moderate costs through their planning, readiness, and effective application of decision and management oversight tools. Moreover, the mutually supportive relationship that existed between the Park's senior management, fire staff, IMT, and community cooperators was an overarching factor that tended to minimize challenges normally associated with integrating the diverse resources needed to fight large fires.

The Park's general policy to let fires burn naturally when possible provided a unique perspective from which to view its decision processes for suppressing the Arthur Fire. While the policy itself may not be suitable for other agencies because of their differing missions and property ownership characteristics, the perspective that this fire-use policy provided to decision makers at Yellowstone offers some lessons that may be applicable to other agencies and generalized to their decision-making processes. That perspective derives from two sources. First, even for fires that require aggressive suppression, the Park's process of developing suppression strategies includes (at some level) the question, "What are the minimum actions we can take to suppress this fire in a safe and environmentally sound manner?" Second, the Park's fire management office has the knowledge, policies, and senior Park management support to select the least invasive suppression alternative justified on any naturally occurring fire.

With this combination of factors present, the Park has shown that it can make even politically difficult suppression decisions (such as closing the east gate Park entrance, restricting air space over the fire, and not using ground forces during initial attack, as they did on Arthur, or undertaking no suppression actions as they did on other fires last year). In short, by the nature of its mission and fire management philosophy, Yellowstone has incentives that tend to minimize its wildland suppression actions.

The Park's mission and philosophy created the mindset that Park officials bring to wildland fire decision making, but that mindset is not dependent on either NPS' mission or its philosophy. The mindset could just as easily be grounded in the current national fire policy—that is, when addressing a particular wildland fire, use only the resources that are commensurate with the magnitude of the risks and values being protected.

The Park offers another lesson regarding what other agencies may face as they become more proactive in developing and implementing fuels treatment strategies. Issues surrounding fuels treatments are not only externally generated, but can originate within the land management units. Differences of opinion among a land unit's fire managers and resource managers must be addressed to allow land units to move forward in a timely fashion with needed fuels treatment programs.

Box F-2. Contacts-Arthur Fire

Johann Anderson, *Fire Machine Battlion Chief, NPS, Yellowstone National Park Fire Department, WY*
Mark Davison, *Contracting Officer, NPS, Yellowstone National Park, WY*
Clint Dawson, *FMO, Shoshone National Forest, Cody, WY*
Mona Divine, *Deputy Chief Ranger, NPS, Yellowstone National Park, WY*
Steve Frye, *(Type I IMT IC), Chief Park Ranger, NPS, Glacier National Park, West Glacier, MT*
Wendy H. Hafer, *Helitack Foreman, NPS, Yellowstone National Park, WY*
Bill E. Hitt, *Training Officer, Park County Fire Protection District #2, WY*
Andy Mitchell, *Wildfire Specialist, NPS, Yellowstone National Park, WY*
Bertalee Mottern, *Finance Section Chief (Steve Frye's Team), USDA Forest Service, ID*
Phil Perkins, *Fire Management Officer, NPS, Yellowstone National Park, WY*
Mike Ramos, *IBA (Steve Frye's Team), USDA Forest Service (retired), MT*
Daniel Reinhart, *Management Biologist/Resource Management Operations Coordinator, Yellowstone National Park, WY*
Roy Renkin, *Vegetation Specialist, Yellowstone Center of Resources, NPS, Yellowstone National Park, WY*
Frank Walker, *Assistant Superintendent, NPS, Yellowstone National Park, WY*
Gaylen Yeates, *Dispatch Center Manager, USDA Forest Service, Gallatin National Forest, MT*

SHEEP FIRE CASE STUDY REPORT
ELKO NEVADA FIELD OFFICE, BUREAU OF LAND MANAGEMENT
AUGUST 9 - AUGUST 18, 2001

The Sheep Complex consisted of the Sheep and Coyote Fires, both started by lightning. The Sheep Fire started August 9, 2001, 20 miles north of Battle Mountain, Nevada and the Coyote Fire started on August 12, 2001, approximately 25 miles north of Carlin, Nevada. Firefighters controlled both fires six days after they ignited. The Sheep Fire was declared controlled on August 14, 2001 and the Coyote Fire was controlled August 18, 2001. The Sheep Fire burned 83,673 acres and cost approximately $2.2 million to suppress; about $26 an acre. The Coyote Fire burned 11,675 acres and cost approximately $17 an acre per acre to control. Although the Coyote Fire was part of this complex, it was not part of the Academy field team's review. The remainder of this report deals primarily with the Sheep Fire.

In summary, the Academy field team reviewing this fire found that:

High temperatures, low humidity, high winds, extremely dry fuels, rough terrain, and competition for resources, were the primary factors that caused this rangeland fire to spread beyond the BLM land management unit where it started and to become costly.

There were no fundamental problems with the management, strategy, or tactics used on the fire. However, while the fire would have been difficult to suppress quickly under the best of circumstances, the dispatch problems experienced in the first critical hours of the fire may have affected the land unit's chances of containing the fire during initial attack and early in its development.

Based on the Academy field team's review of available records and interviews with local officials, there were no major questionable or inappropriate costs associated with this fire. However, if the IMT had elected to use a backfire strategy, suppression and rehabilitation costs could have been reduced.

The BLM officials' decision not to pursue a cost-share agreement with Lander County put a disproportionate burden on the federal government to pay for the costs to suppress this fire.

This case study report describes how the Sheep Fire evolved and was managed, how costs were monitored, and what principal factors drove the fire's costs. It assesses whether (1) agency policies were substantially followed in the decision making related to these incidents, and (2) firefighting costs could have been reduced without reducing safety or firefighting effectiveness. It also identifies lessons learned that can be used to improve the cost-effectiveness of firefighting in the future.

BRIEF FIRE CHRONOLOGY

The Sheep Fire was discovered at about 5:00 p.m. on August 9, 2001. The Incident Commander (IC) decided not to staff the fire that night because of concerns for firefighter safety. Communication problems in the dispatch office delayed the ordering of initial attack resources to the fire during the first operational period.

On the morning of August 10, a crew of eight smokejumpers, one heavy air tanker and a couple of single engine air tankers (SEATS)[16] worked the fire. Around 9 a.m., the fire size was about 600 acres, and it had three distinct heads caused by shifting winds. Air resources were not available, and the initial attack resources assigned to the fire were not effective in any suppression tactics from their time of arrival. Very limited access, steep narrow canyons, and 10-foot high sagebrush contributed to difficult control operations. At about 2 p.m., a strong westerly wind started blowing with gusts up to 30 mph, making the fire virtually unstoppable. At about 2:30 p.m. the fire made a significant run reaching close to 2,000 acres. Based on the complexity of the situation, the Field Office ordered a Type 2 Incident Management Team (IMT).

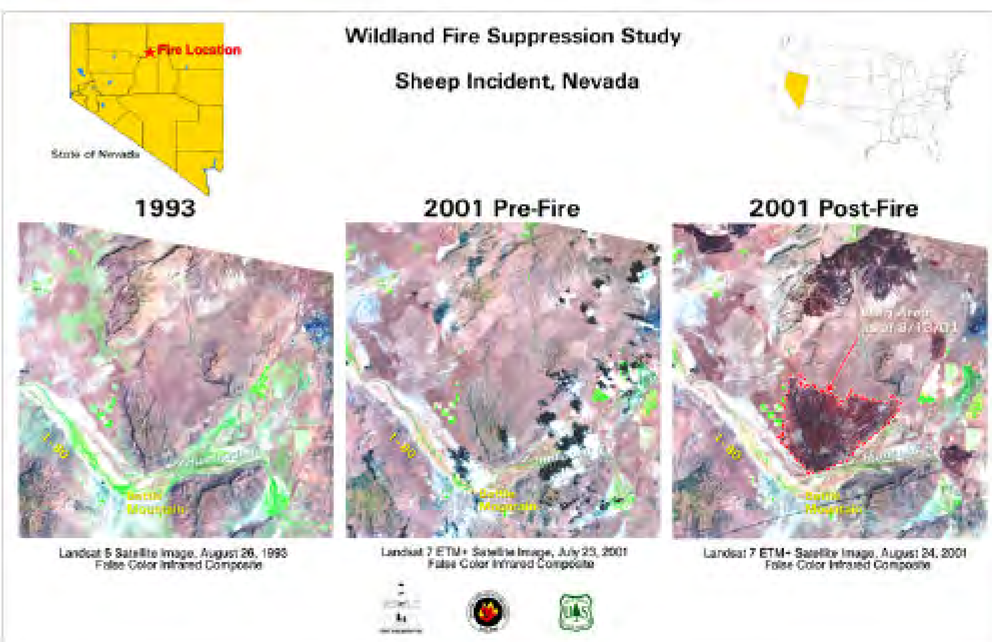
A Type 2 IMT assumed management of the fire at about 6 p.m. on August 11, 2001 after spending the majority of the day in transition with the initial action personnel. By this time, the fire had burned about 30,000 acres. Two days later, the fire was declared contained. A summary of the fire's chronology is included in Table F-6.

[16] A SEAT is a single engine air tanker with a liquid load capacity of approximately 800 gallons of retardant. These aircraft are commonly used as crop dusting planes when not assigned to fires.

Table F-6. Sheep Fire Chronology

Date	Activity
8/9/01	2 p.m.: Battle Mountain BLM Field Office discovered that communications with its dispatch center was not operational.
8/9/01	Approximately 5:00 p.m.: The Sheep Fire was discovered 20 miles north of Battle Mountain, Nevada.
8/9/01	8:00 p.m.: Type 3 IC arrives on scene. Initial action resources were ineffective and returned to Battle Mountain.
8/10/01	, 8:40 a.m.: SEAT arrived on the fire with a load of retardant.
8/10/01	9:00 a.m.: Smokejumpers (8 personnel) arrived on the ground at the fire scene.
8/10/01	2:30 p.m.: The fire made a major run due to strong gusty winds from a passing thunderstorm cell.
8/10/01	7:00 p.m.: Dispatching switched to the Elko Interagency Dispatch Center.
8/11/01	2:00 a.m.: Battle Mountain volunteer fire department (VFD) used for structural protection of two chemical plants on the south side of the fire.
8/11/01	4:45 a.m.: Structural threats are secured; Battle Mountain volunteers released.
8/11/01	6:00 p.m.: Type 2 IMT assumed management of the fire.
8/12/01	4:00 p.m.: Coyote Fire discovered 25 miles north of Carlin, Nevada.
8/13/01	5:00 p.m.: The Type 2 IMT assumed management of Coyote Fire (Sheep Complex).
8/13/01	6:00 p.m.: Sheep Fire contained at 82,000 acres.
8/14/01	Sheep Fire is controlled.
8/18/01	6:00 p.m.: Coyote Fire contained at 11,625 acres and management turned over to a Type 3 IMT.

Figure F-4. Sheep Fire Map



PRECONDITIONS FOR THE FIRE

Features of the Land

The Sheep Fire occurred within the boundaries of the lands managed by BLM's Elko Field Office in northern Nevada. Typical of much BLM land, the area affected by the fire is a checkerboard of ownerships, with approximately equal distribution between BLM and private lands. The land (both public and private) has been predominantly used for cattle and sheep grazing since the mid-1800s. However, ranching now accounts for only about three percent of the economy in this area as outdoor recreation and mining uses share the land. Within this BLM district, there are 220 grazing allotments held by 180 permittees. An area on the east side of the fire-affected area is designated as crucial winter deer and big horn sheep habitat.

Geographic Conditions

The Sheep Fire burned in the Sheep Creek Range of mountains, which run north and south. The fire burned to the tops of the range with the highest elevations at approximately 3,000 feet. The topography of the mountains is mostly rolling, with a few sharp rocky escarpments on the lower elevations. The few roads in the area were overgrown with a bed of fine dirt, which became impassable after relatively little use.

Four years of drought conditions in the northern Nevada desert created rapid burning conditions at the time of the Sheep Fire. The primary fuels in the fire-affected area included sagebrush and cheat grass, both of which have a high rate of spread (75 to 105 chains/hour[17]) without the presence of winds. Normal flame lengths vary from 12 to 20 feet making attack with hand tools and most mechanized equipment ineffective. The live fuel moisture content of the fuels in the area was below 80 percent at the time of the fire. High temperatures, gusty winds, and low humidity with little humidity recovery at night cause major fire runs in these fuel types.

Plans/Policies

Based on the Elko Field Office's current fire management plan (FMP), the Sheep Fire occurred in a fire management zone, or polygon, [18] designated for moderate suppression. However, the two fire seasons prior to the summer of 2001 had been radically more severe than historic norms in the number of fires and acres burned. In 21 years of fire history (1980 - 2001), 61 percent of the acreage burned occurred from 1999 to 2001. Fifteen of the 20 largest fires also occurred during this same time period. Of the 7.3 million acres managed by the Elko Field Office, 1.3 million acres had burned in the prior 3 years. Seventy-five of the 180 permittees had had part or all of their allotments closed because of fire damage. As such, the fire management staff was following a much more aggressive suppression strategy than the FMP specified.

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[17] A chain is a unit of measure used to describe wildland fire rates of spread. A chain is equal to 66 feet.
[18] Polygons are geographical areas containing similar fuel types and management objectives for identified areas in the Fire Management Planning area.

The Elko Field Office is in the process of amending its 1986 Resource Management Plan and FMP to accommodate needed changes to its fire management program. They have redefined the polygons that describe how fire can be used on the land. While they have now identified areas of D polygons, where fire use is allowed, in the revised plan they are very limited and specific conditions must exist before BLM will use a wildland fire for resource management purposes. In general, the new FMP will have a more aggressive fire suppression focus. A review of the public comment letters on the revised Resource Management Plan shows that local residents are in agreement with increased and more aggressive suppression proposals provided in the plan. A Northeast Nevada Stewardship Group composed of local residents is being used as a planning board to assist in the modification of the FMP. These modifications look at all aspects of the land management planning, not just grazing.

The Nevada Department of Forestry (NDF) has statewide mutual-aid agreements with BLM and the Forest Service for fire protection. The agreements designate geographic ‘protection areas’ (or mutual-aid areas) across the state where each agency accepts initial attack responsibilities regardless of land ownership. Initial attack responsibilities are assigned to the agency best able to respond considering factors such as proximity of agency resources, local equipment availability, and ownership patterns. For example, areas around the City of Elko on the Interstate 80 corridor are predominantly private lands and structures, with some interspersed state and BLM lands. NDF has initial attack responsibility in this area. BLM’s Battle Mountain Field Office has initial attack responsibility for the area where the Sheep Fire ignited.

Counties within Nevada may choose to become a fire protection district. Counties electing this option must petition the state and contract with NDF for fire protection. In these instances, the state provides funding assistance for training and equipment and the counties pay for staffing. BLM and the Forest Service also provide training and assist with equipment through grants. Most districts have structure protection and wildland fire capabilities and can provide first response medical.

Cost-share agreements between BLM and NDF for large wildland fires are governed by the Great Basin Master agreement, which allows for suppression support across state boundaries. Parties to the agreement include Idaho, Nevada, Utah, and Oregon. Under the agreement, federal land management agencies and state foresters allow each other to cross boundaries to support wildland firefighting. The agreement also allows the agencies to enter local cooperative agreements in their own states. The agreement provides for cost sharing on an incident-by-incident basis. At some point after fires cross-jurisdictional boundaries and go beyond initial attack, NDF and BLM negotiate how to apportion costs. The master agreement does not specify a methodology for apportionment—it can be on the basis of acres or resources used. For example, the state may bill BLM for structure protection services if it responds to an incident in one of BLM’s protection areas.

About half of the acreage burned on the Sheep Fire was on private land in Lander County. The county had elected not to enter into an agreement with the State of Nevada for fire protection; therefore, it was not covered under the state’s cost-share agreement and was responsible for suppression costs within the county. BLM had an agreement with Lander County for initial action on fires, but the agreement had no mechanism for recovering costs from the county once the fire escaped initial attack.

LOCAL PREVENTION AND MITIGATION EFFORTS

The field office has begun some prevention and mitigation actions within the district. BLM has started green stripping and fuel break work around high-risk communities, but none of the projects were in the area of the Sheep Fire. The field office has taken advantage of national fire prevention teams who are brought in to increase fire safety awareness with local residents.

Preparedness

The Elko Field Office preparedness resources include 10 engines, 1 Type 3 helicopter, and funding for a Type 1 hotshot crew (from Alaska) for 2 summer months. The unit has a SEAT, an Air Attack Group Supervisor, a pilot, and a contract airplane. It also added 2 Type 3 fire engines in 2001 and increased the helicopter crew from 7 to 10. The Elko Field Office had additional resources staged locally because of other fire activity. By the time the 2001 fire season started, they were at or close to 200 percent MEL.

Based on fire activity starting in northern Nevada in July, the BLM State Office added “severity funding” for initial attack resources for the Battle Mountain Field Office (the initial action unit on the Sheep Fire). Resources included five engines, two dozers, an air tanker, one SEAT, and a Type 2 helicopter. During 1999-2001, Battle Mountain spent more than $1 million over MEL just for severity resources, not including national resources and air support.

Around July 4, 2001, there were about 60 fire starts in 2 days, and fires were spreading about 5,000 acres in a burning period. Due to the level of fire activity, BLM, the Forest Service and NDF formed a local multi-agency coordinating (MAC) group to prioritize fire actions and associated resource allocations. The MAC representatives work together often throughout the year and appeared to have a very good working relationship. As July progressed, fire occurrences increased. As August approached, lightning was coming through the area about every 3-4 days; the MAC began meeting twice a day.

KEY MANAGEMENT DECISIONS AND ACTIONS AFFECTING THE COST OF THE FIRE

Initial Attack

By the time the Sheep Fire ignited, there were many fires underway in the area, and despite the high level of preparedness in the area, competition for resources was high. Problems with the dispatch center’s communication system further delayed resource allocations to the fire. Dispatching for the Battle Mountain Field Office is handled by the Central Nevada Interagency Dispatch Center (CNIDC) in Winnemucca, NV. Radio communication difficulties made direct dispatch with the Field Office impossible. To fill the void, a Battle Mountain Field Office staff member was trying to fill resource orders temporarily. Three Type 4 engines, one water tender, and one dozer were dispatched for initial attack. But orders for additional resources and support personnel did not get placed or filled during the initial 12 to 16 hours of the fire. (Dispatching and resource ordering for the fire was transitioned from CNIDC to the Elko Interagency Dispatch Center at 7 p.m., August 10, which improved the efficiency of dispatch operations.)

By the time initial attack resources arrived on the scene, it was getting dark and personnel did not have good information on access into the fire area. In addition, the fire crews that arrived were nearing their maximum work hours for the day and were reluctant to push the rest-work ratio.[19] A local rancher met the initial attack forces near the base of the mountains where the fire was burning and told them the roads leading to the fire would not support the BLM engines and that the terrain was too dangerous to access. Around 8 p.m., a Type 3 IC arrived on the fire and assumed command. Because of concerns for firefighter safety, he decided not to staff the fire that first night. All resources returned to their base of operation for the night.

On the morning of the 10th, a crew of eight smokejumpers attacked the fire at about 9:00 a.m. Contrary to normal fire behavior, the fire had not laid down during the night.[20] When the jumpers arrived, the fire covered about 600 acres and had three distinct heads caused by shifting winds. The smokejumpers were supported by periodic aerial retardant delivery from a Type 1 air tanker and two SEATS. Drops from these aircraft were ineffective because of the limited amount of ground support the smokejumpers could provide. The smokejumpers were the only resource actually doing suppression work on the fire ground. Other equipment and resources were working on secondary actions away from the main body of the fire. By 1 p.m., the fire had grown to approximately 2,000 acres.

At mid-afternoon, the fire made a major run to the east carried by strong erratic winds from a passing thunderstorm. All equipment applications were ineffective, so new incoming resources were staged pending weather changes and the selection of a favorable location to anchor the fire.

The Battle Mountain VFD was used during the night of August 10th to assist local resources in structural protection (chemical plants). The NDF provided assistance with hand crews and other fire overhead support throughout the fire suppression activities.

The fire continued to grow throughout the night of the 10th. A Type 2 IMT was being released from another fire in northern Nevada and was available to assist on the Sheep Fire. The Elko FMO recommended to the Agency Administrator and the MAC Group that this team be deployed to the Sheep Fire as the fire's complexity was exceeding the capabilities of the assigned Type 3 IC and the Elko Field Office's ability to manage the fire.

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[19] Rest-work guidelines recommend that firefighter have one hour of rest for each two hours worked during any given day. Initial attack resources had started work in the morning and had worked 11 hours before the fire was discovered.

[20] Usually, cooler temperatures and humidity recovery occurs at night, causing fire growth to slow down.

The Delegation of Authority and WFSA

The Type 2 IMT was familiar with local burning conditions and the political considerations for the rangelands within the BLM protection areas. The Elko Field Office Manager has established a rotation among the principal staff for assuming Agency Administrator responsibility during large wildland fires. During the Sheep Fire, the Assistant Field Manager for Support Services was the Agency Administrator of record. The Agency Administrator and the FMO developed the WFSA and delegation of authority and participated in the transition to the Type 2 IMT. The Agency Administrator gave the team its delegation of authority and WFSA during a management transition briefing. The Type 2 IMT assumed command of the fire at 6:00 p.m., August 11, 2001.

The objectives outlined in the delegation included concern for firefighter and public safety, protection of wildlife and livestock forage, and minimizing burned acreage to reduce cheat grass spread and loss of sage grouse habitat. The WFSA contained two alternatives: direct attack and a combination of direct and indirect attack. The combined direct/indirect attack alternative was selected to minimize resource damage with the greatest cost effectiveness and maximize firefighter safety. It estimated a containment date of August 14 with less than 5,000 acres consumed and a suppression cost of under $500,000. Neither the acreage nor the cost objective was met. The team prepared a new WFSA on August 13 to place the Coyote Fire under the IMT's command. A combination of direct and indirect attack also was selected for the Coyote Fire

Incident Management Team Phase

Work on the Sheep Fire from the time of discovery until the Type 2 team take-over was negligible. When the Type 2 team assumed command, it essentially took on the initial attack role. Some areas on the fire's west and south sides had burned to a road and were being contained at this location, but spot fires continued to be a problem. The fire line was far from secure, and additional resources were needed to further secure the areas. Prevailing wind speeds were predicted between 5 and 15 mph but gusty and erratic winds associated with the passage of thunderstorms were present daily and dramatically affected rates of spread, perhaps as much as tenfold.

The risks to structures on this fire were minimal, with only a few isolated ranches and some industrial plants present. The local ranchers were more concerned with the loss of grazing lands than they were with their homes and other structures. The ranchers' strong concerns about losing more grazing lands influenced the IMT's strategy to use direct methods of control, constructing dozer lines, over indirect attack, using backfires from identified barriers[21]. Nothing in the delegation of authority from the Agency Administrator would have prohibited this indirect strategy, which would have burned 10,000 to 12,000 acres.

Suppression tactics also were somewhat limited because the historic California Trail and other cultural resources were in or adjacent to the area of the fire. Firefighters constructed dozer lines

[21] A barrier is any natural or man made break in fuel continuity that may be used as fire control lines without addition work to make the fire safe.

in an attempt to directly attack the fire in the areas where cultural resources were located. However, because of dry afternoon thunderstorms and associated wind patterns, the lines proved to be ineffective barriers for stopping the spread of the fire. They only added to rehabilitation efforts by requiring treatment once the fire was controlled.

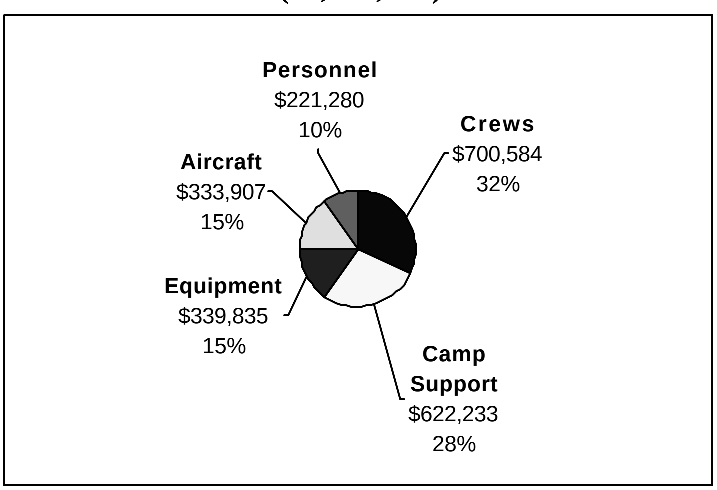
DATA RESOURCES, DECISION SUPPORT TOOLS, AND MANAGEMENT COST CONTROLS

The Elko Field Office has GIS capability, but is a one-person shop without adequate capability for updates and validation of data. Not all data were current for the fire-affected area. Some roads, buildings and mining areas had not been included in the Field Office database. This was a greater problem during the initial phases of the fire than it was once the IMT was in place. Basic mapping data were used as a basis for developing the team's daily incident action plans.

The IMT did not use I-Suite or ICARS to capture and track cost information on the fire. The Finance Section staff had not had much experience with the system and believed that data entry into the electronic systems was more time consuming than the manual, paper systems used traditionally by the team. The Field Office's administrative unit entered the cost data into ICARS system after the fire. These data entry costs are reflected in the total cost of the fire.

The chart below depicts the cost data that are included in ICARS for the Sheep Fire. It should be noted that some of the information might be inaccurate. The area most in question is aircraft costs. ICARS shows costs of $333,907 for one air tanker and one medium helicopter. However, the Academy field team's review revealed that additional SEATS were used, one Type 1 helicopter was used at least two days, four Type 2 helicopters were used for three days, and two Type 3 helicopters were used 3 days.

Figure F-5. Sheep Fire: Total Cost ($2,217,839)



The Agency Administrator ordered an Incident Business Advisor (IBA) to assist in cost monitoring. The IBA provided trigger points on costly applications of tools and equipment. The trigger points used consider high cost items like Type 1 helicopters; computers; cell phones; and idle, unassigned equipment. Because she had worked with this IMT in the past, she had confidence in their fiscal management of the fire.

Emergency Stabilization and Rehabilitation

Noxious weeds[22] and the spread of the seeds from one area to another are a major concern in northern Nevada. Washing vehicles, undercarriages, and tires has proven to be an effective method of controlling the spread of these weeds. Fire managers on the Sheep Fire used this additional clean up activity, which increased the daily suppression and rehabilitation costs for the fire.

Available cost information did not itemize the costs for rehabilitation efforts. Fire lines constructed by bulldozers and, in some cases, hand lines, disrupt the soils and require rehabilitation work to minimize erosion. These erosion control measures are chargeable to the suppression costs of the fire. The IMT's decision to use direct attack in an effort to address the local ranchers' concerns about the number of acres burned resulted in additional fire lines being constructed that were not effective in halting the fire's progress.

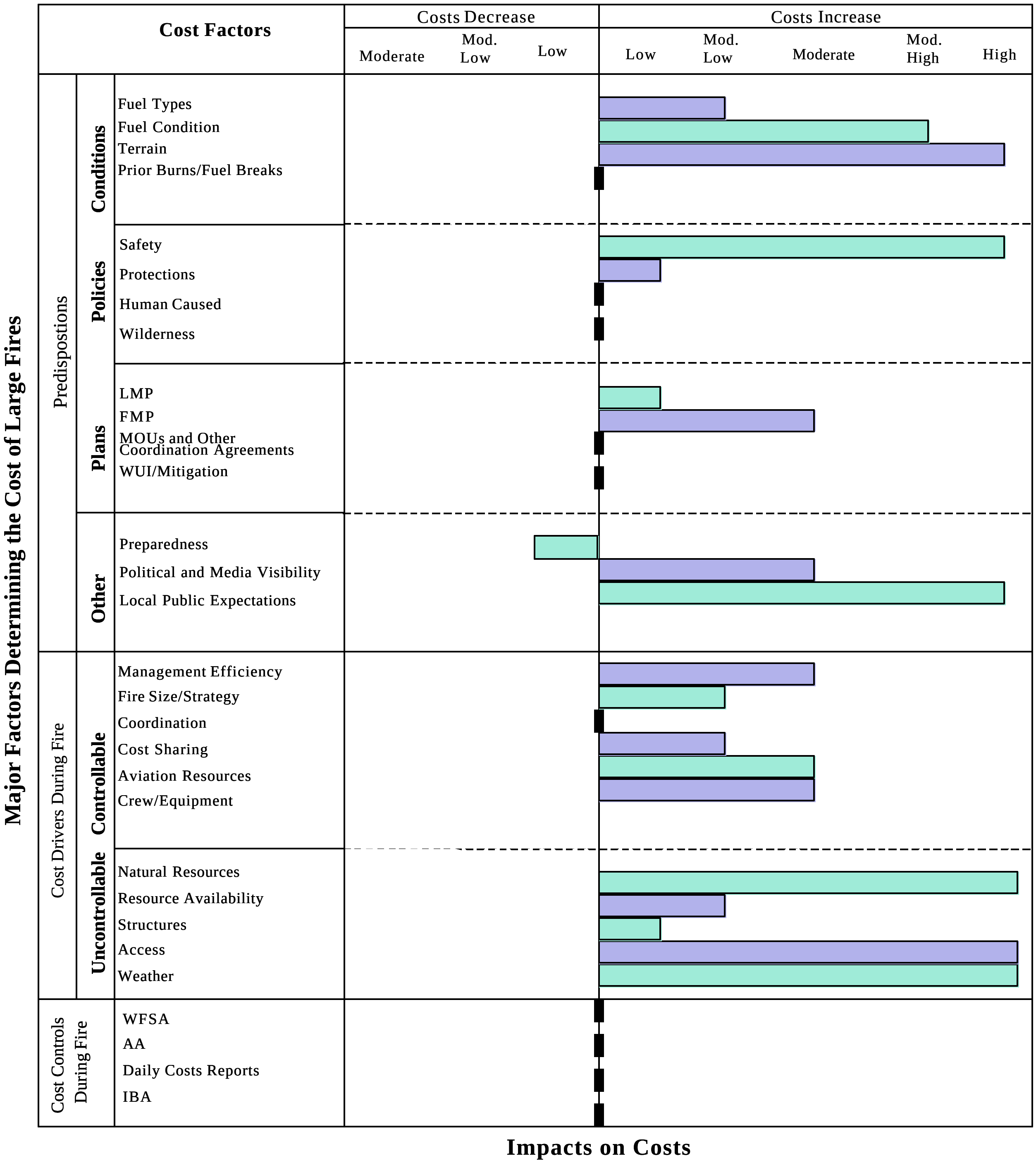
PRINCIPAL COST DRIVERS

The principal cost drivers for the Sheep Fire were mainly out of the control of the fire managers. There were several predispositions and uncontrollable factors that caused this fire to burn a large number of acres and to be costly. Figure F, Generalized Relative Influences of Various Factors on the Cost of A Wildland Fire, exhibits the predispositions and controllable and uncontrollable factors that drove the size and costs of the Sheep Fire.

[22] These include Spotted Knapweed, Houndstongue, Leafy Spurge, Purple Loosestrife, Musk Thistle, and Dalmation Toadflax.

Figure F-6. Generalized Relative Influences of Various Factors on the Cost of a Wildland Fire*

SHEEP FIRE, BLM, Elko, NV 8/9/01 – 8/14/01



* The relative cost impacts of any given factor on a particular fire were judged qualitatively by the site visit team sometimes in consultation with personnel involved in fighting the fire. Some factors had different impacts during different stages of the fire. The case study write-up should be consulted for a more detailed description of each factor.

PREDISPOSITIONS

Concern for firefighter safety, volatile fuel types, and dry fuel conditions were major cost drivers on the Sheep Fire. The terrain where the fire started was largely inaccessible. The roads that existed were overgrown and reduced to fine sand with heavy traffic, limiting access and egress for safety zones.

Due to the severe prior three fire seasons, the fire management staff was following a much more aggressive suppression strategy than the FMP allows. This increased aggressiveness prompts direct, rather than indirect, strategies that are often more costly to implement.

Both the Battle Mountain and Elko Field Offices were prepared for heightened suppression activities through increased severity resources, but these resources were stretched thin because of the high level of fire activity in the area.

Underlying the concerns specific to the fire, there is a constant tension between BLM and the ranching community over the issue of grazing and BLM's process for rotating grazing areas. At the time of the Sheep Fire, this issue had become more controversial because so many ranchers had lost acres due to previous fires. The IMT's sensitivity to this issue resulted in the decision not to use a backfire. Thus, although the decision of whether or not to light a backfire was within the IMT's control, local public expectations to minimize the damage to rangeland drove the IMT's actions. IMT members believed that if they had used a backfire that they could have contained the fire two or three days earlier.

Controllable Cost Factors

The communications problems experienced by CNIDC hindered its ability to provide needed resources during the first few critical hours of the fire. If resources had been able to access the fire before dark, the fire might have been contained during initial attack.

BLM officials did not negotiate a cost-share agreement with Lander County because they did not believe that the county had the resources to pay for the suppression costs. Therefore, the federal government paid the full cost of suppressing this fire.

Uncontrollable Cost Factors

Instead of "lying down" at night, a wind event, compounded by very limited humidity recovery and dry fuels, caused the fire to grow from 600 acres to several thousand acres in the first 24 hours of the fire.

Because of the terrain where the fire ignited, aviation resources were needed to effectively mount an initial attack. However, they were not available because of the time the fire was discovered and other fire activity in the area. When these resources became available on day two of the fire, there wasn't enough air support to effectively retard the fire activity. Delays in the arrival of some supervisory personnel also resulted in equipment, such as dozers, not being deployed in a timely fashion.[23]

The habitat for the sage grouse was at risk of serious damage from the fire. This also prompted the selection of strategies to minimize the size of the fire because of the growing political concerns in the state about protecting sage grouse.

LESSONS LEARNED

In its FMP, the Elko Field Office supported the concept of using less aggressive, and therefore, less costly, fire suppression tactics. However, during the three years preceding the Sheep Fire, the land unit had witnessed a dramatic change in fire behavior throughout the area. Fires had become much more severe and were burning thousands of acres of land. Without a significant fuels treatment program, which would make it safer for fires to burn naturally, the Field Office has little choice but to adopt a more aggressive approach to fighting wildland fires and to limit the areas where fire use fires can occur.

The Sheep Fire is an example of how the pressure of public expectations can significantly influence how a fire is fought and, consequently, its costs. The IMT on this fire was very familiar with wildland fires in the Elko area and recognized that attempts to use dozer lines to contain this fast-moving range fire were probably futile. Yet, to reduce tensions with the local residents, it elected not to backfire several thousand acres. The end result was the same—the acres ultimately burned when the control lines did not hold. But those responsible for suppressing the fire were not viewed as part of the problem because they did not intentionally burn additional acres. This incident raises the issue of the IMT's capacity to effectively deal with local community expectations and pressures while making strategic decisions to most effectively fight the fire.

Although the Field Office may have been correct in its assessment of Lander County's inability to help pay for suppression costs, current policies do not appear to provide adequate guidance on how such decisions are made. In addition, there are no overriding requirements or incentives for local governments to enter into fire protection agreements that outline their responsibility for large wildland fire suppression costs.

The IMT's Finance Section had not received adequate training, nor did it have confidence in I-Suite or the ICARS programs to maintain electronic records. This resulted in duplicate records and, in all probability, contributed to cost inaccuracies. Business management operations need to be improved to keep pace with the growing complexity of the financial management requirements of wildland fire management.

[23] Safety and efficiency requirements mandate the use of appropriate supervision of equipment.

Box F-3. Contacts-Sheep Fire

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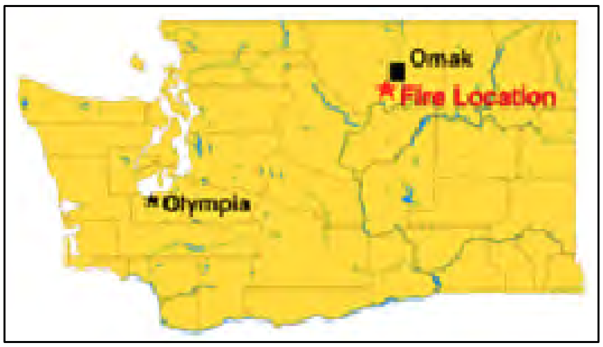
Jacky Anderson, *Management and Program Analyst, Fire Support, BLM, Elko, NV*
Patty Bandelin, *(Type II IMT Division Supervisor), USDA Forest Service, Humbolt- Toiyabe National Forest, NV*
Carol Bass, *(Type II IMT Finance Officer), Program Management Analyst, BLM, Ely, NV*
Walter 'Tooter' Burdick, *(Type II IMT Incident Commander), Fire Management Officer, Ely, NV*
Douglas Crocker, *USDA Forest Service, Humbolt-Toiyabe National Forest, CA*
David C. Davis, *Fire Management Officer, BLM, Battle Mountain, NV*
Bud Derham, *(Type II IMT Safety Officer), BLM at NIFC, Smoke Jumper, Boise, ID*
Ken Estes, *(Type II IMT Station Manager), Operations, BLM, Doyle, CA*
Joe Freeland, *Fire Management Officer, BLM-Elko Field Officer, Elko, NV*
Lisa J. Glenn, *Fire Operations Supervisor, BLM, Battle Mountain, NV*
Dave Haney Humboldt, *Fire Management Officer, BLM, Humbolt-Toiyabe National Forest, NV*
Bob Kielty, *(Type II IMT Planning Section Chief), Nevada Division of Forestry, Western Region, Carson City, NV*
Jim Leta, *Contract Specialist, BLM, Elko, NV*
Jack Lewis, *(Type II IMT Resource Unit Leader), Nevada State Office, BLM, NV*
Leticia Lister, *Rangeland Management Specialist (Resource Advisor), BLM, Elko, NV*
Mike McCarty, *Fire Management Officer, Nevada Division of Forestry, Elko, NV*
Mark O'Brien, *(Type II IMT Situation Unit Leader), BLM, Nevada State Office, Reno, NV*
Dale Owen, *Assistant Center Manager, BLM, CNIDC, Elko, NV*
Bill Roach, *Center Manager, BLM EIDC, Elko, NV*
Chris Robbins, *Rangeland Management Specialist/Resource Advisor, Elko, NV*
Ralph Satterberg, *Center Manager, BLM, CNIDC, Elko, NV*
Gerald Smith, *Field Manager, BLM, Battle Mountain, Battle Mountain, NV*
Bob Trodahl, *(Type II IMT Planning Trainee), NPS, Lake Meade, NV*
Danny Vann, *(Type II IMT Logistics), NPS, Lake Meade*
Kathy Wiegard, *Intelligence Coordinator, BLM, Western Great Basin,*

VIRGINIA LAKE FIRE CASE STUDY REPORT
Coleville Indian Reservation Washington State
August 13-September 9, 2001

The Colville Indian Reservation (the reservation), located in northeastern Washington, is home to the Colville Confederated Tribes (the Tribe).[24] It is the second largest reservation in the country in terms of size and has the third largest timber harvest. With just under 1.4 million acres, the Tribe plans for an annual harvest rate of about 77 million board feet during the period 2000 to 2014. The estimated Net Present Value of the annual harvest of forest products is $125.5 million. Historically, timber revenues have contributed 80-90 percent to the tribal budget.

State of Washington



BIA's Colville Indian Agency (the Agency) has a cooperative agreement with the Tribe for natural resource management of the reservation's land, including the management of the fire management program. Within the Agency, the forest manager is delegated authority for fire management operations. Program direction comes from the Tribe's Natural Resources Committee, through the Tribal Council, to the superintendent of the Agency, and then to the forest manager.

In the early morning hours of August 13, 2001, a storm system moved through the Pacific Northwest. By the time it passed through Oregon and Washington, lightning would ignite 140 fires. Eighteen fires were ignited on the reservation. Two of those fires—Virginia Lake and Goose Lake—escaped initial attack by the afternoon of the 13th and became the Virginia Lake Complex (the Complex). Over the next several days, four other fires would be added to the Complex. When it was over, the Virginia Lake Complex burned over 74,000 acres. Suppression costs were estimated at $25.2 million.

[24] The Colville Indian Reservation is home to the Lakes, Colville, San Poil, Nespelem, Southern Okanogan, Moses/Columbia, Palus, Nez Perce, Methow, Chelan, Entiat, and Wenatchi bands.

The Academy field team that reviewed this fire found that:

- The land management goals to protect the tribe's timber and cultural resources predisposed the land unit toward an aggressive fire suppression strategy to minimize the number of acres burned.
- The overall conditions, (including multiple fire starts, adverse weather conditions, and difficult terrain), the need for structural protection, and pressure by local ranchers to save their rangeland prompted an all-out attack on the fire, which drove up total suppression costs.
- There appeared to be some management inefficiencies during the fire that increased its overall costs, but these were not as significant as the predispositions and uncontrollable factors noted above.
- The final cost-share agreement was heavily weighted toward federal payment for a fire that used significant resources for structural protection of private property.

BRIEF FIRE CHRONOLOGY

A Type 2 Incident Management Team (IMT) was immediately assigned to the Complex and it accepted a delegation for managing the fire on August 14, 2001 at 6:00 a.m. The next day, the St. Mary's Mission Fire was added to the Complex.

Drought conditions and hot, dry weather created extreme burning hazards. By mid-morning on August 15, 2001, the Bureau of Indian Affairs (BIA) requested that a Type 1 IMT be assigned to the Complex due to the increasing complexity of the situation and the potential for losing additional residential structures and ranches. The team assumed the delegation on August 17, 2001 at 6:00 p.m. An Area Command also was established to manage six fire complexes in the region, including the Virginia Lake Complex. Over the next couple of days, firefighters were able to contain the Virginia Lake and Goose Lake Fires and begin mop-up and rehabilitation activities. However, the St. Mary's Fire continued to rage.

Over the next several days, the St. Mary's Mission Fire made significant runs and threatened structures. On August 22nd, the IMT assumed command of two remaining mop-up fires (Gamble's Mill and Indian Dan) from the Brewster Complex. On August 24th, the Bailey Mountain Fire, also from the Brewster Complex, was assigned to the Virginia Lake Complex. Suppression actions continued on the St. Mary's Mission Fire through August 25 and on the Bailey Mountain Fire through August 29, after which mop-up and rehabilitation commenced.

From August 22 to August 25, the Complex was listed as the number one priority fire in the nation. Resources assigned to the fire increased quickly as the national teams and Area Command started to receive their much-needed crews and equipment. On the 19th, 1,112 personnel were assigned to the Complex, including 18, 20-person crews. That figure rose steadily until August 25, when 2,614 people (61 crews, including 550 soldiers from Fort Lewis, which arrived on August 21) were working the fire. Over 2,000 people were assigned to the Complex through August 31. Up to 15 helicopters, 131 engines, 25 bulldozers, and 44 water tenders were assigned to the fire on any given day.

A Type 2 IMT was delegated authority to manage the Complex on September 3, 2001 at 6:00 a.m. to continue mop-up and rehabilitation activities. On September 9, 2001, after 28 days, the management of the incident was assigned to a Type 3 IMT for final mop-up, patrol, and rehabilitation activities. Table F-7 presents a brief chronology of the Complex's history.

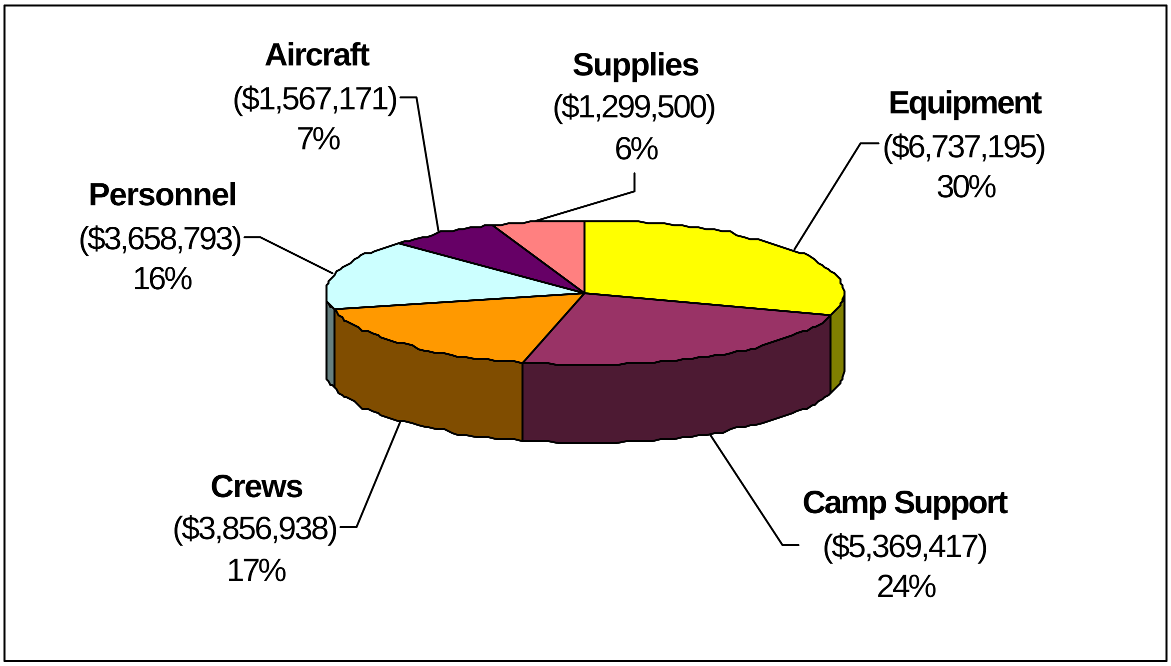
Table F-7. Virginia Lake Fire Complex Chronology

Date	Activity
8/13/01:	Fires start at approximately 3:30 a.m. At approximately 1:30 p.m., the Washington Inter-Agency IMT 1 (WA IMT #1) was assigned to the Virginia Lake Complex, (consisting of the Virginia Lake and Goose Lake Fires). Nine homes were lost and two bulldozers and their crews were burned over during the initial and extended attack.
8/14/01	A Level 3 evacuation order was placed in several areas. The St. Mary's Mission Fire was added to the Complex.
8/15/01	Additional evacuations were ordered. The Governor declared a state of emergency.
8/16/01	The St. Mary's Fire escaped from established control lines and made a run. The Virginia Lake Fire was near containment. An evacuation order was lifted in some parts of the Virginia Lake Fire area. The Goose Lake Fire was almost 100 percent mopped up, and rehabilitation was near completion.
8/17/01	The St. Mary's Fire had extreme fire behavior with flame lengths of 8 feet or longer. Structural protection remained a high priority. A Type 1 IMT was delegated authority to manage the Complex.
8/18/01	The St. Mary's Fire continued to grow steadily, and structural protection remained a high priority. The Virginia Lake Fire was near containment, with reinforced control lines in place. Goose Lake Fire mop-up and rehabilitation continued.
8/19/01	In the afternoon and evening, the St. Mary Fire escaped from established control lines and made a 3-mile run. The Virginia Lake Fire was very near full containment and well into rehabilitation. The Goose Lake Fire was almost mopped up and rehabilitation was near completion.
8/20/01	A Level 3 evacuation remained in effect for some areas, and additional evacuation plans were developed for other parts of the reservation. Late in the evening, a cold front arrived, bringing scattered showers.
8/21/01	In the afternoon, the St. Mary's Fire attempted a very strong push, moving as much as 2-3 miles through a small canyon. Approximately 60-70 residences were evacuated. No additional structures were destroyed. Virginia and Goose Lake Fires were in a patrol, mop-up and rehabilitation status.
8/22/01	The IMT assumed command of two remaining fires (Gamble's Mill and Indian Dan) from the Brewster Complex. An evacuation order was lifted.
8/24/01	Washington State deactivated its mobilization order and initiated some demobilization of resources. The Complex assumed command of the Bailey Mountain Fire from the Brewster Complex. U.S. Army forces began training to assist with mop-op operations.
8/25/01	Mop-up continued on the Gamble's Mill, Indian Dan, Virginia Lake, and Goose Lake Fires. Suppression activities continued on the St. Mary's and Bailey Fires.
8/27-31/01	Mop-up activities continued on the fires.
9/1/01	All the fires were 100 percent contained. Mop-up, rehabilitation, and demobilization continued. A Type 2 IMT from Washington State DNR arrived to assume their delegation.
9/3/01	The Type 2 IMT assumed authority for the Complex at 6:00 a.m.
9/7/01	A Type 3 team arrived and began the transition to take over the incident. Both fires were about 95% ready to be turned back. Demobilization of resources continued.
9/9/01	The Type 3 team was delegated authority to manage the incident. This was 28 days from when the fires started.

COST OVERVIEW

Figure F-7 shows the cost break out for the Complex by major expenditure type.[25]

Figure F-7. Virginia Lakes Total Expenditures.

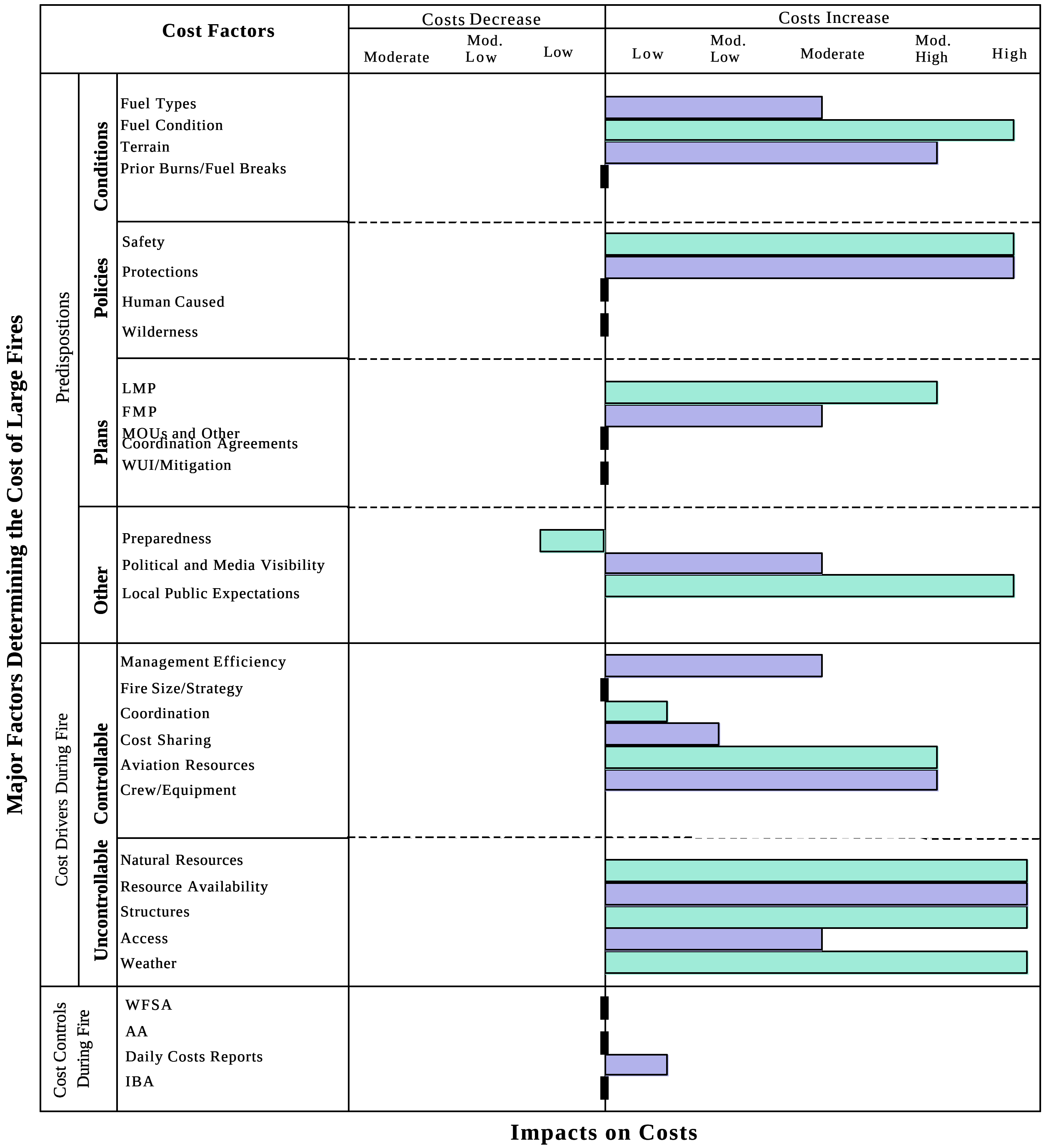


The conditions and events that occurred before and during the Complex reveal that a number of factors affected the cost of suppression efforts. Except for the preparedness level of the Agency, which enabled it to control the majority of the fires that ignited on August 13 and thereby limit the number of fires added to the Complex, all of the factors increased the Complex' total cost. Figure F-8 presents an overview of the major factors that influenced the cost of the Complex. They are discussed in the sections below.

[25] The source of this information was the ICARS data, which provides estimated costs during the fire to help fire managers examine suppression costs. ICARS is not intended to provide actual cost information and, therefore, the total figures in ICARS do not match the latest cost estimates for the fire presented on page 1.

Figure F-8. Generalized Relative Influences of Various Factors on the Cost of a Wildland Fire*

VIRGINIA LAKE, BIA, Colville, WA 08/13/01 – 09/07/01



* The relative cost impacts of any given factor on a particular fire were judged qualitatively by the site visit team sometimes in consultation with personnel involved in fighting the fire. Some factors had different impacts during different stages of the fire. The case study write-up should be consulted for a more detailed description of each factor.

Preconditions For The Fire

The Homestead Act, passed in the early 1900s, allows tribal and non-tribal people to buy land on the reservation. As a result, private land forms a checkerboard pattern throughout the reservation, particularly in the area where the Virginia Lake Fire occurred. According to two Agency officials, not having jurisdiction over all the land on the reservation has created problems in the fire management program. There are access/right-of-way problems with private landowners in order to get to tribal lands. However, it did not appear that those problems occurred during this fire.

On tribal lands, the Complex threatened significant timber stands; a watershed restoration project in which the Tribe had invested about $2 million; habitat for mule deer, whitetail deer, elk, big horn sheep, and sharptail grouse; and a number of historic, cultural, and archaeological sites including St. Mary's Mission, which is considered a cultural treasure by the Tribe.

Plans/Policies

Unlike other federal agencies, BIA does not establish the goals and objectives for the land unit it manages or for the fire management program. The reservation's land management plan—the Integrated Resources Management Plan (IRMP)—and fire management plan (FMP) are prepared by the Tribe and BIA approves them.[26] The Tribe adopted the current IRMP in July 2001, and it was in effect at the time of the fire. It stresses the protection of the Tribe's resources and places a heavy emphasis on 'light on the land' tactics in all aspects of resource management. In the Agency superintendent's delegation of authority to the Incident Management Teams (IMTs) fighting the fire, protection of the Tribe's resources ranked high among the management concerns and priorities.

At the time of the Virginia Lake Complex, the Tribe was drafting a new FMP. The FMP in place did not allow BIA to manage the fire for resource purposes. However, given the fuel and weather conditions and the level of fire activity in the area, this fire would not have been a candidate for such an alternative even if the FMP had allowed it.

The Agency has mutual-aid agreements with the state and adjacent Fire Protection Districts (FPDs) for wildland fire response. FPD 8, which operates within the reservation where the fire occurred, was the first on the scene at the Virginia Lake Fire and was taking active initial attack measures when Agency personnel arrived. The agreement with FPD 8 in effect since July 2, 1962 stipulates that BIA will provide equipment to the district in exchange for the district providing fire protection for specified Indian lands within its 198,000-acre area of responsibility. The district has a long history of fighting wildland fires within the district. It does not provide structural fire protection, but it will respond to a structural fire to prevent it from escaping into a wildfire situation. FPD 8 has about 30 volunteer firemen—consisting of local farmers and ranchers—and 8 engines—most of which are 1960s vintage Type 6 engines.

[26] Contractors, working in conjunction with the BIA Colville Indian Agency, helped prepare both documents.

Local Prevention and Mitigation Efforts

The reservation has actively managed its lands for at least 20 years. Historically, it treats about 6,500 acres annually depending on moisture levels. Until now, fuels treatment activities, such as burning undergrowth, has been in conjunction with logging activities. The Tribe withholds 10 percent of timber sales revenues for fuels treatments related to logging. Until the last couple of years, there has not been a sustained source of funds for other fuels reduction programs. Although the reservation has received funds from National Fire Plan for fuels treatment, the moratorium on prescribed burning after the Cerro Grande Fire in May 2000 and the drought conditions in 2001 further curtailed fuels treatment on the reservation. Over the next 6 to 8 years, the Tribe plans to increase its prescribed burning to 20,000 acres annually.

The Agency has not been involved with the Firewise program, but the fire management staff does participate in a variety of community activities to help get out the fire prevention message. FPD 8 helps provide fire prevention and fire safety information throughout the district. It appeared that most of the structure owners in the fire-affected area had taken some steps to protect their property from wildfires. During the fire, some homeowners constructed bulldozer lines around their homes.

Preparedness

The Agency's initial attack resources were at 100 percent of MEL, including about 50 people, 5 engines, 2 water tenders, one bulldozer, a helicopter, and a single engine air tanker (SEAT). In addition, pre-suppression severity resources were in the area. The Agency had access to three engines from the Flathead National Forest, and BLM had stationed a SEAT at Omak. The Forest Service also had a couple of extra crews on standby at their base in Wenatchee, and the Okanogan National Forest had not released a crew from a fire a few days before in anticipation of additional fire activity. Despite the level of available resources, the high number of concurrent starts quickly drew resources down. Because of the number of fires ignited simultaneously, additional initial and expanded attack resources were not available. In addition to the fires on the reservation, nine other major fires in the region were caused by the same storm system.

Geographic Conditions

Within the Complex fire perimeter, 9 (of the 13) NFFL fuel models were involved--including short grasses with cured herbaceous fuels and cool season annuals, open-growth pine stands, conifer overstories, and over mature, unmanaged stands with heavy dead and down fuels. Topography varied throughout the Complex, from gently rolling hills in the Omak and Okanogan foothills to steeper canyons and drainages.

The climate in the fire vicinity is semi-arid to arid in nature, with cool, dry winters and hot, dry summers. The reservation normally has about 100 to 120 fires annually. As August 2001 approached, burning conditions posed a serious threat to the area. The winter of 2000-2001 was the driest in the prior 50 years. The overall snow pack for the Columbia Basin was 58 percent of normal. Eastern Washington did not receive June rains and, consequently, moved into the summer months with below-normal moisture. Large fuel moistures reached the 97th percentile of dryness, and the energy release component was above the 97th percentile. Temperatures during the fire reached into the nineties while relative humidity was in the teens.

Fire suppression efforts for the Complex were able to take advantage of some of the prior land management efforts. The St. Mary's Mission Fire site contained several timber sale harvest units that the fire started to burn into, and firefighters were able to use some of the old bulldozer lines. Unfortunately, potential savings were offset as the fire also spread into areas of timber reproduction where new growth added fuel. The south end of the Virginia Lake Fire burned into an area that burned routinely. The IMT pushed the fire into that area, which helped with the suppression efforts.

KEY DECISIONS AND ACTIONS AFFECTING MANAGEMENT OF THE FIRE

Initial/Extended Attack

The Agency was anticipating fire activity during the second week of August 2001. On Saturday, August 11, the National Weather Service (NWS) issued a Fire Weather Watch for possible dry lightning late Sunday afternoon and evening. On Sunday, August 12, NWS issued a Red Flag Warning for all weather districts. In anticipation of lightning strikes, the Agency kept staff on duty Sunday night. Dry lightning did develop, but did not enter the reservation. Around midnight, Agency staff went home. At 2:30 a.m. on August 13, the lightning storm entered the reservation, covering its western one-third in the Omak to Nespelem areas. Lightning also was observed in the Inchelium District in the northeast part of the reservation. The Agency documented over 50 lightning strikes.

Throughout the morning of the 13th, the Agency was responding to reported fire starts and reallocating resources to deal with them. In addition to Agency resources, initial attack response came from the Colville Indian Nation Fire Department, FPD 8, and FPD 5. The Agency established an Incident Command and priority was given to those incidents that had very high risks of residential or related structure damage due to the proximity of the lightning strikes to homes and outbuildings. Keeping the fires away from structures was an overriding objective.

The Goose Lake Fire was first reported around 4:30 a.m. It was 30-40 acres and "moving." During the next hour and a half, it grew to about 60 acres in pine trees, and there were concerns that the wind could push the fire. At around 7:00 a.m., the fire threatened 400 tons of hay. The Agency Type 3 Incident Commander (IC) ordered and received an air tanker mid to late morning. At the same time, a helicopter began using bucket and water drops on the fire to protect historical and cultural sites. By around noon, the fire had grown to 75 acres and had moved into an area of sagebrush where bulldozers could not travel.

Predominant north wind conditions prevailed in the Okanogan valley all during the 13th. The Virginia Lake Fire, first reported around 9:40 a.m., was estimated at 50-60 acres by noon and was growing at a moderate rate. FPD 8 personnel with one bulldozer and Agency crew began putting in line. Flame lengths were 2-3 feet and the fire was backing down the slope from a broad ridge top. The IC arrived on the fire around 1:00 p.m. He flew over the fire and, noting a small road, developed an incident action plan (IAP) to widen the line using the road. He called in his resource order (using a cell phone because the radios were not working) for airdrops, two bulldozers and a 20-person crew. A SEAT began making airdrops and the hand crews arrived, but the equipment did not arrive until about 4:00 p.m. Threats to structures did raise the Virginia Lake Fire on the priority list, but resources were limited due to the large number of fires burning in the area. A tanker that was requested was diverted to another fire.

During the afternoon, high winds generated from a passing storm cell—15-50 mph depending on the location—quickly escalated the rate of spread and intensity of the fires and ember showers. The Virginia Lake Fire, which had started in sagebrush and grasses moved into the trees (overstocked pine first, and then heavy timber). Prolific spotting extended one-quarter mile. Meadows of green grass did not provide any security to firefighters. They burned readily and with high intensity. Probabilities of new ignitions were 90-100 percent. The Goose Lake Fire jumped its northwest line and was making a run on two sides.

With the heavy fire activity, the Pacific Northwest Coordinating Group (PNWCG) established a multi-agency coordinating (MAC) group to help prioritize resource allocations within the region. Concerned about the large number of fires started in Oregon and Washington by the storm system, PNWCG ordered the Washington State Incident Management Team #1 (WA IMT #1, a Type 2 team) to stage its personnel in Ellensburg, WA and standby for specific assignment. At approximately 1:30 p.m. on the 13th, the team was ordered to the Virginia Lake and Goose Lake Fires.

At approximately 6:00 p.m. on the 13th, firefighters were able to contain the Goose Lake Fire during extended attack. The fire had consumed 650 acres. However, at 6:30 pm., the IC reported to dispatch that the Virginia Lake Fire was blowing up “big time.” He wanted bulldozers and airdrops. With structures involved, thoughts about costs and light on the land tactics were set aside. In the early evening, retardant drops helped save some houses on the Virginia Lake Fire by turning it in a different direction. However, others were not as fortunate.

Nine structures were lost on the Virginia Lake Fire during initial and extended attack—including the first homes ever lost to wildland fire on the reservation—and two bulldozers with two-person crews were burned over.[27] Although air operations ceased at night, crews continued building lines. As bulldozers reached the incident, they were sent out to build lines around home sites.

Incident Management Team Phase

Because WA IMT #1 was on standby, team members arrived at the incident quickly. BIA conducted an Agency Administrator briefing at 9:00 pm. on the 13th. At that time, there was no delegation of authority. Because of the multiple jurisdictions involved—BIA and FPD 8—the team needed a delegation from both entities. BIA developed its delegation and the team worked with FPD 8 to develop theirs. During the process, the team worked hard to put the district personnel at ease. Tensions and concerns were already running high because of the loss of structures and the threat to the ranchers’ rangeland. The FPD wanted to ensure that they would

[27] One of the individuals sustained minor burns to his hand.

continue to be involved in the firefighting efforts and that things would be done to a certain standard. Because delegations were not in place when the team developed its first shift plan, operations were delayed somewhat. However, this delay did not appear to have a significant impact on the course of the fire.

No WFSA was in place when the team arrived, and the fire management staff and resource advisors normally involved in WFSA preparation were unavailable due to the high level of fire activity on the reservation. A senior WA IMT #1 team member prepared a Developing Incident Situation Analysis (DISA), which is a planning tool approved by the Washington State fire chiefs to help assist in selecting firefighting strategies. It was used in lieu of a WFSA.

Although fires usually lay down at night, the unusual wind activity at Virginia Lake drove the fire to 7,000 acres between 10 p.m. and midnight on the 13th, which was several times larger than what WA IMT #1 anticipated from the briefing. At 1:54 p.m. on August 14, Washington State declared a Fire Mobilization for the Complex, resulting in structural engines and crews throughout the state being dispatched to the Complex.

WA IMT #1 assumed control of the Complex on August 14, 2001 at 6:00 a.m. and began to scout the two fires. The quick takeover of the Complex, less than 24 hours from the team's assignment, relieved Agency personnel to stand by to initial attack other fires and to get some needed rest. The team moved the Incident Command Post (ICP) during the first operation period from the Nespelem Community Center Facility to Okanogan Fairgrounds to provide better access and proximity to the fire locations, so communications were not up until about 6:00 p.m. on the 14th. This did not halt operations, however, as the team used cell phones to communicate. Resources were slow to arrive.

Fire activity on Virginia Lake increased throughout August 14, with very erratic fire behavior and extremely fast rates of spread and spotting. A Level 3 evacuation order was placed in several areas of the fire. Over 30 structures were threatened. At around 1:30 p.m., lightening started the St. Mary's Mission Fire, and the Agency's fire management officer (FMO) asked WA IMT #1 if it would accept a delegation for that fire. The initial attack forces were into their second day and were "running ragged." The number of new fire starts meant that no local reinforcements were available. In addition, state and federal resources were being stretched thin because of the numerous other fires burning in Washington State and throughout the west. The team had reservations about taking on the St. Mary's Mission Fire. There was potential for that fire to grow, and the team was already concerned about the span of control of its division supervisors. Already, too few bulldozer bosses were available to man the available equipment. However, given the status of the Agency's capacity at that time, the team did not believe it had much choice but to take on the new fire.

The team revised its DISA to include the St. Mary's Fire. It identified three alternatives each for the Virginia Lake and St. Mary's Fires: A) direct attack, B) indirect attack, and C) a combination attack. Each alternative included an estimated final fire size, but did not project the cost for implementation. The analysis did include a section entitled 'Estimated Economic Damage,' which listed the economic issues common to the Complex, and estimated the damage from the fire in terms of loss of structures and improvements, timber salvage, loss of habitat, loss of grazing allotment acreage, and damage to the road system. The total came to $7,680,000, with the caveat that the worst-case alternative, indirect attack would cause a significant increase to some of the estimates. The team opted for the combination attack alternative for both fires.

By the end of the 14th, the Virginia Lake and St. Mary's Mission Fires had increased to approximately 28,000 acres and 4,000 acres, respectively. The Okanogan County government declared a State of Emergency. At 8:00 a.m. on August 15, members of WA IMT #1 command, general staff and BIA completed a fire complexity analysis to evaluate the rapidly changing complexity of the fires and the team's ability to manage three fires at once, two of which were developing rapidly and were threatening over 100 residential structures and numerous other outbuildings and structures. Based on this analysis, the team recommended to BIA that it request a Type 1 IMT. At 10:09 a.m., the Agency superintendent made the request and a Type 1 IMT was mobilized.

During the 15th, resource orders were being filled and were arriving at a much faster rate than had occurred previously. However, there was only one person available to perform the equipment inspections needed before sending anything out to the fire. Although lacking the necessary qualifications, an FPD 8 firefighter stepped in to sign equipment operator timesheets in order to expedite getting resources out to the fire.

The line around Virginia Lake was being reinforced and strengthened, and on the St. Mary's Mission Fire, air tankers were working hard to reinforce line constructed by bulldozers and hand crews, while protecting structures. Over 100 structures were threatened. The number of fires ablaze across Washington State caused Governor Gary Locke to declare a state of emergency, which mobilized the Washington State National Guard to help meet the transportation needs for the fire operations and to assist with evacuations. Also on the 15th, the Washington State Department of Natural Resources (DNR), Washington State Fire Marshall, BIA, the National Park Service and the Forest Service issued a delegation of authority to an Area Command team to manage six wildland fire complexes—Spruce/Dome, Icicle, Rex Creek, Brewster, Virginia Lake, and Tonasket—and supervise the ICs. On August 16, the Icicle Complex was the first priority for resources and Virginia Lake was second.

The Type 1 IMT arrived at the Complex on August 16 but did not take command until 6:00 p.m. the next evening. This transition over three operational periods was considered lengthy, and was influenced by several factors. The team wanted to ensure that it established a good working relationship with the Tribe, which previously had a negative experience with a national team. WA IMT #1 did not develop a transition plan and opted instead to discuss concerns with the incoming team. The delegation of authority to the team was not timely—the team received it only about 15 minutes before it took over the fire, at which time the St. Mary's Mission Fire was making a major run. In addition, state-contracted and National Guard helicopters assigned to the fire did not meet Red Card standards.[28] The team had to find other equipment and it painted the rotors of the National Guard's ships red to meet standards.

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[28] Federal policies and procedures for aircraft are different than those for Washington State mobilization. WA IMT #1 believed they were within the guidelines to use DNR-contracted aircraft services, which did not meet all Red Card requirements. The Lohry team would not use those aircraft.

The IC insisted on having a regulation WFSA for the St. Mary's Mission Fire, and an IMT member worked with an Agency staff member to prepare it. The WFSA included two alternatives: A) minimize the fire size and B) indirect attack. The expected cost plus loss was $24.9 million for Alternative A and $26.5 million for Alternative B. Under the worst case outcome, cost plus loss for both alternatives was $49.7 million. Alternative A was selected in order "to minimize loss of structures, forage and timber values, wildlife habitat, water quality degradation, and public concern." According to a senior Agency official, minimizing fire size is always the Agency's objective in order to protect tribal resource values, which is "the single management goal." He further added that because of this objective, the Agency has fewer opportunities than other land management agencies to use wildland fire for resource purposes.

The determining factor for strategy selection was the threat to structures. The IMT used indirect attack when the terrain could help to keep costs down. But most of the time it used direct attack because of the numerous factors that it had to deal with such as protecting the St. Mary's Mission.

On August 17, the evacuation order in some areas of the Virginia Lake Fire was lifted. From August 17 to 19, firefighters were able to almost completely contain that fire. But the St. Mary's Fire continued to grow steadily with high rates of spread and extreme fire behavior. The fire grew from 7,200 to over 29,000 acres. Although the delay in using helicopters limited the team's suppression actions, the weather was more of a factor in slowing the team's ability to meet its initial objectives. Unpredicted winds from an unexpected direction caught the team by surprise on St. Mary's Mission Fire. The fire crept over rocks, reached open ground, and grew larger than the team expected. In addition, Type 1 crews were in short supply. There was rugged terrain that the team wanted to burn out, but it didn't have the crews to do it. Some Agency officials and local cooperators speculated that, with the right air support, the fire could have been stopped before it reached open ground.

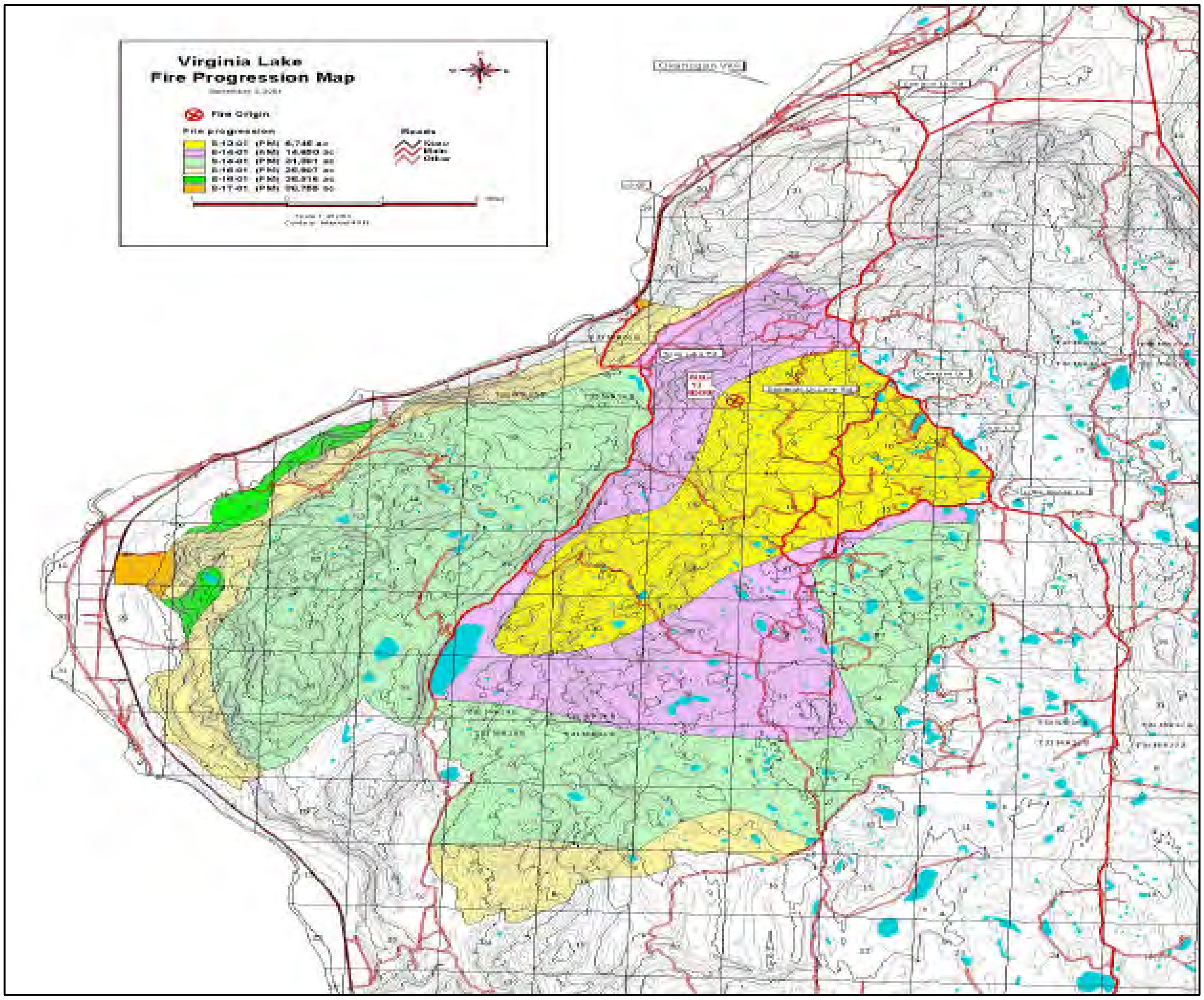
By the 17th, the Complex had moved up in priority and more resources started to arrive. Area Command was ordering and prioritizing resources for the fires it was managing and the Complex' resources grew steadily. The Area Command Air Operations Chief also brought in aircraft inspection teams to Red Card Canadian aircraft on site. The process was highly effective in getting resources onto the fire. National mobilization was in effect and crews arrived from as far away as Puerto Rico. The out-of-area resources created a large demand for transportation of crews from the airport to base camp and from base camp to the fire lines.

Late in the evening on the 20^{th}, a cold front and scattered showers arrived. Despite the improved weather, the St. Mary's Mission Fire made a strong push of about three miles through a canyon on the 21^{st}. Approximately 60-70 residences were evacuated but no additional structures were lost.

On August 22, rainy conditions continued, allowing firefighters to focus on control line completion and reinforcement and mop-up around structures. Other fires in the area where nearing containment and the Area Command began to reduce the management structure of the various fires it was managing. The Complex IMT assumed command of the two remaining fires from the Brewster Complex—the Gamble's Mill and Indian Dan Fires.

On August 24, the Washington State Mobilization Act was deactivated, which initiated demobilization of some structural protection resources from the Complex. A U.S. Army battalion arrived and began training to assist with mop-up operations. The Complex also was scheduled to assume command of the Bailey Mountain Fire of the Brewster Complex on that day. No other major fire activity occurred. By September 1, all the fires were 100 percent contained, and a Type 2 IMT from Washington State DNR arrived to assume control of the fire. After a day of shadowing the Type 1 team, the Type 2 team assumed its delegation of authority on September 3 at 6:00 a.m. for mop up and rehabilitation activities. By this time the Complex was '…basically a demobilization operation.' The Type 2 team would remain on the fire until 100 percent of the standards for turning back the fire to the reservation were met. On September 9, 28 days from when it started, a Type 3 team was delegated authority to manage the fire until final turn back to the Agency. Figure F-9 illustrates the fire's final size.

Figure F-9. Virginia Lake Complex Fire—Final Fire Size



Data Resources, Decision Support Tools, and Communications

The national teams found that the Tribe had good GIS mapping capability and data on its natural and cultural resources; logging and reforestation efforts; and land treatments. The teams used those resources extensively throughout the fire. Data on structures and roads were much less complete.

Communications was a challenge throughout the incident because of the geographic scope of the fire and the communications network needed. The area where the Virginia Lake Fire occurred contains many ‘dead areas’—steep canyon walls and the minerals in the soil—where radios and cell phones cannot operate. In addition, the local cooperators and the national teams often used different radio frequencies and were unaware of the other’s activities.

COST CONTROLS DURING THE FIRE

Although managing the fire in a cost efficient manner was included as a goal in the delegations of authority for the Complex, firefighter safety and protection of structures and the Tribe's resources were the overriding considerations in strategy selection. According to a senior member of WA IMT #1, using the protocol of protecting life, property, and resources resulted in large numbers of resources being used to herd the fire away from structures.

To track and monitor the fire's cost, the IMTs used I-Suite, in whole or in part, although they all used the ICARS software package to track daily costs. (For example, WA IMT #1 was not fully trained in the use of the I-Suite equipment tracking package—Incident Resource Status System (IRSS)—and generated the equipment information by hand.) There are no indications that the teams experienced difficulties using the system. However, there were some problems with the currency and accuracy of the data in the system. When the Type 2 team took over the fire from the Type 1 team, the Type 2 Finance Section found that the Type 1 team had been unable to post all of its time records before it departed, which meant that unneeded resources could not be demobilized. The Type 2 Finance Section had to recreate records by asking crews to identify for whom they worked and when they arrived on the fire; accepting the crews' word for the time claimed. It took the Finance Section about three days to catch up the paperwork and release the unneeded crews. The Type 2 team also discovered that some equipment identification codes were assigned to multiple pieces of equipment. When the team ordered one bulldozer, three might show up, all having the same identification number. These data problems resulted in more costs being charged to the fire than necessary. Fortunately, the Type 1 team had already demobilized all air resources, which are the most expensive.

The IMTs, Agency and tribal personnel reviewed cost during the daily briefings. However, there was more focus on risk and gains from various actions than on costs. As the wildland fire severity increased throughout the country and the fire management community moved into national mobilization of resources, resources started to arrive from great distances.

The WFSA, which is intended to serve as a tool for evaluating the benefits of alternative suppression strategies and their costs throughout the fire, did not appear to play any significant role in cost containment.

Relationship with Local Cooperators

The primary local cooperator fighting the fire was FPD 8 and its relationship with the national teams was problematic. The atmosphere on the fire was tense from the outset as the FPD 8 firefighters were desperately fighting to protect their homes and livelihoods. Although FPD 8 had fought a number of fires over the years to protect its homes and rangelands, the reservation had not seen many large wildland fires, and district personnel were not experienced working with the unified command concept. The local firefighters had a difficult time relinquishing authority for the fire's management to the national teams. Part of their reluctance, however, was because they did not believe the national teams valued or were willing to use their local knowledge of the area and the local wildfire behavior. The teams did not seek the local firefighters' input on how to navigate the reservation's complex road system or understand the area's unusual wind patterns. (On August 17, the Type 1 team was surprised by such a wind event on the St. Mary's Mission Fire, which was partly responsible for that fire making a run.)

There were numerous points of contention between the national teams and FPD 8. District personnel repeatedly reported to the fire without the proper equipment and were asked to leave. There were conflicts on the fire line between the teams, whose priority was to keep the fire away from structures, and some of the FPD firefighters who valued the land, which was their livelihood, above homes and objected to the teams driving the fire onto the rangeland. Many FPD 8 members refused to leave the fire lines long after they exceeded the work-rest guidelines. A number of district people were threatened with arrest if they did not leave a given area.

FPD 8 officials were concerned about the lack of resources available to the first national team when it assumed its delegation and wanted to keep district personnel in place to maintain the ongoing firefighting efforts.

In addition to the overall tensions within the community, the IMTs also had to address some political concerns within the county. The drought had raised concerns about water usage, and at least one county commissioner was actively engaged in overseeing the suppression activities to ensure that the teams were doing all they could to minimize the acres burned.

The IMTs also reported to the Tribal Council on a daily basis. The Tribal Council was very knowledgeable about the reservation and its resources and continually emphasized its priorities to minimize the fire's damage to reservation's natural and cultural resources. The Tribe also provided the teams with good information about the reservation's fire history, the location of prior burns, and where they had had been previous problems containing fires. The Tribe also assigned a Tribal Council member to the fire as a liaison to identify tribal concerns, provide information useful to the teams, and to represent the Tribe at the IMT briefings.

Management Oversight

The Agency superintendent delegated management oversight of the Complex to the FMO and forest manager. The FMO and/or the forest manager attended all IMT briefings and reviewed daily fire costs with the teams. There was no Incident Business Advisor on the fire.

Cost-Share Agreement

The Type 1 team started working on a cost-share agreement before it was demobilized. The agreement, which was among BIA, Washington State DNR, and Washington State Military Department, was not finalized until September 24, 2001. The cost apportionment agreement period was August 13-31, 2001. The terms of the agreement required the Washington State Military Department to pay for all resources ordered through the Washington State Fire Resources Mobilization Plan during the period August 14-23, 2001. For the remaining resources, costs were shared on the basis of "Negotiated Percentage of Effort," based on daily activity, by jurisdiction. BIA's negotiated percentage was 95 percent, and Washington State DNR's was 5 percent.

PRINCIPAL COST DRIVERS

Of the many factors that influenced the Complex' suppression cost, the preponderance of the principal cost drivers was largely outside of agency or fire managers' control.

Predispositions

The dry fuels condition (aggravated by four years of drought) and the steep, rocky terrain in some of the fire areas were instrumental in driving up the fire's costs. The fuel conditions added to the fire's intensity and extreme behavior, and the difficult terrain increased the difficulty of attacking the fire, requiring the use of a greater numbers of Type 1 crews.

The Tribe's land management goals of protecting its timber and other natural and cultural resources predisposed the IMTs toward an aggressive fire suppression strategy to reduce the number of acres burned. The Tribe's and Agency's goal to minimize the impact on the Tribe's resources, coupled with the concerns of the local ranchers and farmers, (who were the primary cooperators in the firefighting effort) about the loss of their range and farm lands and livelihood, helped drive the strategy to take aggressive suppression actions and minimize the fire's size.

Firefighter safety, always the first concern during fire suppression operations, were intensified because of the burnovers during initial attack and the fact that the Thirtymile Fire, where four firefighters died, occurred nearby shortly before the Complex fires. The IMTs were especially careful to avoid risks to firefighters, regardless of cost considerations.

The Agency had taken a number of steps to ready itself for fires on August 12, but it was unable to deal with the large number of fires that ignited. As one Agency official noted, given the dry fuel conditions, the windy weather conditions, and the number of ignitions, it was inevitable that one or more of the fires would become large.

Uncontrollable Factors

The inability to obtain needed resources in a timely fashion, particularly during the first few critical days of the incident, significantly contributed to the fires' escape from initial attack, and hindered the IMT's ability to contain the fire. There was a lot of competition for resources. The Agency and the surrounding land units were responding to multiple fires and resources throughout the region were quickly drawn down. Air resources (retardant) were not available during initial attack. The Type 2 team's requests for resources could not be filled as quickly as needed, and the team was not getting a lot of the air support and crews it requested. Even after resources started flowing more freely to the incident as the fire's priority rose, the Type 1 team was unable to get the number of Type 1 crews it requested.

Approximately 200 structures, including the St. Mary's Mission, were threatened during the course of the fire, and keeping the fire away from them was a primary driver for the suppression strategies selected. A large number of resources, including expensive air resources were used to prevent the loss of additional structures during the IMT phase of the fire. Many of the engines, provided as a result of the Washington State mobilization, were large structural protection engines that are more expensive than wildland fire engines.

Adverse weather conditions also were a primary factor influencing the fire's cost. High winds drove the fire quickly through the dry fuels and inhibited firefighters' ability to get a line around the fire.

Controllable Factors

The IMTs and FPD 8 were unable to establish a constructive working relationship. As a result, local knowledge and experience with wildland fires on the reservation, which could have been useful in developing and implementing suppression strategies, were underutilized. In addition, the FPD's lack of experience working in a unified command resulted in some behaviors that were perceived by IMT members as obstructions to the suppression activities.

Mobilization of the National Guard and an Army battalion increased the fire's costs. Their pay rates are higher than civilian federal firefighters, and their logistical requirements—a separate base camp, kitchens and showers—added to the support costs for the incident. According to members of the Type 1 team, by the time the Army soldiers arrived on the scene and were trained, conditions on the fire had changed to the point where they were not really needed. However, once activated on a fire, they are assigned for a minimum of two weeks. The soldiers were used primarily for mop-up activities.

Suppression tactics focused heavily on directing the fire away from structures and large numbers of federal resources were engaged in those activities. Although the state paid for their structural engines activated during the fire, the federal share of the remaining costs (95 percent) seems high.

CONCLUSIONS/LESSONS LEARNED

The use of air resources has become an essential ingredient for many initial attack operations. There was a general feeling among Agency staff that additional air support during initial attack might have prevented the Virginia Lake Fire from escaping. If those resources had been available, the outcome might have been quite different. The land management agencies should re-analyze their need for air resources during initial attack to ensure that they adequately meet the current needs.

The Academy field team found no major problems with the overall management, strategy or tactics used on the fire. However, this fire points out the critical importance of cooperation between the IMTs and local cooperators. The tension between the parties diverted the IMT's time and energy away from their primary task of suppressing the fire. Better use by the IMT of local knowledge about the wind patterns around the St. Mary's Mission Fire area might have enabled them to better anticipate the fire behavior on August 17 and develop tactics that might have contained the fire at that point.

The business management functions of fire suppression activities must keep pace with the complexity of the fire. The inability of the Type 1 team to maintain current time-keeping records delayed the demobilization process, which caused unneeded resources to be charged to the fire and prevented them from being reassigned to other fires.

It does not appear that the land management agencies have a system to determine the level of effort devoted to protecting public resources versus state and private resources. I-Suite could be used for such a purpose, but it would require significantly more time to track resources in such a fashion. Nevertheless, the agencies need such a system if they are to develop 1) a better understanding of how federal resources are spent during large wildland fire suppression actions and 2) a more comprehensive approach to allocating suppression costs among those who benefit from those efforts.

Box F-4. Contacts-Virginia Fire

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Terri Covington, *Fuels Technician, BIA Colville Indian Agency, Nespelem, WA*
Darrel Dick, *District Officer, Omak/Nespelem, BIA Colville Indian Agency, Nespelem, WA*
Gary Jennings, *(Type 2 Incident Commander), Asst. Fire Management Officer, USDA Forest Service, Wenatchee National Forest, WA*
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Charles LaPlante, Jr., *Operations Supervisor, BIA Colville Indian Agency, Nespelem, WA*
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MOOSE FIRE CASE STUDY REPORT
Flathead National Forest and Glacier National Park, Montana
August-November 2001

On August 14, 2001, a lightning storm crossed the mountains of northwestern Montana and ignited more than two-dozen fires on the Flathead National Forest and adjacent lands. One of these became the Moose Fire. Before containment, it consumed more than 71,000 acres over a seven-week period, demanded the attention of local and national media, and cost about $20 million to suppress. The largest wildland fire on Forest Service lands in 2001, it took the longest time period to contain and then control. However, the Moose Fire was not the costliest such fire. The cost per acre of only about $275 made it among the lowest of the 2001 Forest Service large fires.

In summary, the NAPA team that reviewed this fire found that:

- Heavy fuels, rough terrain, hot and dry weather, combined with competition for resources and management attention from other ongoing fires, led to preconditions for a major fire on this forest and adjacent state forest and national park lands.

- There were no fundamental problems with the management, strategy or tactics used on the fire. However, while the fire would have been difficult to suppress fully under the best of circumstances, there was some evidence that opportunities existed to improve their chances of containing the fire during initial attack and early in its development. Management continuity on this lengthy fire could have been improved had the incident management teams been allowed to stay longer than the 14 days allowed by current policy.

- Difficult and complex interactions among the local, state and federal managers; the IMTs; and Flathead county officials illustrate the difficulties in some locations of (1) making full use of local resources in fire suppression, and (2) conducting the landscape-scale planning called for in national fire management polices and plans.

- Based on the Academy field team's review of available records and interviews with local officials, the costs incurred appeared to be consistent with the strategy and tactics chosen for suppressing this fire.

This case study report describes how this fire evolved, how it was managed, how costs were monitored, and what were the principal factors driving fire costs. It assesses whether (1) agency policies have been substantially followed in the decisionmaking related to these incidents, and (2) firefighting costs could have been reduced without reducing firefighting effectiveness. It also identifies lessons learned that can be used to improve the cost effectiveness of firefighting in the future.

The following table provides a brief chronology of the fire.

Table F-8. Moose Fire Chronology

Date	Activity
8/16/01	First significant smoke cited; initial attack ordered. First WFSA drafted.
8/17/01	Type 2 IMT (Swope) on nearby Werner Peak fire assigned responsibility for the Moose fire.
8/18/02	Fire is 150 acres in size; suppression efforts centered on heavy use of aerial retardant and helicopter support
8/19/01	Three of four air tankers assigned are diverted to another fire.
8/20/01	Fire is at 340 acres in the morning and grows to 2,200 acres by dark.
8/21/01	Moose fire made a run to the north and active fire behavior was experienced.
8/23/01	Another Type 2 IMT ordered; second WFSA prepared.
8/25/01	Houseman Type 2 IMT assumes command of the fire.
8/28/01	New WFSA prepared; extreme fire behavior experienced. Base camp moved to Columbia Falls, south of the fire; third WFSA prepared.
8/29/01	Home Ranch Bottom community evacuated.
8/30/01	Humphrey Type 1 IMT assumes command of the fire.
9/1/01	Strong winds drive fire size to 40,300 acres; fire moves into Glacier National Park.
9/2/01	Fire made significant runs to the south and east forcing the evacuation of three campgrounds and a ranger station; size now 46,000 acres.
9/3/01	Structure protection continues on the North Fork Road and around Lake McDonald inside the park. Personnel assigned peaked at 1,113
9/4/01	Size now 52,000 acres; several structures threatened but none lost.
9/5/01	Size now 58,500 acres but no further spread due to rain showers.
9/6/01	Size now 64,000 acres and 787 personnel assigned.
9/7-9/01	Minimal fire activity; personnel now total 558.
9/11/01	Swope Type 2 IMT assumes command; suppression efforts suspended following terrorist attack in New York and Washington, DC.
9/13/01	Warmer and dryer weather contributed to increased fire behavior.
9/16/01	Elevated fire behavior. Size at 67,400 acres; 695 personnel assigned.
9/17-21/01	Size increases to 69,365 acres due to burnout operations.
9/24/01	Stanich Type 2 IMT assumes command; burnouts continue along fire perimeter.
9/25-26/01	Higher humidity and cloud cover decreases fire activity.
9/28/01	Rain helps fire suppression. Size at 71,000 acres; 59% contained.
9/29/01	Good progress made with indirect fireline construction.
9/30/01	Mop up and rehabilitation activities continued
10/3/01	Size stays at 71,000 acres; 88% contained; 280 personnel still assigned.
10/5/01	Management of the fire returned to local land units.

CONTEXT AND PRECONDITIONS FOR THE FIRE

The Moose Fire originated on the Flathead National Forest in northwestern Montana and migrated into Glacier National Park about two weeks after being ignited. The Flathead is one of ten national forests in Montana that stretch from the heavily timbered high peaks of western Montana to the open expanses of the eastern plains. Encircled by other national forests and protected lands, the Flathead lies on the western slope of the Continental Divide and contains 2.3 million acres, 47 percent of which is congressionally designated wilderness. It provides habitat for wolves, peregrine falcons, bald eagles, and grizzly bears. Wetlands, ponds, and lakes are scattered throughout the forest, providing refuge to numerous species of waterfowl. The Flathead is among of most scenic and heavily forested units managed by the USDA Forest Service (FS). Glacier National Park adjoins the Flathead on its eastern boundary.

Local management and staff are committed to maintaining, protecting and restoring the forest's considerable resources for current and future generations, and they aspire to be leaders in conservation and sustainable multiple use management. The Academy field team was told they are team oriented and work together to accomplish their goals. The forest budget for FY2001 was $14.9 million and they had a staff of 201 FTE as of June 30, 2001.

As to fire management, the forest experiences an average of 52 wildland fires a year, most of which occur in July and August. About 61 percent are caused by lightning with the remainder being human caused. The forest had 81 fires in FY2001, all but two of which were extinguished during initial or extended attack. Of the forest's 2.3 million acres, more than 161,000 acres are protected by the Montana Department of Natural Resources and Conservation (DNRC). The forest protects about 135,000 acres of state and private lands within the forest boundaries. The forest's fire preparedness allocation was $3.25 million in FY2001, up from $2.7 million in FY2000.

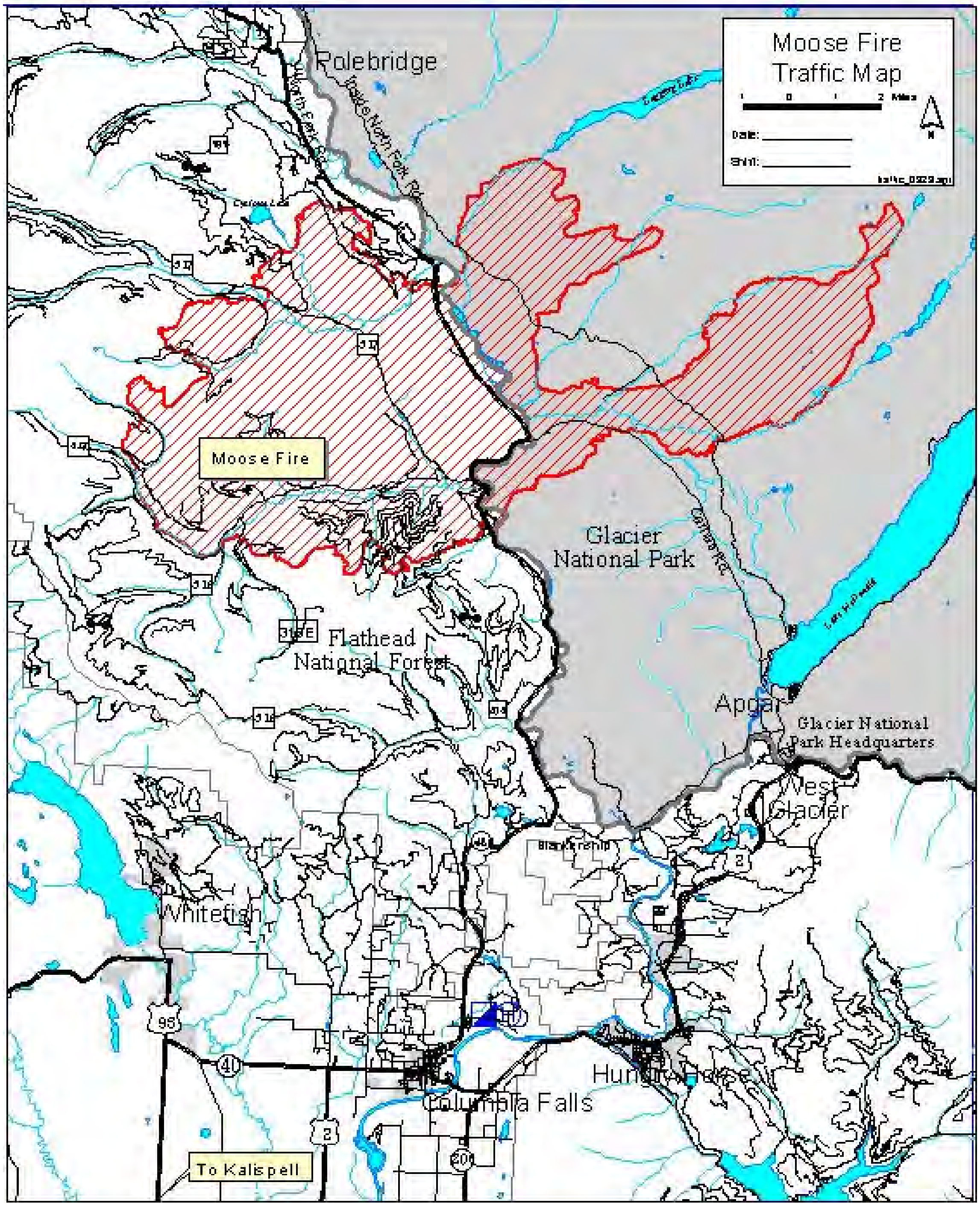
The forest manages 1.1 million acres of designated wilderness, and that includes almost 1 million acres in the Bob Marshall Fire Management Plan, which allows for wildland fire use. Over 6,000 acres were burned in FY2000 for wilderness resource benefits in the fire use program. The forest also manages a prescribed fire program focused on treating between 5,000 and 6,000 acres of hazardous fuels a year.

Features of the Land Affected by the Fire

The 71,000 acres within the Moose Fire perimeter included lands managed by two federal agencies (FS and NPS), a state forest managed by MDNRC, and private lands. The fire itself occurred on lands generally outside the community interface although isolated structures were defended by both federal firefighting forces and local county volunteer fire staff. Small communities such as Home Ranch Bottoms and Apgar, as well as private in holdings along the north shore of Lake McDonald were at times perceived as threatened by the fire, but no structures were lost.

In its later stages the fire burned about 25,000 acres in Glacier National Park but park visitors did not heavily frequent these areas.

Figure F-7. Moose Fire Footprint on Flathead National Forest and Glacier National Park



Fire-related Geographic Conditions

The Moose Fire occurred in rugged and heavily forested mountainous terrain that had not had a major fire in several decades. It burned on fuel models 8 and 10 (conifer stands), which included subalpine fir, lodgepole pine, and white bark pine. The slopes were moderate to steep on a west to southwest aspect. The soil was very rocky in places. A few meadows and scree slopes were in and around the fire perimeter.

When the fire started, fuels were drying out, temperatures were increasing, and there had been no precipitation for about two weeks. Energy release components (ERCs) were approaching 60, which is above the 97th percentile.

Local Demographic and Economic Characteristics

Flathead National Forest is located mostly in Flathead County, MT, which has a population of about 75,000. Its largest city is Kalispell, population about 17,000. The Flathead Valley is said to be home to some of the best year round recreational activities—summer or winter—including skiing, golf, sailing and snow mobiling.

Timber harvesting continues there, mostly on state and private lands. Harvesting on the Flathead has declined from a rate of over 100 million board feet a year to less than 20 million board feet in FY2001. Active timber harvesting had not occurred in the Moose Fire area for more than two decades.

Local Prevention and Mitigation Efforts

There had been few prevention or fire-hazard mitigation efforts in the Moose Fire area. The Firewise program was primarily a state activity that the Academy team was told had been modest in that area in recent years. Homeowners in the path of the fire generally had not taken extensive measures to make their properties resistant to wildland fire.

Land Units' Plans and Policies

At the time of the fire, the Flathead National Forest operated under a forest plan prepared in 1985. The plan was amended numerous times over the years, partly stemming from court decisions on local land management disputes. Provisions of the plan, as amended, appeared to have little or no impact on management of the Moose Fire or its total costs.

The Flathead and two other forests are collaborating on the initial stages of drafting a new forest plan. In fire management, returning the forest to its natural fire cycle will be a real driver of forest planning—the opposite of constraints in existing plans. If they can get there, they believe it will reduce suppression costs. However, that is not going to be cheap, according to forest managers.

The fire management plan (FMP) was last revised in 1996. A new plan had been drafted in 2001, but it was not in effect at the time of the fire. The FMP's provisions had little or no effect on the fire's cost. The forest followed a full suppression policy for the Moose Fire, although that evolved into minimum impact suppression tactics (MIST) once the fire entered Glacier National Park. Mandated MIST tactics in the park significantly reduced suppression costs.

Fire Preparedness

For the first time in many years, the Flathead's fire preparedness was fully funded, staffed and equipped. At the time of the fire, however, many of these resources had been diverted to other fires either locally or regionally. Three days into the fire, the Flathead's fire management officer was assigned to an IMT out of the state, a situation that had the potential to disrupt management continuity. However, the Forest implemented a transition plan prepared in 2000 for handing off fire program management to one of two individuals in the event of the FMO's absence for any reason. One of those individuals, the resource staff officer, assumed the forest's fire program leadership when the FMO was assigned to IMT duties. A transition took place that included a briefing on current fire activity, preparedness actions and anticipated tasks to be accomplished in conjunction with current fire program workload. During the FMO's assignment in Washington State, he remained in contact with the Resource Staff Officer by telephone. Even though the forest had implemented an excellent transition plan, interviews of local officials indicated that the loss of a highly experienced person in this key position with intimate knowledge of the local fire program could have affected the quality of management decisions.

Flathead County and the state also had resources available for fire suppression. The former was active in providing structural protection to homes and buildings threatened by the fire. There were 21 fire units in the county, all but two of which were volunteer units. Most were available to fight wildland fires under the county's own qualification system.

KEY DECISIONS AND ACTIONS AFFECTING MANAGEMENT OF THE FIRE

As noted above, the Moose Fire was one of the two fires of the 81 total fires experienced on the Flathead in 2001 that escaped initial/extended attack and grew into a large fire. Immediately following the lightning strikes on August. 14, another ignition demanded the attention of local firefighters. This became known as the Werner Peak incident, the largest and most active of about five fires within the local complex. The Werner Peak fire and nearby spot fires were given priority after reconnaissance flights on the 15th. Responsibility for this fire came under the Stillwater Unit of the Montana DNRC, as provided in the cooperative agreement between the state and the Forest Service.

A Type 2 incident management team commanded by Bill Swope, a district FMO on the Flathead, assumed management of the Werner Peak complex early on the morning of the 16th. Up to 700 people and extensive equipment were deployed on the Werner fire, and the teams successfully contained the fire in a week at about 700 acres.

Initial and Extended Attack

The Moose fire lay dormant for two days and was first spotted by an aircraft early on the afternoon of the 16th. It was about 4.5 miles west of the Werner fire. A Type 4 incident commander was dispatched to the fire that afternoon, and she arrived on the scene around 3 pm. There was no access to the fire, itself, and it was already beginning to make a run. An initial crew had been dispatched to the fire, and it was on the other side of a small drainage looking at the fire. A helicopter dropped down to pick up the Type 4 commander, and she flew over the fire to size it up. It was about 20 acres when the first crew arrived.

The fire moved up a steep west-facing slope in moderate winds and grew to about 60 acres. It was beginning to do some spotting. Air attack from the Werner Fire also looked at it but they didn't think retardant would be effective at that point. The IC asked them to return and look again. They found neither access nor potential escape routes. Two or three aircraft made water drops but with little effect.

The Type 4 commander also called a Type 3 IC and asked him to come to the scene. He made an initial examination and didn't like what he saw—a very active fire with a very active perimeter and no access. Some bucket work was going on, but they couldn't get on the fire at that time of day. He basically looked for somewhere to start. He was going to fly over the fire but didn't want to substitute a recon flight for the bucket work.

The fire burned actively throughout the night. The next morning, six smoke jumpers came over from Werner Peak and the Type 3 IC also ordered a dozer. They also had ordered a Type 1 helicopter and Type 1 crews, but none were available due to the higher priority assigned to other fires and the limited availability of this type resource. The IC provided that day (Aug. 17) an assessment to a Flathead district FMO that this was an incident that required Type 1 resources, especially crews, and one that required a real substantial air commitment. He was beginning to consider an indirect attack. An agency-standard complexity analysis completed by the IC and FMO indicated that the appropriate level of management for the incident at this time was Type 2.

Nothing tried so far had slowed this very active fire, including the Type 3 IC, six jumpers and one other person who got on the fire's perimeter. A Type 2 crew also arrived, but it was not effective, primarily due to the fire's size and very active behavior. There were more airdrops, including retardant; a dozer line below the main slope was created as part of an indirect strategy that tied into existing roads. However, this strategy needed time to pull off and the IC wasn't optimistic that they had it.

At this early stage, costs were not a consideration. Getting the needed resources to fight the fire was the main concern. The continuing fire activity outside the Moose Fire had stripped available resources in the geographic area. Everyone was dispatched out, according to one Forest Service manager.

WFSA Preparation

On the evening of the 16th, the district FMO began drafting the first Wildland Fire Situation Analysis (WFSA), with the help of others, on advice from crew on the scene that an incident management team and additional resources were needed. Looking at the national situation and discussing it with dispatch, they called Bill Swope, the IC on the Werner Peak Fire, and asked him if he would take charge of the Moose Fire as well. They also cleared it with the state. Given that Swope already had a team in place for the Werner Peak Fire, the managers thought this strategy would provide the best possibility to increase the priority of the combined incidents, leading to a better chance of obtaining the critical resources needed to accomplish the suppression objectives.

The initial complexity analysis prepared for the WFSA indicated a Type 2 IMT was appropriate for this fire. They were having success on the Werner Peak Fire with a Type 2 IMT, and Flathead management thought the Moose Fire was within Type 2 parameters. Initially, the fire was low-priority because it did not blow up right away and other larger fires were burning in Oregon and Washington[29]. At that point Moose wasn't threatening any structures. They could not get Type 1 crews, which was what the Type 2 IMT needed to manage the fire. According to one of the fire managers, the longer a fire like Moose sits there without the necessary resources, the greater the risk of major growth.

Additional feedback came the next morning on where the fire could be stopped, and alternative A in the WFSA—220 acres and full suppression—was adopted. Alternative B minimized costs by falling back and a 660-acre size, but the fire managers wanted to put it out as soon as possible to avoid major growth.

For the three to four operational periods that Swope was IC for Moose, he did not remember any big wind event, but the fire grew from 300 to 2,200 acres on August 20. By then he and his team were getting close to their 14-day limit, so it was decided to turn the Werner fire back to the state and order another Type 2 IMT for Moose.

The Moose Fire went through three additional WFSAs. Flathead management prepared WFSA #2 after the fire grew beyond the size estimated in WFSA #1. The third one was completed when they could not get resources, and the fire made its big push toward Glacier National Park. WFSA #4 was prepared in mid-September when it was clear the total fire costs would exceed the estimate of $9 million in WFSA #3.

In summary, it appears that the complexity analysis in WFSA #2, prepared and approved August 23, should have resulted in a requirement for a Type 1 IMT instead of Type 2. However, national fire activity at that time placed heavy demand on incident management teams. On that date, 10 of the 17 Type 1 IMTs in the nation were assigned, including both of the Northern Rockies Type 1 teams. Five of six Northern Rockies Type 2 teams also were assigned, and the sixth was out of rotation for rest and recuperation. Because of the large commitment of IMTs and the extended time that would be involved in bringing in an out-of-area team, the Northern

[29] These other fires included the Virginia Lake Complex, a case study reviewed by another Academy field team.

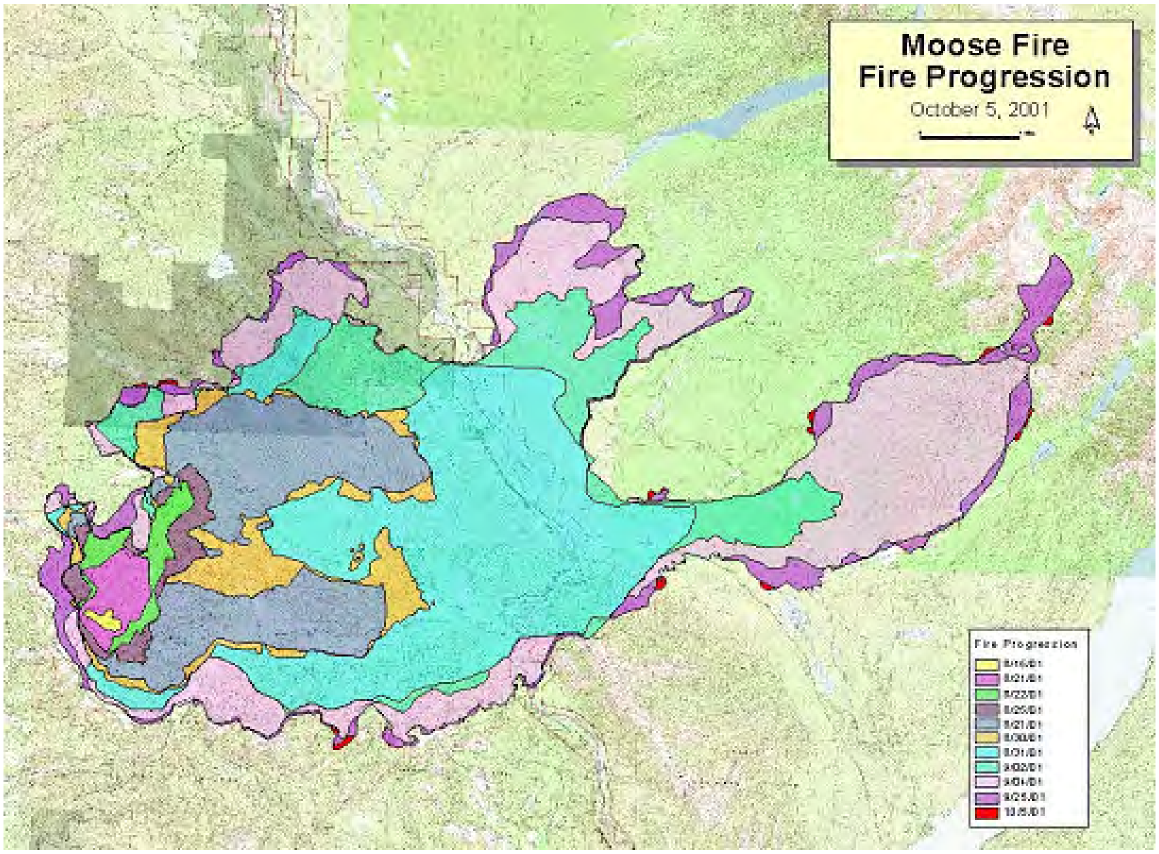
Rockies coordination Center had prepositioned a Type 2 IMT (Houseman) in Missoula. Because of Houseman's availability to deploy to the Flathead within 6 hours (compared to 24-36 hours required to mobilize and transport an out-of-area team), Houseman's team was ordered for Moose. This national competition for resources, however, did not lessen the need for a Type 1 IMT to respond to a fire of this magnitude.

The WFSA process also did a poor job of estimating final fire size and cost. For example, the highest cost estimate for the worst-case scenario was $9 million vs. final fire cost of over $20 million. Otherwise, WFSA preparation was timely and agency administrators were fully involved. In commenting on a draft of this report, a Flathead official said the WFSA process does not, and currently cannot, provide a completely objective way to assess the probable duration, commitment of resources, and therefore the cost of a large fire incident. Most fire managers, when faced with great uncertainty about the factors that will influence the outcome of a large fire, will underestimate those factors in the WFSA. He said, for example, when the original Moose WFSA was prepared in mid-August, it was impossible to predict that the 2001 fire season in northwestern Montana would have the second latest season-ending precipitation event on record, which extended the fire season and the life of this fire well into October. He also said a key element of the WFSA tool is daily review and revision as indicated by changed conditions in real time. This element requires line officers, fire managers, and IMTs to consider the direction and limitations provided by the WFSA, the probability of success of prescribed and alternative strategies and tactics, and together reflect that consideration in WFSA reviews and revisions.

Incident Management Phase

While the incident management phase actually began with the assignment of the Moose Fire to the Werner Peak complex and Swope's IMT on August 19, the first outside IMT, headed by Bob Houseman, did not arrive on the scene until August 22. By then the fire had made its first major run and had grown in size to more than 4,000 acres. The fire progression map below shows how the fire spread during the seven weeks before it was declared contained on October 5.

Figure F-10. Moose Fire Progression Map



Houseman and his Type 2 IMT were staffed mostly from North Carolina, and the Moose Fire was their first assignment on a major western fire. They were unfamiliar with the territory and asked for a longer-than-usual transition period of five days. Houseman's team transitioned with Swope on the 23rd and shadowed his team on the 24th. There was an agency administrator team meeting on the 23rd where Houseman's IMT was given WFSA #2 and the delegations of authority. Swope and others provided what information they could, but Houseman stated they did not get enough information to take over the incident, especially on the resources actually assigned to the fire. The Werner Peak Fire was sharing resources back and forth, and Houseman said there was a little bit of a breakdown in what resources his team would actually be receiving for Moose.

Local fire managers knew that the fire was moving into an area that would create a fuel-driven fire. In addition, the terrain was really rugged. It wouldn't have taken a wind event to escape. It was spotting for up to a mile. So containment lines and mop-up alone would not work. They had to put the fire out. This required significantly more work on the interior after containment lines were in to ensure that the fire was not going to escape. This, in turn, drove up costs.

The local managers got together with Houseman and decided that the only alternative was to anchor and flank the fire. Houseman faced a difficult situation as he had very limited experience with this terrain and fuel conditions. However, he said his team performed admirably under the circumstances. He sought direction on such things as the use of dozers and night lines. However, he could never get ahead of the fire.

At the time Houseman's IMT took over the fire, ground crews, other ground resources, and air support had transitioned over from Werner Peak. Resources were adequate initially. Houseman's problem was with the resources made available thereafter and their adequacy for the strategy they were given to execute. He said there was a fiasco in getting resources formally transitioned to Moose. It was not clear just which crews or engines would be coming to them. In hindsight, they should have ironed this out in greater detail.

According to the closeout report on the Werner Peak Fire, the ordering process got bogged down with the expectation that all resource demobilized from Werner would be reassigned to Moose. Negotiations between the two teams for resources confused and complicated the process. Ordering and reassigning of resources through dispatch was seen as a must, but some resources were directly reassigned without going through dispatch. Also, the dispatch operation did not evolve into expanded dispatch, the typical practice in such situations. The Flathead official who commented on the draft report said expanded dispatch was not implemented in a manner that may have met the organization paradigm of some; however, Flathead Interagency Dispatch Center (FIDC) had already increased the number of personnel and hours of operation and assigned specific large incident support duties to provide necessary service to the Werner Peak Fire. That level of service was further developed to accommodate the requirements of the Moose Fire. The large fire support responsibilities were managed separately from the on-going initial attack operations of FIDC, which were also increased with additional personnel and hours of operation. An exception was that aircraft dispatching continued to be managed by the initial attack function of FIDC since the available aircraft (air tankers specifically) were being used for multiple on-going large fires and new fires throughout the life of Moose. A separate and expanded media/public relations function was implemented by the Forest, which did not impact FIDC in any way. Although this operation was apparently effective, most fire units have been using the standard expanded dispatch organization for several years. Experience has shown that separating the initial attack and large fire support functions, spatially and organizationally, usually produces a better result for both activities.

Houseman made additional requests for Type 1 crews, but those resources were not available due to the heavy demand and commitment to higher priority fires elsewhere. He documented that he could not meet their objectives if he did not get these crews. The Moose Fire was not high enough up on the regional and national priority lists, he said.

Houseman's team went to work right away on developing an indirect strategy. When they began drafting their proposals, they met with Flathead and State of Montana forest managers to discuss environmental/T&E and safety issues. Local officials on the Flathead wanted Houseman's team to thoroughly understand local conditions so as to ensure that they would develop strategies and tactics that gave the highest consideration to firefighter safety. The environmental issues also had to be addressed. That included everything from burnouts to line construction that would help create the breaks that Houseman's team thought were necessary if the fire made a major run. The Flathead official who commented on the draft report said, however, that those were mitigated, and they did not cause any change in the general suppression objective for the fire or eliminate any strategic or tactical options that had a reasonable probability of success.

Houseman initially wanted to make a stand along the Coal Creek drainage area and another drainage that tied into Coal Creek on the eastern side, but he met resistance from local managers for the first two days of his command. That resistance was due primarily to a concern on the part of Flathead officials with more experience in the fuel type, terrain and fire behavior being exhibited. They did not believe the proposed plan had a high probability of success, and it may not have provided sufficient options to mitigate risks to firefighter safety. Houseman's team took over on the 25th and the fire blew on the 27th, so they had only had two days for preparation. During that time, they were trying to find places where they could take a stand and stop the fire. His whole philosophy there, as well as back in North Carolina, was to fight the fire as aggressively as they could without violating any of the fire safety orders. Even if they had been given a complete green light, he was not sure they could have succeeded, given the short time they had available before the fire blew up.

The extreme fire behavior on August 27 caused Flathead management to reevaluate the situation. On the 28th, they prepared a third WFSA calling for a Type 1 IMT. On the 29th, a Type 1 IMT headed by Larry Humphrey from the Southwest Region arrived and started the transition process. By the next day, when the Humphrey IMT assumed command, the fire had grown to 17,100 acres and it began active burning and crowning. Heavy fuel accumulations combined with steep terrain made progress difficult. On Sept. 1 the fire grew to 43,000 acres. It made significant runs to the east and south, crossing the North Fork of the Flathead River and entering Glacier National Park.

According to the deputy IC, the transition to the Humphrey IMT was good, but somewhat delayed by dispatch and travel time. The request for a Type 1 IMT was routed through the GACC and onto Boise where the contact was made with the Humphrey team, which was at the top of the on-call list. It was late in the day, causing further delay. The day after they arrived, the fire doubled in size.

Until the fire entered the Park, the direction was to minimize fire size while acknowledging public and firefighter safety first, protection of property second, and resource objectives third. The Park resource staff, however, wanted and the Delegations of Authority specified that the IMT was to manage the fire as much as possible using tactics that would minimize suppression effects because of the fire's location in a remote area with minimum resources at risk. In addition, the Park had direct responsibility for structural protection of buildings on private land near Lake McDonald within the Park boundaries. Structural protection of these buildings increased fire costs by about $194,000, but allowing the fire to burn where Park values at risk were limited lowered suppression costs by an undetermined amount.

The deputy IC said NPS was a full team member and a good partner. Nevertheless, terrain and fuels hampered the IMT, and a state official was concerned about losing potential timber resources. Despite the fact that directions were provided by three different cooperating partners—NPS, the state, and the Forest Service—cooperation among the three agencies was said to be outstanding.

Fire activity slowed on September 5 due to 0.2 inch of rain. For the next three days, very little fire movement was noted. Lower temperatures and higher humidity helped crews build fire lines by hand and with dozers. By then, mop-up and rehabilitation had begun and excess resources were being released.

Humphrey's team was nearing the end of its14-day assignment period, and Swope's Type 2 team was up in the rotation again, and Swope became IC for the second time on September 11. Because of the terrorist attacks that day, the IMT pulled everyone off the fire. They were back up and running on September 12. Swope was concerned there was a lot of old fire line that hadn't been mopped up. Humphrey's team had downsized personnel and equipment, but because a predicted season-ending weather event had not occurred, Swope believed they would be in business for some time. Therefore, they ramped up a bit. Total staffing had declined to 425 on September 10, but by Sept. 16 personnel assigned had increased to 695. According to Swope, there was still a lot of potential for additional fire growth.[30]

Swopes team's highest priority was to secure existing fire lines. Next was to get the smoke out of Home Ranch Bottoms. By the end of Swope's assignment period, the fire had grown to close to its final size of 71,000 acres, partly due to burnout operations to prevent further uncontrolled fire spread.

Emergency Stabilization and Rehabilitation

A Type 2 IMT headed by Chuck Stanich took over the fire from Swope's team on the evening of September 24. Stanich asked for the assignment due to his team's extensive burned area emergency rehabilitation (BAER) experience. The team implemented approximately $70,000 worth of BAER activities.

The Stanich team's first assignment was to go through the fire camp and release any equipment that was not needed. This team also provided protection for three or four structures in Home Ranch Bottoms, a community threatened by the fire.

The team supervised most of the suppression and BAER rehabilitation except for seeding and culverts. They also performed all runoff and drainage work. The team took limited suppression action in selected areas to keep the fire confined to the park. Their strategy was a continuation of the previous team's strategy. At the outset of Stanich's tenure, Flathead management revised the cost portion of WFSA because they knew the cost estimate would be exceeded. The previous WFSA's cost estimate apparently had little impact as a ceiling on total fire costs.

The Flathead official who commented on the draft report said the WFSA is intended—in fact it is required—to be reviewed on a daily basis and revised when changed conditions indicate revision to be necessary. Direction that is provided in a WFSA that is no longer valid as a result of

[30] The Anaconda Fire that occurred on Glacier National Park in 1994 made its big run in October.

changed conditions is replaced by updated direction, including cost estimates as needed. To be sure, the best possible factual information, professional assumptions, and projections should be used every time a WFSA is prepared. He said, however, to hold to an invalid WFSA's direction is not responsible, nor is it responsible to knowingly over-estimate conditions or limitations in a WFSA in order to avoid later situations where conditions in the WFSA are exceeded, requiring revision.

On October 5, management of the fire was returned to the forest following a formal declaration of full containment. The fire was not declared officially out until November, after the season's first snowfall.

Local Participation in Fire Suppression and Structural Protection

During the Moose Fire, Flathead County's fire and emergency services provided structural fire protection on private lands on the west side of the North Fork of the Flathead River. However, the county refused to participate in delegations of authority to the various ICs or to participate in a formal unified command.[31] Instead, the county established and maintained a separate incident management plan, incident command post (ICP), and organizational structure; conducted a separate planning process; and managed a separate process for ordering resources and implementing tactics. However, on several occasions, the second IC (Houseman) incorporated the county into his command structure, assigned the county responsibility for structure protection, and identified county resources as part of the tactical plan to protect private property.

The third IC (Humphrey) did not establish a similar relationship with the county. Moreover, his IMT opposed some of the actions planned or carried out by the county, believing that they were unnecessary and unsafe. Conversely, the county's emergency management director believes that the Forest Service "demonstrated a total disregard for the public's safety and well being" by abandoning the North Fork Community and relocating the fire base camp from in front of the fire to behind the fire (from North Fork to Columbia Falls).

The differences in interpretation and redemption of fire protection responsibilities between the county and the Forest Service and Montana DNRC are not new. The county believes that, while it can work with a unified command, it cannot legally delegate its responsibilities to the Forest Service. Conversely, the Forest Service and State believe that a delegation of authority is highly advantageous to provide comprehensive management and accountability for public safety and private property protection.

The Flathead FMO told the Academy team that wildland fire management cooperation with local governments normally occurs under the six-party agreement with the state. He believes the forest is not allowed to negotiate separate agreements with local governments. All 56 Montana counties are to be represented by the state, but Flathead and two other counties do not recognize this agreement.

[31] The county contends that a formal unified command was never established while Forest Service officials believed that the delegations of authority from the forest supervisor, the park superintendent and the state constituted such a command.

The state often has cost-sharing issues with Montana counties. If a local fire department responds to a wildland fire, they expect reimbursement, but they often don't get it if the fire is outside their protection district. By 2005, the goal is to have agreement on who is responsible for all state lands. Some land is now in no one's jurisdiction.

The Flathead FMO said here is some ambiguity in agency policy as to where FS responsibility for structural fire protection starts and stops. The county argued that they had to engage in structural fire protection because the Forest Service was not doing its job. The Flathead FMO agreed that local forces were not being used fully, however, since the county choose to conduct operations following a separate plan and organization, it was more difficult to coordinate the various fire suppression resources and actions than is desirable. The FS doesn't have the authority to dictate use of local resources, he said.

When the forest determines the location of a fire, they will respond with the closest available agency—FS, NPS or the state. Depending on the location of the fire and the level of attention of the dispatch staff, they also notify the county that they are responding to a fire at a given location. Flathead County then makes the decision as to whether they want to respond as well. The county emergency management director believes they should be notified immediately by the FS dispatch whenever there is a wildland fire detected.

The county believes that it should be reimbursed for its fire suppression services and has submitted a claim of over $291,400 to the Forest Service. At the time of the Academy's field visit, the Forest Service had thoroughly reviewed the county's claim and determined that services costing slightly less than $30,000 were appropriate for reimbursement from fire suppression funds under existing authority.

COST CONTROL MECHANISMS DEPLOYED DURING THE FIRE

The local land units and the IMTs share responsibility for controlling costs during a fire. On the Moose Fire, three such mechanisms deserve brief discussion here.

WFSA

As noted above, four WFSAs were prepared for the Moose Fire. Generally, WFSA preparation was timely and agency administrators were fully involved. However, the WFSA process did a poor job of estimating the final fire size and cost. For example, the highest cost estimate for the worst-case scenario was $9 million vs. a final fire cost of over $20 million. Also, the WFSA process did not appear to provide any meaningful cost ceiling for suppression operations. When fire costs approached the cost estimate in WFSA #3, the local managers simply prepared a fourth WFSA with a higher cost estimate.

Agency Line Officer Negotiations

Delegations of authority were timely and well prepared, and coordination between agency administrators was excellent. The several written delegations from the federal and state agencies for this fire generally mentioned costs as a consideration. For example, the FS district ranger's delegation of August 29 listed as one of nine principal objectives: "Effective management of costs commensurate to values protected and strategic direction in the WFSA selected alternative is imperative. Property accountability should demonstrate adherence to National direction on acceptable fire loss/use rates." Similarly, the NPS delegation of August 28 listed six management considerations, including: "Consider cost efficiency in all fire management decisions." However, the federal agency and state line officers were unable to coordinate with Flathead County emergency operations leadership or obtain necessary delegation of authority from the county, nor were county officials willing to grant such delegation.

Incident Business Advisor

An incident business advisor (IBA) was assigned to the Moose Fire a week after the fire started, about the time the Houseman IMT transitioned in. The IBA so appointed described his position as having "100-percent recommendation authority and zero-percent decision authority." He said the IBA represents the agency line officer; on the Moose Fire this was the forest supervisor. He also tried to team up with the regional office business and administration officer. He saw the job as needing someone who can be an extension of the forest supervisor for an emergency situation and serve as the contact between the IMT and the agency line officer. The IBA said he functioned equally in both directions, and he felt he was working for both.

The IBA attended the Houseman transition meeting. His impression was that the team was eager, hard working, knew how to suppress a fire. However, they needed help on how to do business in this forest – forms, policies, and procurement practices, that sort of thing. The initial effort was to sort out the "business matters" between the Werner Peak Fire and the Moose Fire. A big effort was required to get the equipment and supplies paperwork sorted out and to get the two camps coordinated and organized. The other major effort was to determine who and what were where and when on the two fires.

Cost-sharing Agreement

The Werner Peak Fire eventually burned onto Forest Service protected land. At that time, the forest and the state entered into a cost-share agreement using cost-agreement experts from the state and the forest. However, tracking and apportioning the resources and the cost of those resources became "extremely difficult," as noted by the IBA. For example, there were crews put on "stand-by" that were never assigned to either the Werner or the Moose fires. These costs then needed to be divided up between the state and the forest. Several months after these fires, they still didn't know what was the total fire cost or what costs should be apportioned to the state and the forest.

PRINCIPAL FACTORS DRIVING THE FIRE'S COSTS

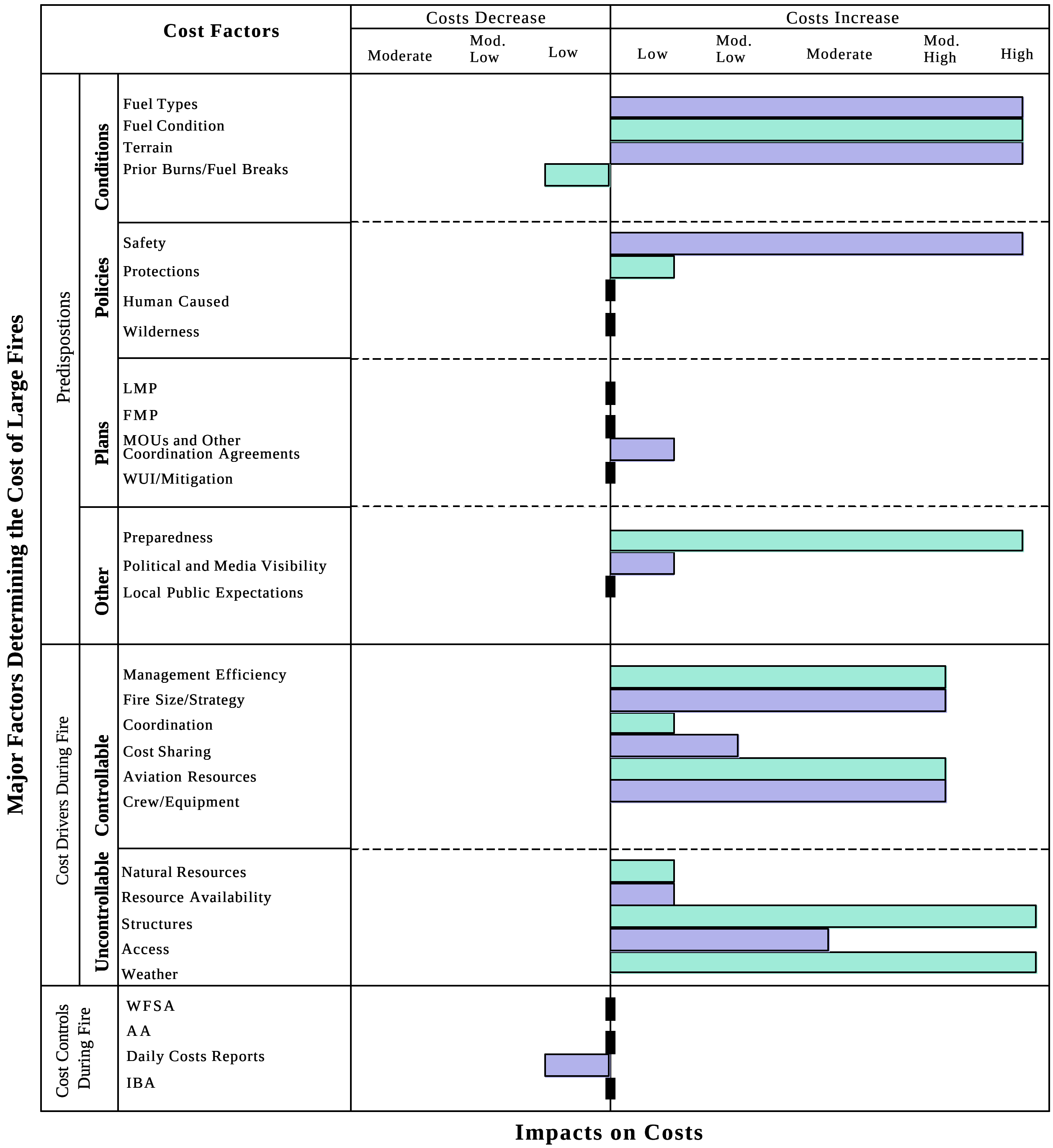
The total estimated cost for the Moose Fire was about $20 million at the time of our field visit. Given the size of the fire, the terrain and fuel loadings, and its duration, this amount appears to be reasonable, especially when compared to other recent fires of this size. The single most important contributor to the total cost was the escape of the fire from initial attack and the inability of any of the incident management teams to contain the fire in its early stages.

The NAPA team identified several other factors contributing to the fire's costs, but available records in the final fire package did not provide sufficient detail to estimate precisely the portion of these total costs attributable to any specific factor. Instead, the NAPA team developed qualitative estimates for these factors, based on its review of available records and on-site interviews.

Figure F-11 identifies these factors and their estimated impacts on total costs. It shows both increases and decreases in costs for the various factors. For example, the presence of a burned area from a 1994 fire in Glacier National Park helped slow the advance of the Moose Fire and likely lowered the costs that otherwise would have been incurred. On the other hand, the high political and media visibility of the fire, especially after it entered the park, increased public information costs.

Figure F-11. Generalized Relative Influences Of Various Factors On The Cost Of A Wildland Fire*

MOOSE FIRE, Flathead NF & Glacier NP, MT, 8/14/01 – 10/05/01



* The relative cost impacts of any given factor on a particular fire were judged qualitatively by the site visit team sometimes in consultation with personnel involved in fighting the fire. Some factors had different impacts during different stages of the fire. The case study write-up should be consulted for a more detailed description of each factor.

Predispositions

Many factors existing at the time the Moose Fire ignited contributed to the total costs. Heavy fuel loads, steep and rough terrain, and dry fuel conditions were the major drivers. Heightened concern for firefighter safety drove costs higher with the selection of indirect attack strategies and an expressed reluctance to put crews out ahead of the fire. (The Academy team supports this concern and is merely identifying firefighter safety as a cost driver.)

The absence of good cooperative relationships between FS, State of Montana, and Glacier National Park with Flathead County also increased costs, although to a lesser extent than the primary factors discussed above. Local firefighter resources might have made a greater contribution to fire suppression had their resources been integrated with federal resources in current fire protection plans, such as the Academy team found on the Green Knoll Fire.

Uncontrollable Cost Drivers

The NAPA team identified five uncontrollable factors that contributed to the cost of the Moose Fire:

1. Major wind events during the course of the fire led to its rapid spread, suspension of suppression operations, recall of firefighters to safety zones, and relocation of the incident base camp.
2. Difficult and complex relationships between Flathead Co. and FS and its IMTs resulted in independent suppression action by county firefighters and a $300,000 bill from the county.
3. The Flathead NF FMO was called out on August 17, three days after the fire started, to an out-of-state Type 1 assignment for 11 critical days. He appeared to have able, though less experienced, fill-ins but some continuity of oversight could have been lost
4. The September 11 terrorist attacks resulted in suspended air operations and slowed demobilization.
5. The NAPA team heard anecdotal assertions of poor conduct and performance by certain Type 2 crews, but they weren't reflected in the crew ratings. This indicates a need nationally for better evaluations, documentation, and follow-up of poor performance.

Of these factors, the weather was the most significant.

Controllable Cost Drivers

The NAPA team found no major questionable or inappropriate costs incurred, based on its review of the final fire package and interviews with FS and NPS officials. No one interviewed was aware of any inappropriate spending. However, the team identified three cost factors that could be considered controllable:

1. The Forest Service spent over $600,000 on structural protection activities, some on private land near Glacier National Park. About $200,000 resulted from an NPS policy to provide structural protection for private in-holdings. However, an argument can be made that the other costs were a local government or private-owner responsibility.
2. Each IMT had its own decision support systems and expert staff. Transitions were complicated by the use of different software and the need for data conversion by a private contractor. This increased costs and delayed some data products for a brief time.
3. Difficult and complex relationships between Flathead Co. and the FS, State of Montana, and Glacier NP and the IMTs resulted in independent suppression action by county firefighters and a $300K bill from the county to cover its costs.

CONCLUSIONS

The NAPA team found no fundamental problems with the management, strategy or tactics used on the fire. However, while the fire would have been difficult to suppress fully under the best of circumstances, there was some evidence that opportunities existed to improve the chances of containing the fire early in its development:

1. Initial attack reinforcements from off-forest were not ordered following the lightning storm of August 14. With multiple fires, near-record ERCs, and serious drawdowns of GACC and national resources for other fires, reinforcement orders and other steps, such as placing dozers or local fire engines on standby, might have improved resource availability for the Moose Fire.
2. There was a period of about two hours between the initial report of the Moose fire and the time the first air tanker was diverted to the Moose fire from Werner Peak. By then, the fire had grown to 20 acres and airdrops made thereafter were reported as ineffective. Also, smoke and terrain were a safety hazard. Had air tankers been diverted to the Moose fire sooner, there is a possibility that the Moose fire could have been contained on initial attack.
3. After the first few days, the fire spread so fast at times that none of the teams could keep up. Emphasis on suppressing the Werner Peak Fire occupied management's attention during this critical period. After that, indirect attack and marginal containment was the best anyone could do.
4. Pre-positioning additional resources and assignment earlier of a Type 1 management team could have improved their chances of keeping the fire small.
5. On the other hand, there were some significant benefits from the actions that were taken:
    - Consistent with the high priority for firefighter safety, there were no major injuries or deaths on a large fire of seven-week duration.
    - No structures were lost—not even a vacation cabin in the fire's path—nor was there other major private property damage.

- Potential spread of the fire into populated areas was prevented.
- There was excellent cooperation among FS, NPS, and Montana DNRC.
- There were some fire use benefits on Glacier National Park.

With five incident management teams on this fire, continuity of leadership and accountability are major issues worth considering on other fires. That raises the question of whether the 14-day rule should apply to management teams in the same way as it does to firefighters on the line. The local unit or a contractor who would be on site for the duration of the fire might provide some specialized services.

Box F-5. Contacts-Moose Fire

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Cathy Calloway*, Fire/Fuels Planner, Flathead National Forest, Kalispell, MT*
Jack Cohen,* *Research Physical Scientist, USDA Forest Service, MT*
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Jeff Whitney, *(Deputy Incident Manager), Chief, Fire Management Branch, Region 2, Fish and Wildlife Service*
Dale Williams*, Chairman, Flathead County Commissioners, MT*
Michael Woods*, Fuels Crew Foreman, USDA Forest Service, Flathead National Forest, MT*

***** *Fire Sciences Laboratory*

STAR FIRE CASE STUDY REPORT
Eldorado and Tahoe National Forests, California
August 25 – September 22, 2001

On the morning of Saturday, August 25, 2001, a fixed-wing reconnaissance aircraft reported a wildland fire on private lands within the Eldorado National Forest. Although it was never confirmed, the fire—named the Star Fire—was assumed to be human-caused. Before it was brought under control 19 days later, this fire would burn almost 17,500 acres of public and private land on two national forests—the Eldorado and the Tahoe. The cost to suppress the fire was about $28.2 million, making it one of the most costly wildland fires in 2001.

In summary, the Academy field team that reviewed the Star Fire observed the following.

- The lack of the right resource (a Type 1 helicopter) at the right time prevented a successful initial attack. A Type 1 helicopter to assist in the initial attack did not arrive until more than 10 hours after the forest initially requested one and 5 hours after the fire began significant expansion. The helicopter delay may have been because of competition from other fires or a deficiency in communicating the need.

- The fire never posed a threat to any human interface area. However, several factors left the forests with no option other than to aggressively suppress it. These factors included (1) the Forest Service's policy requiring that all human-caused fires be suppressed; (2) the presence of private commercial timberlands on the Eldorado; (3) highly valued natural resources on the Tahoe, including the northern-most native population of giant Sequoia trees, old-growth sugar pine trees, rust-resistant sugar pine populations, and old-growth and wildlife values; and (4) local expectations that the fire would be suppressed in the shortest length of time.

- Concern for firefighter safety shaped suppression strategies and the eventual size and cost of the fire. Direct line construction along the fire's northeast perimeter was halted as a safety precaution after a falling tree injured a hotshot crewmember. The method of suppression then shifted from primarily direct attack to indirect attack. For instance, a decision was made to locate the control line some distance away from the fire's active edge and to use a burnout to consume the fuel between the edge of the fire and the control line.

- Once the fire overwhelmed initial and extended attack and became large, there were few, if any, opportunities to significantly reduce the costs of managing the fire. For example, almost 25 percent of the cost of the fire was spent for aircraft, primarily Type 1 helicopters. However, neither the Academy field team nor a Forest Service regional fiscal review team found anything to suggest that their use was not cost-effective.

- Three Wildland Fire Situation Analyses (WFSA) were prepared for this fire. However, while the WFSAs were prepared by experienced personnel consistent with applicable guidance, they seemed to have little influence on determining strategy or controlling costs. The first WFSA significantly underestimated the final fire size (1,200 acres vs. almost 17,500 acres) and had a success probability of only 14 percent. The second WFSA significantly overestimated the final fire size (64,000 acres vs. 17,500 acres) and had a success probability of only 7 percent. The third WFSA was prepared on the 18th day and was not required for the transition from the Type 1 team to the Type 2 team. In addition, it had a success probability of only 65 percent and estimated the final fire size to be 94,000 acres even though the fire was 90 percent contained. Moreover, the strategy to suppress the fire was developed by the Type 1 Incident Commander independent of the applicable WFSA.

A brief chronology of the fire is provided in the box below.

Table F-9. Star Fire Chronology

Date	Daily Cost (in millions)	Cumulative Cost (in millions)	Activity
8/25/01	$0.6	$0.6	• At approximately 6:40 am, a fixed-wing reconnaissance aircraft reports a wildland fire on the Georgetown Ranger District of the Eldorado National Forest • First WFSA and delegation of authority are prepared
8/26/01	$0.8	$1.4	• Fire grows to over 3,000 acres and enters the Tahoe National Forest • Type 2 team assumes command
8/27/01	$1.1	$2.5	• Fire doubles in size to about 6,000 acres • The second WFSA and delegation of authority are prepared
8/28/01	$1.4	$3.9	• Fire grows to about 8,000 acres • Type 1 team assumes command
8/31/01	$1.4	$8.2	• Fire now about 10,500 acres • Letter of delegation prepared to begin Burned Area Emergency Rehabilitation (BAER)
9/3/01	$1.5	$12.8	• Fire remains at about 12,000 acres • Favorable conditions enable firefighters to initiate a burnout operation in Duncan Canyon.
9/4/01	$1.5	$14.3	• Fire is about 12,400 acres • Burnout operations continue for a second night
9/9/01	$1.4	$21.0	• The fire is about 16,100 acres • Burnout operations continue for a third night
9/10/01	$1.4	$22.4	• The fire is about 16,800 acres • Burnout operations continue for a fourth night
9/11/01	$0.9	$23.3	• The fire remains at about 16,800 acres • The fire is 90 percent contained • A Type 2 team assumes command • The third WFSA and Delegation of Authority are prepared
9/12/01	$0.9	$24.2	• The fire remains at about 16,800 acres
9/13/01	$0.8	$25.0	• The fire is declared contained at 16,800 acres (Note: Later revised to almost 17,500 acres)
9/18/01	$0.4	$27.8	• A Type 3 team assumes command • A fourth Delegation of Authority is prepared
9/21/01	$0.1	$28.1	• The fire is declared controlled
9/22/01	$0.1	$28.2	• Final estimate of costs

The table below shows the total costs by cost type. Crews and aircraft were the largest cost categories.

Table F-10. Star Fire Costs

Category	Cost (in millions)	Percent
Crews	$ 8.9	32
Aircraft	$ 6.4	23
Camp Support	$ 4.8	17
Personnel	$ 3.5	12
Equipment	$ 2.9	10
Supplies	$ 1.7	06
Total	$28.2	100

THE FORESTS' SETTINGS

The Eldorado and Tahoe national forests are 2 of 18 national forests in California. They are located in the eastern portion of the State between Reno, Nevada, and Sacramento, California, and straddle the north central Sierra Nevada mountains.

In addition to bordering each other, both the Eldorado and Tahoe forests also border the Humboldt-Toiyabe National Forest and the Lake Tahoe Basin Management Unit. In addition, the Eldorado borders the Stanislaus National Forest, while the Tahoe borders the Plumas National Forest.

The Eldorado National Forest

Portions of four California counties lie within the boundary of the Eldorado National Forest. The forest's western boundary interfaces predominantly with private lands. The forest's gross area is 786,994 acres, including 190,270 acres (24 percent) of non-federal ownership.

The forest ranges in elevation from 1,000 feet in the foothills to more than 10,000 feet above sea level along the Sierra crest. This mountainous topography is broken by steep canyons of four rivers. Plateaus of generally moderate relief are located between these canyons.

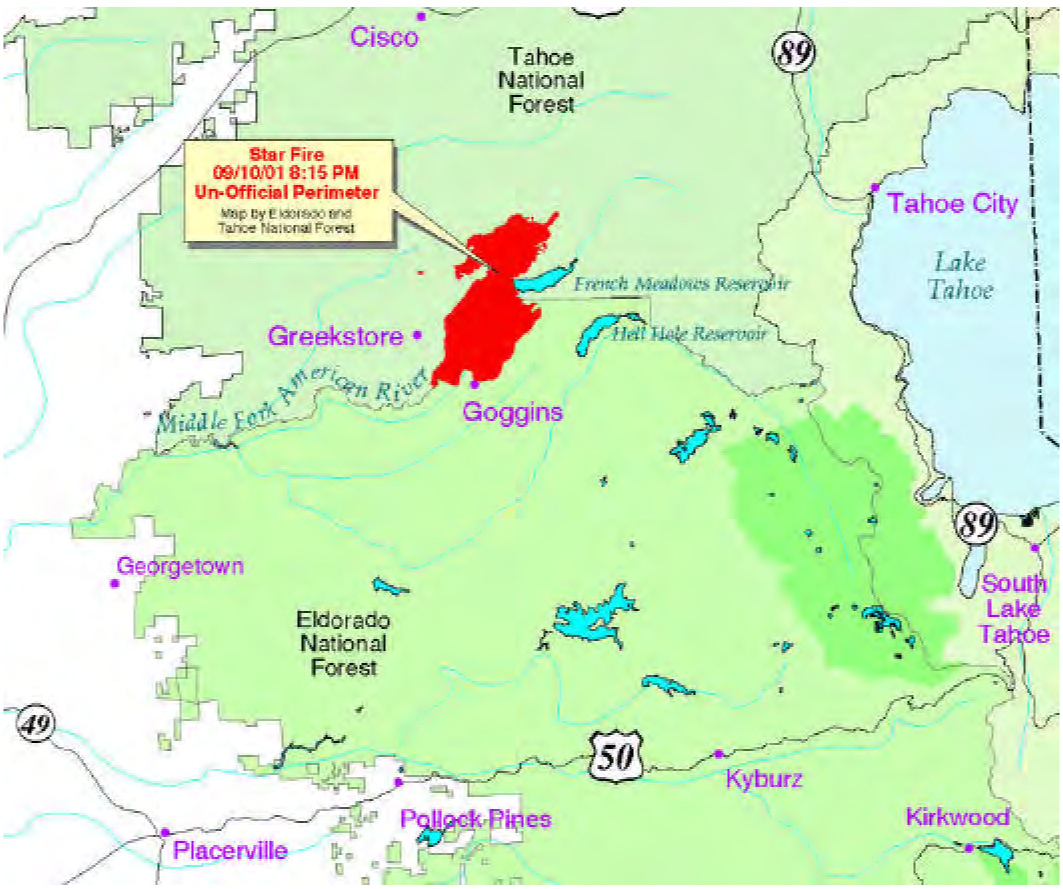
The principal vegetative types are woodland, hardwood (chaparral), mixed conifer, true fir, and subalpine. The major commercial forest species are white fir, red fir, Ponderosa pine, Jeffrey pine, sugar pine, Douglas fir, and incense cedar. A wide variety of hardwoods, brush, grasses, and forbs are mixed with each of these forest types.

The Tahoe National Forest

Tahoe National Forest lands range from an elevation of 1,500 feet in the golden foothills on the western slope to over 9,400 feet on top of Mt. Lola along the Sierra Crest. Of the 1,208,993 total acres within its boundary, 397,253 acres (33 percent) are owned by private individuals, corporations, and other governmental agencies.

A map showing the location of the Star Fire is included below.

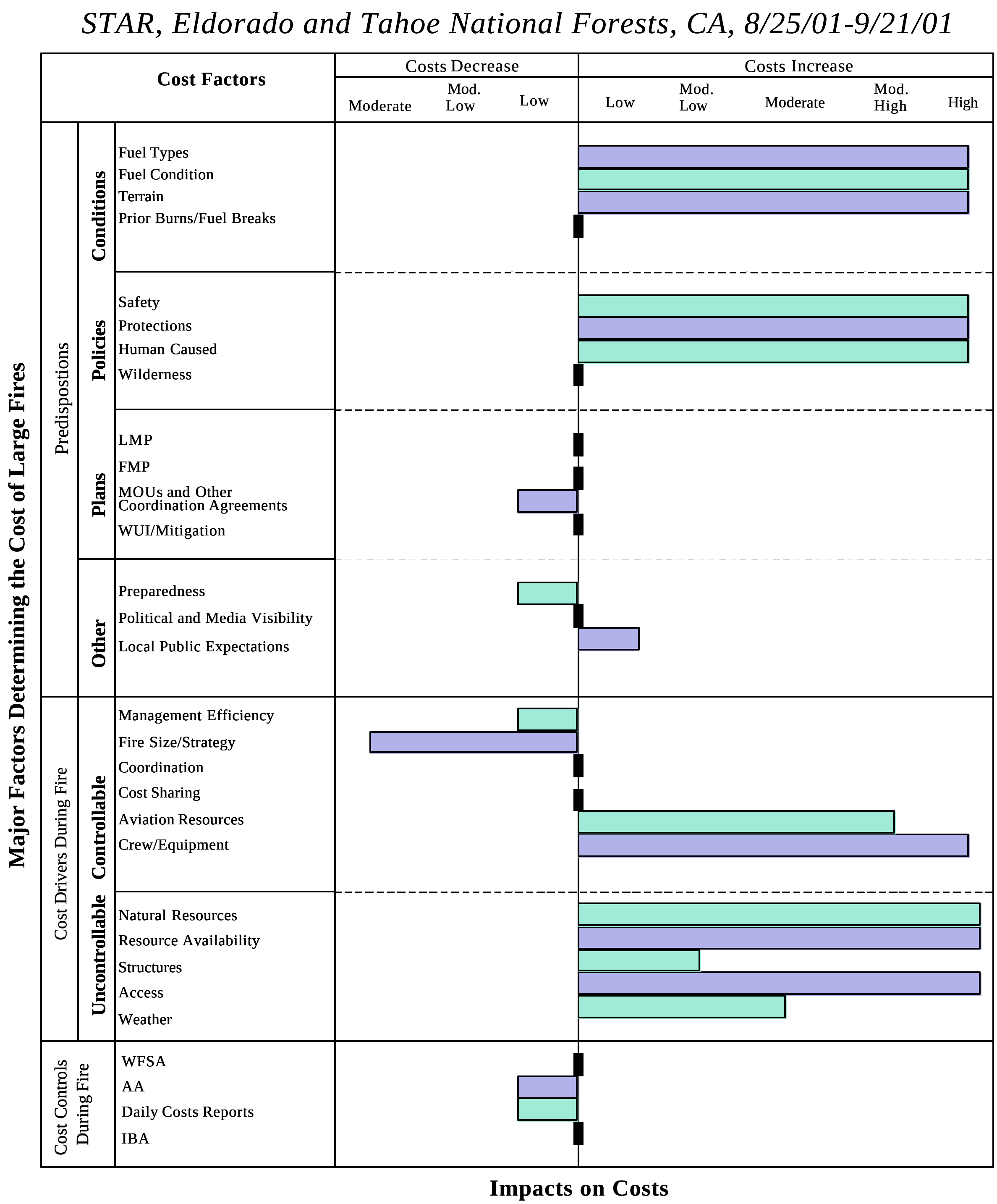
Figure F-12. Star Fire Location on Two National Forests



PRINCIPAL FACTORS DRIVING THE COSTS OF THE STAR FIRE

The Academy team identified factors that appeared to either increase or decrease the costs of the Star Fire. Although their impacts on costs could not be precisely quantified, the team was able to develop generalized estimates of their influence on costs on the basis of available records and on-site interviews. These estimates are reflected in the chart below and discussed in the narrative that follows.

Figure F-13. Generalized Relative Influences of Various Factors on the Cost of a Wildland Fire*



* The relative cost impacts of any given factor on a particular fire were judged qualitatively by the site visit team sometimes in consultation with personnel involved in fighting the fire. Some factors had different impacts during different stages of the fire. The case study write-up should be consulted for a more detailed description of each factor.

CONDITIONS WERE RIPE FOR A LARGE WILDLAND FIRE

The three major factors affecting fire behavior—weather, topography, and fuels—were all present prior to the Star Fire. On the day that the fire began, extremely dry, heavy fuels; low relative humidity; warm temperatures; and steep slopes greater than 80 percent combined to establish conditions ripe for a large wildland fire.

Prior to European contact, fire return intervals on the Eldorado forest were between 0 and 35 years in all vegetation classes except for chaparral, in which the fire return interval was between 35 and 100 years. Today, as a direct result of wildland fire suppression policy, fire return intervals have lengthened to 35 to 100 years, representing a loss of 3 to 5 fire cycles. These longer intervals have allowed forest fuels (surface, ladder, and species composition) to accumulate beyond historical levels with the increased prevalence of shade-tolerant conifers in the understory. This has created hazardous fuel ladders by linking surface fuels to upper canopy layers. These increases in vertical and horizontal continuity of fuels have increased the probability of large-scale, stand replacement fires that kill more vegetation and are more difficult to control.

The Eldorado forest has been on the leading edge of the effort to reduce hazardous fuels. Beginning in about 1978 the forest began a prescribed burning program. However, air quality limits the window of opportunity in which the forest can burn. Then in the early 1990s, the forest began looking at thinning high-hazard areas as a way of meeting its timber-harvest target. The forest has treated the easy acres by burning, masticating, and thinning about 4,000 acres a year. However, the hardest acres are still out there, and no fuels treatments had occurred in the areas burned by the Star Fire. Some areas on the Tahoe had been treated in the 1970s and early 1980s. However, they had not been treated since then, so they did not serve as a fuel break after the fire entered the forest.

In the past, the Eldorado forest harvested about the same volume of timber that grows on the forest each year. The volume grown is about 240 million board feet per year and they harvested about 236 million board feet.[32] At the height of the program in the late 1980s and early 1990s, they were also treating 12,000 to 15,000 acres a year with the money received from the Brush Disposal (BD) permanent appropriation and the Knutson-Vandenburg (K-V) trust funds. However, the forest's timber target now is only 10 million board feet and BD and K-V funds have dried up.

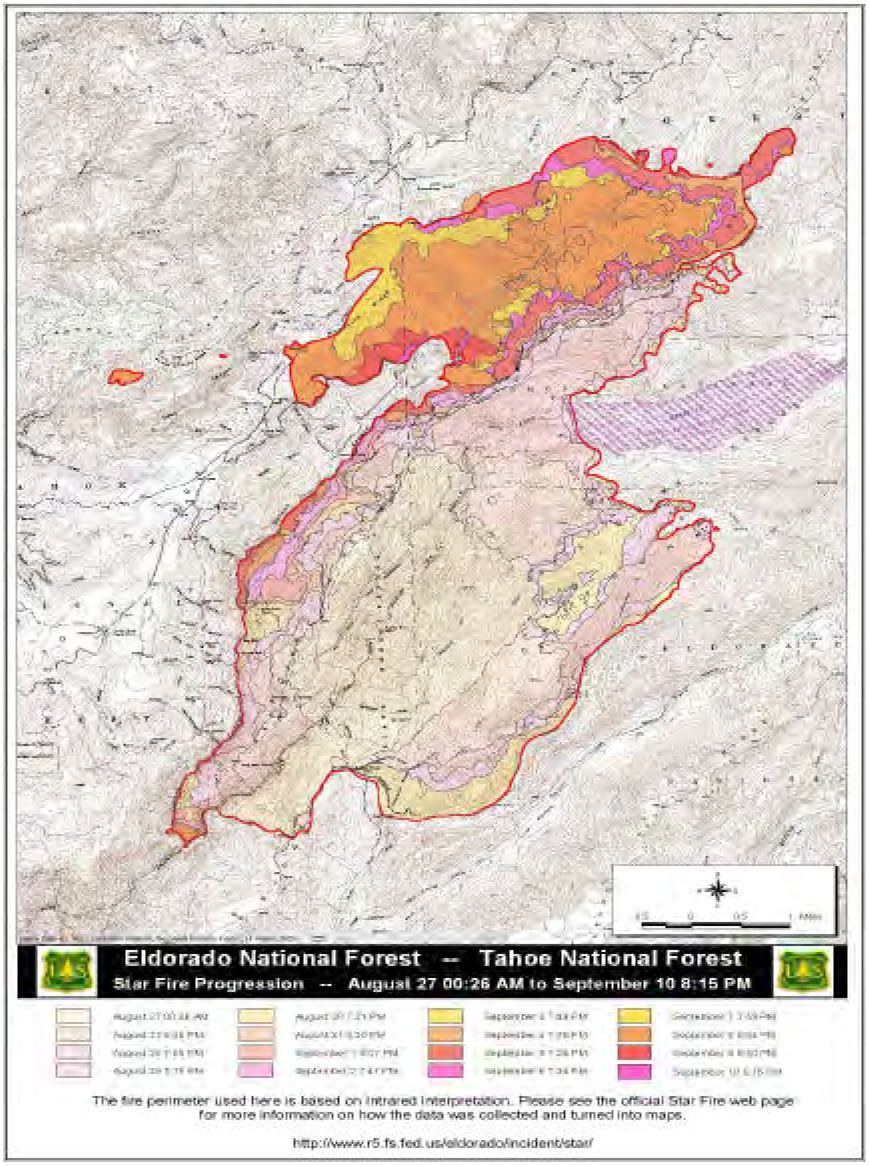
Almost half of the Eldorado forest (46 percent) is now in Fuel Model 10, which represents areas that are timbered and have a heavy downed fuel component. A large fire occurs on the Eldorado typically once every 7 to 14 years, usually during periods of very high fire danger for several days, low or no humidity recovery, and moderate to high winds.

The fire danger rating on the day preceding the Star Fire was extreme. Conditions were so severe on the two forests that both had instituted campfire restrictions in late June 2001. In addition, another wildland fire on the Tahoe—named the Gap Fire—had prompted the forest to ban all

[32] A board foot is a measure of wood volume equal to an unfinished board 1 foot long, 1 foot wide, and 1 inch thick.

campfires within its boundaries. The forests had also initiated aircraft reconnaissance flights to detect early fire starts.

The fire progression map below shows the spread of the Star Fire, including major expansions.



THE ELDORADO NATIONAL FOREST WAS PREPARED TO SUPPRESS A WILDLAND FIRE BEFORE IT BECAME LARGE

At the time of the Star Fire, the Eldorado forest was prepared to suppress wildland fires before they became large. For example, the Forest Service's Pacific Southwest Region (Region 5)—which includes both the Eldorado and Tahoe forests—maintained mutual aid for initial attack through a Statewide Cooperative Fire Protection Agreement (also known as the Four Party Agreement) and a Cooperative Fire Protection Agreement (also known as the Five Party

Agreement). A Cooperative Fire Protection Agreement for the Central Sierras had also been written. In addition, the Eldorado forest maintained cooperative and mutual aid agreements with several local fire districts either within or adjacent to its boundaries. However, since the Star Fire was limited to the forests' backcountry, none of the counties or local fire districts was involved in suppressing the fire.

In addition, at the time of the Star Fire, the Eldorado forest's dispatch organization was adequately staffed. The Eldorado Emergency Coordination Center (ECC) is an interagency center staffed by the Forest Service, the California Department of Forestry and Fire Protection (CDF), and all the county fire departments for El Dorado and Amador counties. The ECC is staffed 24/7 year-round, primarily by CDF (14 or 15 positions) and is located in one of their buildings. The Forest Service funds a Manager, an Assistant Manager, and five dispatchers. On the day that the Star Fire began, there were four Forest Service dispatchers and one vacancy. In addition, all five of the fixed lookouts identified in the forest's National Fire Management Analysis System (NFMAS) report were staffed on the day that the fire began.

The ECC uses a Computer Aided Dispatching (CAD) System that determines the appropriate resource response; that is, the number of resources necessary based on a fire's location, weather conditions, and resource availability. All responses are determined on the basis of the "closest resource concept."

As far as the availability of resources for initial attack, the Eldorado forest was short of its desired preparedness level. Of the 206 fire positions identified at the Most Efficient Level (MEL) for the forest, 60 (29 percent) were vacant on the day that the Star Fire began. However, there were no other fires on the forest at that time, so adequate initial attack forces were available. In addition, the forest had ensured an adequate pre-season sign up for local emergency equipment.

The Eldorado forest's working relationship with the Placer County Water Agency and the Boreal Ski Area also resulted in excellent cooperation. The water agency and ski area assisted with the logistics associated with the incident command post and incident base and provided a helibase location suitable for safe and efficient management of a complex helicopter operation.

THE UNAVAILABILITY OF THE RIGHT RESOURCE AT THE RIGHT TIME PREVENTED A SUCCESSFUL INITIAL ATTACK

No matter how well prepared a national forest, a few unwanted wildland fires will escape initial and extended attack. In the case on the Star Fire, the unavailability of the right resource at the right time prevented a successful initial attack.

During initial attack, the Type 2 helicopter on the incident was disabled when the bucket wrapped around the tail boom and landed on the stabilizer. A Type 1 helicopter was ordered about an hour after the fire was reported to assist in the initial attack. A Type 1 helicopter did not arrive until roughly 6 pm, which was more than 10 hours after the initial request and 5 hours after the fire began significant expansion. The helicopter delay may have been because of competition from other fires or a deficiency in communicating the need. This delay was the first of several significant events that shaped suppression strategies, fire size, and consequent costs.

The unavailability of a Type 1 helicopter in no way implies a criticism of preparedness. Obviously, a preparedness level that would virtually ensure that 100 percent of all wildland fires are suppressed during initial or extended attack would not be economically or politically tenable.

Wildland fire management is a form of risk management. Risk management is the process of assessing, evaluating, and manipulating exposures, likelihoods, or values of individual risks to maintain them at acceptable levels and at reasonable cost. Eliminating risk—in this instance, ensuring that a Type 1 helicopter would always be available--is not a cost-effective or feasible goal because the cost of risk reduction grows rapidly as any risk approaches zero. Thus, the incremental increase in effectiveness of having an additional Type 1 helicopter available would need to be weighed against the incremental increase in cost when it is idled or used simply because it is available.[33]

ONCE THE FIRE BECAME LARGE, THE ONLY OPTION WAS TO SUPPRESS IT

Once the Star Fire escaped initial and extended attack and became large, several factors left the Eldorado forest, and subsequently the Tahoe forest, with no option other than to suppress it.

For instance, Forest Service policy requires that all human-caused wildland fires be suppressed. Because the Star Fire was likely human caused, the forests had no option, given the policy, other than to suppress it. In addition, according to both forests' Fire Management Plans (FMP), the appropriate management response for most wildland fires on the forests is "a suppression action." Moreover, under the FMPs, a fire-use fire requires an approved Fire Use Guide for a specific area. However, at the time of the Star Fire, none had been completed.

The values at risk also required both forests to aggressively suppress the fire. During the first few days, the Star Fire burned over 3,600 acres of private commercial timberlands within the Eldorado forest's boundary. According to the forest's FMP, "suppressing fire aggressively is the highest priority on private lands and public lands adjoining private lands."

When the fire burned onto the Tahoe forest, protecting natural resources became a primary concern. Natural resources threatened by the fire included the old growth and wilderness characteristics in the Duncan Canyon Inventoried Roadless Area, the northern-most native population of giant Sequoia trees (Big Tree Grove), old-growth sugar pine trees, and rust-resistant white pine populations. In addition, the January 2001 Sierra Nevada Forest Plan Amendment—which amended the land and resource management plans of 10 national forests, including those of the Eldorado and Tahoe—limits the use of fire-use fires in these areas.[34]

[33] See *Fire Economics Assessment Report*, Fire and Aviation Management, USDA Forest Service (Sept 1, 1995).
[34] *Record of Decision: Sierra Nevada Forest Plan Amendment Environmental Impact Statement*, USDA Forest Service, Pacific Southwest and Intermountain Regions (Jan. 2001).

During the fire, 40 firefighters used tactics similar to those used to protect structures to reduced dense vegetation and create defensible space around one Sierra redwood grove. They also spent about $2,000 to protect four rust-resistant white pines having an estimated resource value of $20,000.

At no time did the distribution and severity of the Star Fire pose a threat to any human interface area. However, the Placer County Water Agency has many power generating structures in the area of the fire. The fire also threatened power lines, old mining cabins and other archeological and historic sites, and grazing allotments.

Finally, local expectations were that the fire would be suppressed in the shortest length of time. Responding to several media sources that had reported that there was a "let burn" strategy for the fire, the Forest Service issued press releases stating that from initial attack on, all personnel assigned to the fire had "made maximum effort to put the fire out."

FIREFIGHTER SAFETY WAS A HIGH PRIORITY

On several occasions the Incident Management Team and agency administrators (line officers) discussed the cost of strategic and tactical decisions, including the use dozers and Type 1 helicopters. However, firefighter safety and minimizing the size of the fire drove the decisions. Cost did not become a primary consideration until they began to demobilize.

The 1995 Federal Wildland Fire Management Policy and the 2001 update state that the "protection of human life is the first priority in wildland fire management."[35] This priority is captured in the Sierra Nevada Forest Plan Amendment and the forests' FMPs as well as in the four Delegations of Authority prepared for the Star Fire.

During the fire, the placement of ground crews at critical sites was often not possible because of very steep and unsafe terrain. For example, conditions at the bottom of Duncan Canyon were much too hazardous for firefighters to enter because of the lack of escape routes and safety zones.

In addition, the eventual size and cost of the Star Fire grew when direct line construction along the fire's northeast perimeter was halted as a safety precaution after a falling tree injured a hotshot crewmember. Although the Incident Management Team believed that it was safe to continue direct line construction, five hotshot crew superintendents refused.

The method of suppression then shifted from direct attack to indirect attack. A decision was made to locate the control line some distance away from the fire's active edge and to use a burnout in Duncan Canyon to consume the fuel between the edge of the fire and the control line.

[35] *Federal Wildland Fire Management Policy and Program Review*, U.S. Department of the Interior and U.S. Department of Agriculture (Dec. 18, 1995) and *Review and Update of the 1995 Federal Wildland Fire Management Policy*, U.S. Departments of the Interior, Agriculture, Energy, Defense, and Commerce; U.S. Environmental Protection Agency; the Federal Emergency Management Agency; and the National Association of State Foresters (Jan 2001).

THE EXTENSIVE USE OF TYPE 1 HELICOPTERS SEEMED APPROPRIATE

Because very steep and unsafe terrain made the placement of ground crews at critical sites often impossible, the suppression strategy relied on the extensive use of Type 1 helicopters to successfully stall the fire's advance on two occasions. Both the Academy field team and a Forest Service regional fiscal review team found nothing to suggest that the extensive use of Type 1 helicopters was not cost effective.[36] The extensive use of Type 1 helicopters appeared consistent with the incident objectives delineated in the WFSAs and incident action plans and was also a valid protection measure for the high-value resources at risk. In addition, the Type 1 team's use of Type 1 helicopters in lieu of airtankers resulted in a significant cost savings when measured by cost per gallon of water delivered to the fire.

A BURNOUT OPERATION WAS SUCCESSFUL

Firefighter safety in the steep canyons and allowing the fire to burn through Duncan Canyon in a more natural, less intense way, thus keeping tree stands more intact, were the primary reasons for going indirect and initiating a burnout to reduce fuel between the active fire and the control line.

Unfavorable winds delayed the burnout in Duncan Canyon. However, subsequent changes in the weather pattern contributed to significant decreases in fire activity as well as a successful burnout operation. Favorable conditions allowed the Incident Management Team to burn about 10,000 acres less than they originally planned.

The burnout operation to prevent the fire from extending beyond Duncan Canyon helped shape the course and cost of the fire. According to the burnout plan, although the operation itself would require additional air support to ensure that it proceeded at the planned rate, if successful it would bring the suppression effort to an end much more quickly. Moreover, the Burned Area Emergency Rehabilitation (BAER) Team Leader and a Resource Advisor on the Tahoe forest believe that the fire would have threatened more of the old-growth and wilderness characteristics in the Duncan Canyon Inventoried Roadless Area if the containment and burnout strategy had not been employed.

However, there was a period of 3 to 5 days when the Type 1 Incident Management Team had more personnel on the fire than it could effectively use. The Incident Commander and his Operations Chief debated whether to cut loose a couple of hundred people with the hope of getting them back or hang on to them until the weather changed and they could begin the burnout. They decided to keep the resources on the fire rather than risk not getting them back when conditions were favorable to initiate the burnout.

[36] *Star Incident: Regional Fiscal Review Team Report*, USDA Forest Service, Pacific Southwest Region, Eldorado and Tahoe National Forests (CA-ENF-012745, Sept. 2001).

DEMOBILIZATION APPEARED TO REFLECT A CONSIDERATION OF COSTS

Under the demobilization plan, release priorities established by the Type 1 Incident Commander were as follows: (1) state and local cooperators, (2) contract crews and equipment, (3) Type 1 hotshot crews, (4) Type 2 crews from outside of the region, and (5) Type 2 crews in the region. Demobilization and resource orders were used to scale back staffing where the workload was tapering off and to readjust staffing where it was increasing. Some personnel were shifted from one unit to another on the basis of anticipated and actual workload.

The Type 1 team also appeared cost-conscious in maximizing the utilization of contracted equipment. Members identified contracted equipment that could be replaced with cache items. In addition, several large visuals, such as spreadsheets and camp maps, were used to identify and track contracted units. Underutilized or ineffective items were identified and released in a timely manner.

For example, up to four airtankers were used on the first 5 days of the fire. However, when they proved to be ineffective in suppressing the fire because of the steepness of the slopes, they were placed back into initial attack status. In addition to reducing the cost of the Star Fire, placing airtankers back into initial attack status can also reduce region-wide costs and improve initial attack efficiency by making them available for other fires.

OVERSIGHT WAS PROVIDED BOTH DURING AND AFTER THE FIRE

Region 5 has a good pool of Incident Business Advisors (IBA) and one was assigned to the Star Fire after the Type 1 team assumed command. Currently, the focus of an IBA on a wildland fire is very narrow. However, the region has implemented an IBA training program to broaden their focus and to make them more valuable to agency administrators. The IBA on the Star Fire spent a lot of time looking at contracts and issues of the Finance Section and buying unit. He would question rather there were less costly alternatives available. Both Forest Supervisors also looked to the IBA to address problems they were experiencing with contract equipment and other cost-related issues.

During a fire, it is important that an Incident Management Team has the appropriate financial and logistics expertise to manage the business side of the fire. During the Star Fire, the Type 1 Team's Finance Section provided expertise in the finance area to oversee processes and operations in support of the fire and to ensure proper incident business management.

After the Star Fire, Region 5 performed a Large Incident Cost Assessment that focused on the fiscal aspects of the fire's management. Depending on the resources available, the region conducts such reviews of two or three large-cost fires each year to identify primary cost drivers. The Regional Incident Administrative Coordinator is then using the results of these reviews to influence the tools and activities that support the Incident Management Teams and forests and to identify opportunities to improve efficiency as well as needed technologies.

COST-RELATED CONCERNS AND OBSERVATIONS

Although there did not appear to be an opportunity to significantly reduce the costs of managing the Star Fire after it became large, there did appear to be opportunities to improve the overall efficiency and effectiveness of the fire suppression effort.

The Value of Wildland Fire Situation Analyses in Reaching Informed Decisions

Three Wildland Fire Situation Analyses (WFSA) were prepared for this fire. However, while the WFSAs were prepared by experienced personnel consistent with applicable guidance, they seemed to have little influence on determining strategy or controlling costs.

The first WFSA was prepared on the first day for use by the Type 2 team. Its target outcome significantly underestimated the final fire size (1,200 acres vs. almost 17,500 acres) and had a success probability of only 14 percent. Like many WFSAs, it was prepared under pressure and in a short period of time in preparation for the transition to the Type 2 team.

Agency administrators quickly realized that they had "drawn the box too small" when on the second day the fire grew to over 3,000 acres. The second WFSA was prepared on the third day to guide suppression actions by the incoming Type 1 team. While the first WFSA was overly optimistic, the second WFSA reflected a worst-case scenario. Its target outcome significantly overestimated the final fire size (64,000 acres vs. almost 17,500 acres). According to agency administrators, they were only one wind event away from a 120,000-acre fire.

The second WFSA also had a success probability of only 7 percent. However, according to agency administrators as well as the Type 1 Incident Commander, the WFSA process has become extremely complicated and the series of assumptions results in the low probabilities. Although the WFSA told them that their preferred alternative had only a 7 percent probability of success, they knew in their guts that the probability of success was much higher.

Rather than rely on the second WFSA, the Type 1 Incident Commander, who is also the Eldorado forest's Fire Management Officer, developed his own strategy to suppress the fire. He then ordered resources based on his target outcome, in effect invalidating the WFSA.

The Incident Commander's strategy was a "best-ridge," rather than a "next-ridge," strategy that looked out 2 to 3 days. Although the target outcome in the second WFSA estimated the final size of the fire to be 64,000 acres, his strategy was to contain the fire at between 25,000 and 30,000 acres. The Incident Commander credits the favorable change in the weather, the success of the burnout operation, and the effective use of Type 1 helicopters for limiting the fire size to less than 17,500 acres.

The third WFSA was prepared on the 18th day for use by the incoming Type 2 team. This WFSA was not required for the transition to the Type 2 team. In addition, it had a success probability of only 65 percent and estimated the final fire size to be 94,000 acres even though the fire was 90 percent contained.

The Fire-Related Experience of Some Agency Administrators and Resource Advisors

The overall responsibility and accountability for large wildland fires rests with the agency administrators. Therefore, knowledgeable and capable agency administrators are essential to effective cost containment.

Both the Academy team and the regional review team found that, overall, cooperation among the Resource Advisors, BAER Team Leader, and Incident Management Teams was excellent and facilitated the implementation of cost-effective tactical measures to protect natural resource values. In addition, both Forest Supervisors and District Rangers took an active role in the fire.

However, several line officers assigned to the Star Fire expressed concern about their lack of experience in dealing with a large wildland fire. Comments were made about the fire being a "baptismal;" not being as prepared as they should have been; lacking the experience and knowledge of fire effects, fire management, and fire behavior as well as fire-suppression skills; lacking a clear understanding of the roles of and relationships with other parties; and being directed by previous supervisors not to make themselves available for wildland fire assignments. This lack of experience was mitigated to a large extent because the Type 1 Incident Commander on the Star Fire was the Fire Management Officer on the Eldorado forest.

Several Resource Advisors expressed similar concerns. For one, the Star Fire was the first time that he had worked as a Resource Advisor and he did not have a good understanding of his role. Another Resource Advisor "scrambled" for 3 or 4 days trying to pick peoples' brains as to what her duties were supposed to be. Moreover, neither of the Resource Advisors had received any Resource Advisor training. However, their lack of experience and training was mitigated to some extent by the availability of resource staff on both forests to help ensure that timely and accurate resource information was available to the Resource Advisors.

The Performance of Some Contract Crews and Equipment

There was occasionally a delay, especially during the first few days, in getting some federal Type 1 hotshot crews to the incident. This was due primarily to the distance that the crews had to travel. However, the Incident Commanders on the Star Fire received all the crews that they requested within a few days.

While the number of crews was not an issue, their performance and productivity were. When an Incident Management Team orders a Type 1 or Type 2 crew, it has no idea how the crew will perform. On a given day, there were up to 20 contract crews on the Star Fire. The Type 1 Incident Commander, both Type 2 Incident Commanders, and other Forest Service officials expressed concern about the poor performance and productivity of some of the Type 2 contract crews. They expressed similar concerns about some Type 1 inmate crews from the California Department of Forestry and Fire Protection, stating "thirteen felons and a captain is not a Type 1 crew." They believed that the poor performance and productivity of some of the nonfederal crews necessitated deployment of additional crews and slowed the implementation of the strategy. For instance, the performance and productivity of some Type 1 and 2 nonfederal crews resulted in "doubling-up;" that is, assigning two nonfederal crews to do the work of one Forest Service crew.

Contract equipment was also a problem. Much of the contract equipment could not pass pre-inspection. In addition, several pieces were in such bad condition that they had to undergo significant repairs before they could even be sent home.

The Availability of Forest Service Personnel to Fill Key Non-Firefighting Positions

While crew availability was not an issue, the Type 1 team had difficulty filling key non-firefighting positions. This difficulty was linked to two issues. One is the National Wildland Coordinating Group's work/rest guidelines limiting incident assignments for all personnel--including those in non-firefighting and support positions--to 14 days, excluding travel. The other is the reluctance of a growing number of Forest Service personnel to participate in fire suppression activities. Personnel from the California Department of Forestry and Fire Protection (CDF) were able to fill many of these key positions, including safety officers and demobilization unit leaders. However, it costs considerably more to use CDF personnel than it does to use federal employees. For example, CDF personnel are paid portal-to-portal, 24 hours a day, which drives up costs considerably.

In addition, the 14-day work/rest guidelines require additional personnel just to track when individuals arrive on a fire and when they are to be released. Transitions between Incident Management Teams are also costly. Moreover, the increase in transitions places an added burden on the various dispatch organizations.

The Cost of Contract Equipment

The regional review team reviewed the acquisition and utilization of specific kinds and types of contracted equipment and services that significantly contributed to the overall cost of the Star Fire. The team recommended that an assessment be done to determine if it would be more cost effective to distribute "standard camp facility needs, such as tents, generators, and computers" as cache items rather than to continue to lease them on each incident as is the current practice.

The Cost of a National Contract Caterer

The regional review team also observed that, over a 15-day period, the Forest Service could have saved $667,000 by utilizing mobile kitchen units operated by the California Department of Corrections in lieu of the national contract caterer.

Logistics and Communications

Logistics was a problem on the Star Fire. In particular, at the time of the fire, the Eldorado forest had not completed a plan for the quantity, location, and infrastructure needs of incident base locations to support large fires. The forest believed that such fires occur so infrequently (typically once every 7 to 14 years) that such a plan was not warranted. As a result, the first incident base quickly became too small for the resources arriving and had to be moved because of safety and archaeological concerns. Thus, a lesson learned from the fire is the need to better plan for the quantity, location, and infrastructure needs of incident base locations to support large fires.

Problems with telephone communications also contributed to the cost of the fire. The satellite system and the CDF communications van were expensive. In addition, peoples' time was required to manage the system and get expensive phone lines in place. Also, decisions were made and not made on the basis of the ability to communicate. The Incident Management Teams did not send crews out until they could communicate back and forth with them.

Box F-6. Contacts-Star Fire

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ACCOUNTING FOR WILDLAND FIRE COSTS IN WILDLAND FIRE SITUATION ANALYSIS (WFSA)

PROSPECTS AND PROBLEMS

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ACCOUNTING FOR WILDLAND FIRE COSTS IN WILDLAND FIRE SITUATION ANALYSIS (WFSA): PROSPECTS AND PROBLEMS

Introduction and Overview

Each year, thousands of fires are ignited by natural and human causes on lands managed by federal agencies. The vast majority of these fires are controlled and suppressed by initial attack efforts. However, some fires escape, requiring the responsible agency administrator[1] to organize and implement an appropriate suppression response based on a Wildland Fire Situation Analysis or "WFSA." WFSA is a decision support process that provides an analytical method for evaluating alternative suppression strategies that are defined by different goals and objectives, suppression costs, and impacts on the land management base. A WFSA alternative describes a suppression strategy consistent with the "delegation of authority," (a set of instructions) communicated from a land unit administrator to an incoming incident commander. The "delegation" identifies what is important to protect, and may also establish cost targets.

This paper asks two questions about WFSA: (1) how does WFSA currently consider the costs of wildland fire, and (2) how could it be improved? WFSA is a tool for analyzing potential decisions. People make decisions; WFSA only helps them develop a more complete view of the problem, identify where more or better information is needed, and gauge how different alternatives compare (based on criteria that the decision makers define themselves).

The federal fire management agencies do not have a consistent measure of efficiency for evaluating fire suppression efforts. WFSA represents efficiency with different measures, such as suppression cost efficiency, and incorporates judgments about efficiency. These measures all provide comparative or relative measures of decision alternatives being evaluated, but their validity may be limited by the methods that produced them.

History & Background of WFSA

WFSA is a complex, computerized decision support tool based on principles from the decision sciences.[2] It has evolved and been used over a number of years, beginning in the late 1970's with a change in fire policy that required an agency administrator to develop an Escaped Fire Situation Analysis or "EFSA" for fires that became uncontrolled. The general form of the EFSA

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[1] The term "agency administrator" is used in this paper to represent the individual with administrative responsibility for a land management unit. In the USDA Forest Service, this individual is referred to by the general title "line officer" and includes Forest Supervisors and District Rangers. In the US Department of the Interior (USDOI) the agency administrator has differing titles. For example, in the USDOI National Park Service (NPS), the agency administrator at the park level is the Park Superintendent. In the USDOI Bureau of Land Management (BLM) the agency administrator at the district level is the District Manager. In the USDOI Bureau of Indian Affairs (BIA) the agency administrator is the Superintendent. In the USDOI Fish and Wildlife Service (FWS) the agency administrator at the refuge level is the Refuge Manager.

[2] The decision science principles included in WFSA include decision analysis, multiattribute utility theory, and economic modeling. See, for example: Raiffa, H. (1970). *Decision analysis*. Reading, MA: Addison-Wesley. Von Winterfeldt, D., & Edwards, W. (1986). *Decision analysis and behavioral research*. New York: Cambridge University Press.

was embodied in the USDA Forest Service Manual (5131) as analytical requirements or "steps." In the 20-plus years of its implementation, the policy has undergone revisions leading to the directions that guide WFSA today. The Forest Service version of these directions is shown in Figure G-1.[3] In essence, the policy identifies three distinct analytical requirements for the agency administrator to meet:

1. Identify criteria for evaluating suppression alternatives;

2. Develop suppression alternatives; and

3. Analyze suppression alternatives using the evaluation criteria, and select thealternative that "best provides for firefighter and public safety, minimizes the sum of suppression costs and resource damages, and has an acceptable expected probability of success or failure."

The agency administrator is also responsible for approving the selected suppression alternative, notifying the firefighting teams of the selection and any modifications to it, monitoring and evaluating the relevance of WFSA to the fire situation, and filing WFSA with the final fire report.

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[3] The policy shown in Figure 1 is the Wildland Fire Management Policy for the Forest Service. Other federal fire management agencies have issued similar policy directions in their respective fire management policies. In the case of the National Park Service, the policy enabling WFSA is contained in RM 18, Chapter 9. Direction for the other DOI fire management agencies is provided in Departmental Manual 620 DM 1.

Figure G-1. USDA Forest Service Wildland Fire Management Policy, FSM-5131.1

5131.1 - Wildland Fire Situation Analysis. The Wildland Fire Situation Analysis (WFSA) (NWCG - WFSA, revised February, 1998) documents the decision-making process for determining the appropriate suppression action and estimated cost of an incident that is expected to, or has exceeded, the action planned for in the fire management plan.

5131.11 - Preparation Requirements. A WFSA must be completed when:

1. Wildfire escapes initial action or is expected to exceed initial action.
2. A wildfire being managed for resource benefits exceeds prescription parameters in the fire management plan.
3. A prescribed fire exceeds its prescription and is declared a wildfire.

5131.12 - Analysis Requirements. A Wildland Fire Situation Analysis (WFSA) must include the following steps:

1. Identification of Criteria for Evaluating Suppression Alternatives. Develop criteria that reflect the priority for firefighter and public safety, that reflect Forest Plan objectives and constraints (including environmental and social concerns), that permit assessments of potential resource damage, and that allow for estimates of potential suppression and rehabilitation costs. Consider local, regional, and national fire suppression activities and reinforcement capabilities.

2. Development of Suppression Alternatives. Develop alternatives, consistent with Forest Plan goals, that represent a range of strategies for the wildfire suppression situation. Each alternative must:

   a. Focus on firefighter and public safety,
   b. Be implementable,
   c. Be accompanied by a strategic plan of action,
   d. Calculate the forces required in consideration of those available,
   e. Assess the probability of success and consequences of failure using a decision tree (see WFSA for an example), and
   f. Estimate the time of containment and control, acres burned, suppression cost, and resource damage.

3. Analysis of Suppression Alternatives. Use the evaluation criteria to analyze alternatives. Determine whether estimates of expected wildfire and suppression actions are consistent with the Forest Plan objectives and values. Select the alternative that best provides for firefighter and public safety, minimizes the sum of suppression costs and resource damages, and has an acceptable expected probability of success or failure.

4. Approval and Notification. The responsible line officer selects WFSA suppression alternative and approves any and all revisions. The line officer ensures that the public and cooperators are informed of the selected alternative as appropriate and ensures that the geographic area coordination center is notified of the selected alternative and probable commitment of resources. The line officer ensures that an appropriate level Incident Management Team is assigned, based upon WFSA analysis of complexity.

5. WFSA Monitoring and Evaluation. Each day, the assigned line officer will validate the selected suppression alternative based on the current and predicted situation. The Incident Commander will revise and update WFSA prior to the next burning period, if needed; the assigned line officer must approve the revised WFSA.

6. Documentation. Before leaving an incident, the Incident Commander must ensure that WFSA, including any revisions, is documented and filed with Form FS-5100-29, Individual Fire Report.

The original EFSA policy provided little guidance about how the analytical requirements were to be undertaken. A generic paper template was provided, but local units (forests, parks, etc.) could modify and adopt the form they judged best. As a result, the earlier EFSA process was not standardized. Since the EFSA process was not computerized, it was often a listing of evaluation criteria, goals, and objectives, along with rough ratings of the relative importance of each. These ratings sometimes were numerical, but often were simply check marks (e.g., more checks for more important criteria). Decision alternatives were generally described straightforwardly as fire suppression tactics, and a typical EFSA might list three alternatives as, for example, direct attack, indirect attack, and direct/indirect attack. Each alternative would then be evaluated by a rating scale of "pluses" and "minuses" for how well it performed in terms of the evaluation criteria. Accompanying each alternative was an estimate of suppression costs and occasionally an estimate of the economic impact on the land.

An important aspect of the early EFSA was the general guidance about when the EFSA should be completed. The policy stated that the process should be completed when the fire exceeded initial attack. Since most fires exceed initial attack in the late afternoon or early evening, the analysis was often done late at night. As it took about three hours to complete, EFSA's were often done under extreme time pressure.

The EFSA changed to WFSA in the late 1990's as part of a shift in national fire policy. The most significant change was the development of a computerized version of WFSA by John Anderson (Balance Technologies, Missoula, MT), a private software developer who prepared a version of WFSA that could operate on a standard PC. The initial version of the "PC-WFSA" was piloted on the Willamette NF, and quickly adopted by other forests in Forest Service Regions 5 and 6. The effort was funded by the developer, and WFSA software was purchased by federal units as a commercial product. In approximately 1998, the Pacific Southwest Research Station purchased rights to the software from the developer.[4]

The evolution of WFSA to the PC-WFSA affected its implementation in several ways. First, it provided a standardized "form" for the analysis and simplified the documentation aspects. It also permitted units to "front load" or "template" parts of WFSA that are generic to classes of fire or fire situations that are typical of the unit, thereby reducing the workload associated with completing a WFSA. In addition, it provided WFSA a more powerful analytical framework and the ability to incorporate cost-related databases. At the same time, however, WFSA became more complex and less transparent to its users.

From a cost-control perspective, the early EFSA required the user to estimate and "consider" suppression costs as well as economic impacts to the land management unit. However, it provided no specific tools or processes to make such estimates. Cost-control was largely a matter of awareness and incorporation of cost factors into decision making as part of expert judgment and evaluation of suppression alternatives. WFSA, because of its computerized implementation, now incorporates more cost-related elements into the analysis, including suppression cost estimation as well as economic impacts to the natural resources reflected in

[4] Subsequent development and modification of WFSA was done by the PSW Research Station and led by Carl Dammann of the USDA Forest Service (now retired).

National Fire Management Analysis System (NFMAS) values.[5] However, neither WFSA nor its EFSA predecessor provides a means for including the monetary value of private inholdings and/or communities threatened by wildland fire. From a cost perspective, WFSA limits its economic analysis to elements under direct control and management by the federal agency.

Structure of the WFSA process

Currently, WFSA is synonymous with the computer program by which it is implemented. This need not necessarily be the case, because its fundamental principles may be followed even without using a computer. Using these principles, WFSA prioritizes alternatives according to three different approaches: (a) how well each alternative meets land and fire management objectives, (b) the suppression costs of implementing each alternative, and (c) the economic impact of each alternative on the natural resource base.

Values, goals and objectives in WFSA. In the early stages of the analysis, the user identifies evaluation criteria used to compare the decision alternatives. The software structures these into four distinct categories of value: Safety, Economics, Environmental, and Social. A fifth category called "Other" is provided to include factors not covered in the four preset categories. These value categories are further divided into subcategories. For example, "Safety" is divided into firefighter, aviation, and public. The user can specify additional subordinate categories. Each category should reflect the related contents of the land management plan for the unit. In practice, however, relevant and specific data from the land management plan and expertise on the natural resource areas involved may not be available when the WFSA is being prepared.

In this initial phase of preparing WFSA, the user assigns priority values, on a 1-10 scale, to each of the categories. The software prompts the user to specify an overall objective for the category. The same process applies for each of the subordinate categories. In principle, subcategories not relevant to the analysis are not included even if the overall land management plan for the unit may contain related land management objectives. For example, an incident occurring on a unit that has Threatened & Endangered Species land management objectives would not include that category if the fire was not expected to burn into areas where those resources could be harmed.

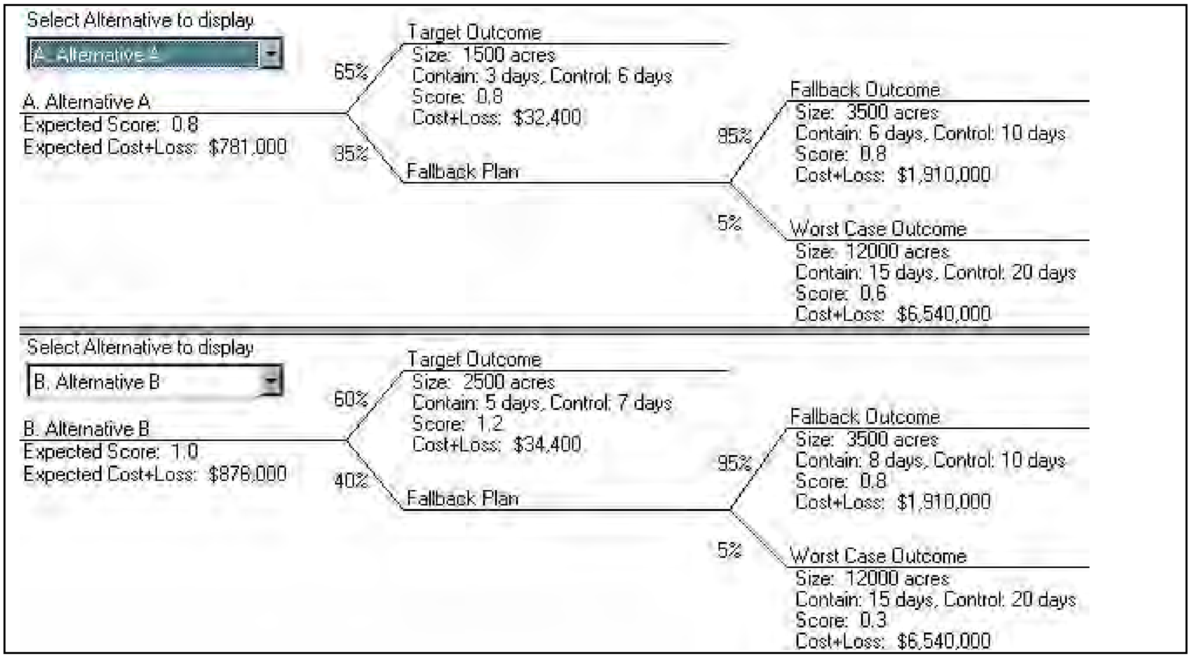
The numerical ratings for each of the categories and sub-categories are weighted in WFSA relative to the roles that each will play in evaluating the alternatives. The priorities and weights reflect the relative importance of the objectives included in the analysis, and are used to "score" each decision alternative.

Decision alternatives in WFSA. The analyst then specifies alternative strategies for managing the wildfire incident. Each strategic alternative is given a name and description. Refinements of WFSA software have included greater direction for users by providing example strategies—such as "minimize fire size" or "protect high value areas"—that can be selected from a menu. The structure of the problem is represented in a decision tree, such as the one shown in Figure G-2. The decision tree structure in WFSA is currently limited to two "options," with a maximum of

[5] NFMAS is the budgeting tool used by the Forest Service, the Bureau of Indian Affairs, and the Bureau of Land Management to estimate needs for firefighting preparedness. The National Park Service uses a similar tool called FIREPPRO, and the Fish and Wildlife Service uses FIREBASE.

three possible final outcomes: successful, successful fallback, and worse case outcome. For each outcome, the analyst provides a definition in terms of acres burned, time to control, and time to contain. The analyst specifies a probability of success for each, which the computer program automatically partitions into success and failure.

Figure G-2. Example of the decision tree representation of alternative fire management strategies in WFSA. In this example, Loss values were set to zero. Therefore the Expected Cost + Loss values shown in the example are for suppression costs only.



Although the analyst may specify any number of alternatives, only three or four are generally used. A minimum-cost strategy is encouraged but not required.

The analyst then works through the branches of the decision trees (strategies) to evaluate how well each outcome meets the fire management objectives previously identified, and assigns a rating on a 1-10 scale, with 1 = "worst" and 10 = "best."

Estimating suppression costs in WFSA. The analyst determines a suppression cost for each outcome associated with a given alternative strategy. Two different methods are provided for making this determination. One method selects individual suppression resource items from a menu that shows their unit cost. The program compiles the selected items and calculates their total cost, somewhat like a "shopping cart" approach. A second method uses average costs per acre. The program multiplies the acreage estimated for each outcome by these cost factors. The resulting dollar value is an estimate of suppression costs. If the user selects individual resource items, instead, the total cost for each outcome is shown and compared with a cost per acres estimate. The user can reconcile the two estimates to produce a final suppression cost estimate.

Suppression cost estimates in WFSA are not considered as budgets, but rather as projections of suppression costs for comparing the cost efficiency of alternative suppression strategies.

Economic evaluation in WFSA. In addition to comparing alternatives in terms of suppression costs, WFSA also evaluates alternatives in terms of their economic impact on the natural resource base using a table of NVC or "Net Value Change" figures obtained through NFMAS.[6] NFMAS values represent the monetary impact of fire on the natural resource base, either in terms of loss or Net Value Change. These values are imported when the WFSA begins, and are unique to the land management unit. NFMAS values are expressed as monetary impacts per acre, and are multiplied by the estimated number of burned acres.

This aspect of WFSA can be confusing to analysts not familiar with NFMAS values. For example, though users are free to change the NFMAS values to better suit local circumstances, few have confidence in how they would explain such changes. Though some NFMAS values have a clear underlying rationale because they are based on market values (e.g., timber) others may be less so because the basis for their monetary value is not clear (e.g., threatened and endangered species protection).

NFMAS values are limited to their direct impact on resources managed by the federal agency. This restriction means that values at risk not managed by the agency, such as private inholdings, will not be included in monetary form in WFSA even if they have a market valuation (e.g., residential homes). This does not mean that such values at risk are not taken into consideration as part of WFSA process, but rather that they are not directly considered in monetary form and are not calculated by WFSA.

Evaluation of decision alternatives in WFSA. The evaluation of decision alternatives in WFSA is a complex process based on the principle of "expected value." Outcomes are weighted by their probability of occurrence and are added to produce an overall score on which the various alternatives leading to those outcomes can be compared. The decision tree shown in Figure G-2 illustrates this process. The figure shows two hypothetical fire management strategies, one labeled Alternative A, and the other labeled Alternative B. Both strategies are shown as they would be represented in a WFSA, with a successful outcome, a successful fallback, and a worst-case outcome.

This example of the evaluation approach taken in WFSA considers only suppression costs. It considers each outcome as the leaf on a tree, and each leaf has associated with it an estimate of fire size. The suppression resources needed for each outcome are determined. Then, starting with the most distant branches (i.e., successful, fallback, and worst case), the suppression cost estimates are multiplied by their respective probabilities to produce an expected suppression cost for that branch. This is the expected cost for the entire branch. The expected cost of the overall strategy is obtained by multiplying the suppression cost of a successful outcome by the probability of success, and adding it to the expected cost of the fallback branch multiplied by the

[6] In general, the FS, BLM, and BIA use NFMAS values in the development of their WFSA's. The other fire management agencies, NPS and FWS, generally do not use NFMAS values. However, the capabilities exist within WFSA software for users from these agencies to input monetary impacts of fire effects that are appropriate for their respective land management units from the FIREPRO and FIREBASE models they use.

probability of failure. The resulting monetary value represents the expected cost of the strategy and, when done for both strategies in the example, serves as a basis for their comparative evaluation.[7]

The same general scheme is used to obtain expected NVC values, but here the calculations become more complex because each outcome has associated with it several NVC values, representing specific resources at risk in this fire. The program aggregates across NVC values for each outcome to produce a total NVC per acre. These values, then, are fed back according to the expected value calculations. The end result provides the same relative monetary comparison as in the suppression cost case.

A third evaluation score provided in WFSA is based on the priority ratings the analyst provides at the beginning, as well as the ratings of the impact of each outcome in an overall strategy. This approach is more complex than either of the two discussed above, but still utilizes the principle of expected value to derive an evaluation "score" for each alternative. To determine the score, the subjective ratings attached to each outcome are multiplied by their respective probabilities. The resulting expected values are then weighted by the relative coefficients associated with the various value categories. Then, they are added up to produce an aggregate score for each outcome. The same process of feedback through the decision tree for each alternative yields an expected value score to show how well each strategy meets, in a relative sense, the multiple objectives considered in the analysis.

Complexity analysis in WFSA. WFSA also helps its user to conduct an "Incident Complexity Analysis." The complexity analysis consists of a checklist based on eight categories of factors that contribute to the complexity of an incident. The user is guided through a menu system for each category and indicates which of the factors are present in the current situation. The checklist has 38 factors. After the checklist is completed, the user assigns an incident type to the fire, ranging from a low of "4" to represent Initial Attack, to "1" to represent a Type 1 incident. The assignment of an incident type to a WFSA fire is judgmental and is not based on a computational model within WFSA. The complexity analysis may tend to overweight the various factors in the complexity analysis, leading to more Type 1 incidents. However, no research is available on this matter. If such research did show such a bias, this could lead to additional fire costs, since Type 1 incident teams typically carry more management expenses than Type 2 teams, which also cost more than Type 3 teams. However, it should also be noted that the larger, more capable teams, if justified by the complexity of the fire, may help to hold costs down through more efficient management of the fire.

Implementation of WFSA in the Field

WFSA has faced several implementation challenges. While there are a large number of fires each year, only a very few require that a WFSA be done. Estimates of WFSA fire frequency suggest that less than 1% of all fires require a WFSA; by some estimates the percentage is as low as 0.25% to 0.5%. Forests that have a relatively high fire frequency may have several WFSA fires in a year. However, forests with low fire frequency may encounter WFSA fires rarely,

[7] The decision tree representation in WFSA combines suppression costs and NVC values. However, suppression costs are shown independently of NVC values in the tabular and graphic outputs of WFSA.

perhaps one every three or four years. Some agency administrators never have to prepare a WFSA on their unit. This means that the experience needed to prepare a WFSA is variable. Given the complexity of the tool, even a well-trained user may have difficulty maintaining proficiency in WFSA skills.

One objection to WFSA is the pressure to complete the analysis quickly after determining that a fire is beyond local management capabilities. Several factors contribute to this viewpoint. The WFSA process draws upon a broad diversity of land and fire management expertise. In addition to the agency administrator, WFSA requires inputs from a fire management officer and from natural resource specialists qualified to judge the impact of the fire on the unit's natural resources. Thus, preparation of a WFSA, though the responsibility of the agency administrator, is a team effort that calls upon the breadth of the unit's land and fire management expertise. However, this range of expertise may not be available at the time WFSA is conducted. Indeed, WFSA is often required at a time when most of the expertise needed is in the field dealing with the fire situation. WFSA is typically conducted in an "atmosphere of defeat," and during a time when human resources are the least available.

The challenges imposed on users to provide meaningful inputs to WFSA are exacerbated in stressful situations. As an analytical tool, WFSA is better situated to a less pressured situation. Furthermore, many users do not have a sufficiently deep understanding of the WFSA model to know how the process will utilize their various inputs, and how changes in the information and judgments the user makes will affect the output of the analysis.

A related issue is the knowledge-level that users have about the thought processes that are needed to provide meaningful judgments and estimates in WFSA. For some parts of WFSA, users may not understand a particular judgment that WFSA requires, leaving them with questions about how best to make ratings on subjective scales, or what the meaning of such ratings would be in light of one another. For example, one of the most confusing aspects of WFSA for most users is probability assessment. These assessments are a key element of the WFSA process because they support the weighting of coefficients by which decision outcomes are aggregated to compare the alternatives. In the case of suppression cost evaluations, probability assessments determine how expected costs are calculated. Systematic errors in these assessments can have a significant effect not only on the alternative supported by WFSA, but also on its anticipated costs. Many users have reported that this aspect of WFSA is one of the least sound aspects of the analysis, despite its criticality to the process. Users of WFSA generally have little knowledge of probability theory, and are unfamiliar with probability assessment techniques or how to apply them in the context of fire management decision analysis.

Similar difficulties are faced by users in other areas of WFSA where the quality of the WFSA process is dependent on the user's judgmental skills and understanding of the processes needed to produce the best quality inputs. These include the use of priority ratings to produce the weights used by WFSA in evaluation, judgments and estimates of suppression costs associated with each outcome, and the structuring of the decision tree associated with the various fire management strategies being analyzed.

The WFSA process tends to frame the decision problem for the user. Sometimes the effect of this framing is not fully appreciated. For example, WFSA's structure presents issues in a certain order. Thus, when users enter WFSA at a certain point, they tend to carry through the analysis to the end, a linear approach to analysis that does not benefit from reconsideration of the underlying assumptions. In addition, few users understand the principles of sensitivity analysis and how it can be applied to WFSA to develop helpful ranges of outputs related to ranges of key input variables such as variance in probability assessments, relative importance of objectives, and cost-related factors such as suppression cost estimates and NFMAS values.

One area where the structure of WFSA may bias the analysis is in how the decision trees for alternatives in the analysis are constructed. In structuring a decision alternative, users are prompted to build the decision tree by first considering a successful outcome for the strategy, followed by a successful fallback outcome, and then a worst-case scenario. This can tend to lead users to think in terms of success, and anchor their subsequent judgments of other possible outcomes on the success scenario. Alternatively, users could consider the worst-case scenario first, and then develop other outcomes by working backward from that scenario. Both directions are valid approaches, but both involve different perspectives on how a given strategy may play out over time.

For example, the success-first approach tends to frame outcomes in terms of consequences of success, while the latter frames outcomes in terms of the consequences of failure. While neither perspective has an exclusive claim to correctness, the two perspectives may have different implications for cost factors and may bias cost projections in different ways. A success-oriented problem structuring may yield lower suppression cost estimates, but be highly contingent on the accuracy of a high probability of achieving the projected outcome. If the probability assessment is biased upward, then other outcomes in the alternative may be under-weighted and appear to result in lower costs. Similarly, if each WFSA began with a least-cost scenario, it might bias cost projections downward.

These kinds of approaches to analysis are within the capability of WFSA, but are dependent upon a knowledgeable user who understands how to approach such problems using the tool to produce a "well-analyzed fire management decision."[8] These uses of WFSA are less dependent on improvements or changes to the software, and more dependent on developing users' analytic skills.

Efforts to solve WFSA problems. Various efforts have been undertaken to address the problems posed by WFSA. The software version of WFSA resulted from an effort to ease the process of producing the documentation associated with the paper-and-pencil version. The current version of WFSA provides a more standardized analysis than the older EFSA. It also permits better technical analysis of cost factors and improved capability for projecting suppression costs.

A review of the unusually costly 1994 fire season (i.e., Truesdale Report) recommended improvements to the EFSA that included (a) emphasizing its importance and timely completion, (b) requiring revised EFSA's to analyze an alternative with minimum suppression actions for

[8] Rains, M. (2000). *Policy implications of large fire management: A strategic assessment of factors influencing costs*. USDA Forest Service, State and Private Forestry, Washington, D.C.

fires not contained in five burning periods, (c) reviewing the risk analysis process in the EFSA to determine its effectiveness in decision making, and (d) assuring that fire suppression objectives are measurable and associated with specific costs for attainment.[9]

A 1997 study also identified problems associated with WFSA.[10] Based on interviews and survey responses of 71 senior agency administrators, fire management officers, and natural resource area specialists, the study documented perceptions of WFSA, including training deficiencies and needs. That study found that the majority of WFSA training was on the job, with many of the study participants having received no or inadequate formal training. Recommendations from the study included the need to review and evaluate current WFSA training practices and to explore the potential of developing WFSA proficiency standards with periodic review and retraining if necessary.[11]

A subsequent WFSA-related research effort was undertaken in conjunction with the Pacific Southwest Research Station to develop a decision skills course for fire and natural resource managers.[12] The result of the effort was a three-day decision skills course that used a combination of classroom and case-study techniques, and that emphasized five key decision science elements: value structuring and prioritization, representation of decision alternatives, probability assessment, economic values, and sensitivity analysis. Elements of the course have been included in a number of WFSA training exercises. However, the course itself is now taught on an ad-hoc basis and is not regularly offered.

WFSA training also occurs at the local unit level, and is often conducted by agency personnel who have more WFSA experience than others.

The Role of WFSA in Fire Management Decision Making

Figure G-1, which shows the policy direction that defines how a WFSA is to be done, also illustrates that WFSA includes a combination of analysis, reporting, and review functions. The reporting and review functions of WFSA are outside of the analysis support provided by the software, and relate to its communication function. There is little empirical research to show how WFSA is used in the fire management decision-making process. According to the policy direction, the analytic aspects of WFSA are intended to support the delegation of authority and review functions, with periodic updating to ensure that the fire management strategy chosen on the basis of WFSA is still appropriate.

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[9] *Fire suppression costs on large fires: A review of the 1994 fire season.* USDA Forest Service, Fire and Aviation Management, Washington, D.C.

[10] MacGregor, D. G. (1998). *Improving the escaped fire situation analysis (EFSA) fire management process in the forest service: Final report of results and recommendations*. Final report of Project #PSW-97-004-RJVA, Pacific Southwest Research Station, USDA Forest Service, Riverside, CA.; MacGregor, D. G., & Gonzalez-Cabán, A. (1999). Improving Wildland Fire Situation Analysis (WFSA) implementation practices. In A. Gonzalez-Cabán & P. Omi (eds). *Proceedings of the symposium on fire economics, planning and policy: Bottom lines.* Gen. Tech. Rpt. PSW-GTR-173. Albany, CA: Pacific Southwest Research Station, Forest Service, US Dept. of Agriculture.

[11] See also Rains (2000) where recommendations included better and more consistent training in WFSA, along with benchmarks or standards for WFSA proficiency.

[12] MacGregor, D. G., Gonzalez-Cabán, A., Dammann, C., & Cleaves, D. (2000). Development of a decision skills course for fire and natural resource managers. Final report of Project #PSW-98-023-RJVA, Pacific Southwest Research Station, USDA Forest Service, Riverside, CA.

From interviews and other anecdotal evidence, however, it appears that WFSA is frequently either conducted or supervised by a unit's FMO (Fire Management Officer), or their assistant. In some cases, this may be because the local agency administrator responsible for WFSA does not have a sufficient level of experience with fire management to be comfortable with the task. Agency administrators in units with infrequent fires may have never experienced a WFSA fire, and WFSA can present too steep a learning curve for them. Because of inexperience and thinness of qualified fire personnel on many land units, the initial WFSA may outline only the higher priority fire management objectives and only minimal analysis of a small set of alternative strategies. In such situations, the incoming incident team may refine the WFSA in conjunction with the local unit. Very often the incident team brings greater fire management experience and better WFSA expertise. On longer-running fires, WFSA may be developed cooperatively between the local unit and the incident team and refined over time. However, most WFSA fires do not go beyond the first WFSA, which means that the strategic alternative selected is the "official" guidance for managing the fire throughout its run. On large, complex, or long-running, fires as many as six (or more) WFSAs may be prepared to respond to changing conditions.

As the number of WFSA's on a long-running fire increases, the tendency is for WFSA to "track" the fire. In these cases, WFSA may be less of a decision *analysis* tool and more of a decision *documentation* tool. Though the application of WFSA is sometimes faulted for "failing to get out in front of" large fires, from a cost-control perspective this reality of how WFSA is applied may present opportunities for introducing "trigger points" when preset suppression resource expenditure levels would initiate a review of WFSA to help meet cost objectives. Currently most of the reviews of WFSAs are done to evaluate how well a current strategy meets fire management objectives, without direct reference to monetary costs. However, the policy does not preclude the agency administrator from calling for a cost-related WFSA review.

Strategic vs. tactical direction. Comments are in order about the relationship between strategy and tactics as they pertain to WFSA and to fire management decision-making. WFSA enables and encourages analysis of fire management strategies, apart from fire suppression tactics. This orientation of WFSA reflects its intended linkages to the land management and fire management planning processes, both of which provide overarching direction concerning land management goals and objectives. WFSA is, in principle, a direct extension of these planning frameworks to an emergency incident.

From interviews and observations in WFSA training exercises, it appears that many personnel involved in preparing WFSAs have difficulty developing and articulating fire management strategies that are not descriptions of fire management tactics. One function of WFSA is to provide an incoming incident team with a higher level of strategic direction based on land and fire management planning goals for the local unit. These are goals, which the incoming teams would not be aware of without some form of local communication. How those strategic objectives are to be achieved is a matter of tactical decision-making on the part of the incident team. To the degree that the incident team is provided clear strategic direction, they may be in the best position to achieve the fire management objectives contained in WFSA in the most cost-efficient manner. To the degree that WFSA provides tactical rather than strategic direction, the incident team may not be aware of what the local unit would most like to accomplish, thereby underutilizing abilities they may have to provide cost-efficient suppression.

Several measures can be taken to help improve the quality of strategic direction in WFSA. Education in WFSA principles and potential uses can place increased emphasis on the strategic aspects of the analysis, thereby providing local unit analysts with the skills they need to express locally-defined land and fire management planning in terms of strategic guidance. Since the development of strategic guidance takes time and human resources, WFSA could be "pre-prepared" by developing WFSA's prior to a unit's anticipated fire season. Though some units do this type of WFSA pre-work, there is not a consistent effort to do so, nor are there adequate guidelines.

To the degree that WFSA overemphasizes tactical direction in fulfilling its role in fire management decision-making, this may reflect too heavy involvement of fire expertise in its conduct. WFSA would benefit from being more closely tied to the land management planning process and the fire management planning process. Fire management plans need to be developed that can directly lead to fire management strategies considered in a WFSA.

Wildland Fire Cost Factors & Their Relationship to WFSA

Many factors enter into the costs of wildland fire, some of them are included directly in WFSA, some indirectly, and others not at all. Cost factors directly included in WFSA have been previously discussed, particularly suppression resource costs and impacts to the land management base as represented by NFMAS values. However, the WFSA decision support process is also influenced by broader factors. It is important to consider how well these factors are included in WFSA, and how their influence is accounted for.

Some of these broader cost factors relate to the rules and regulations with which agency personnel must comply. For example, air quality standards imposed by federal, state, and local agencies are often the basis for WFSA objectives. Meeting such objectives can be expected to influence costs, though WFSA does not identify to what degree suppression cost estimates are attributable to attaining such objectives. For example, a post fire review that examines WFSA to learn how air quality standards may have impacted the suppression resources used would have difficulty allocating those costs to the WFSA objectives even though WFSA preparers may have considered constraints imposed by the air quality objectives. Because WFSA does not link its cost estimates for suppression to its objectives, it cannot identify the contributions that these factors make to suppression costs.

A similar statement can be made concerning "downstream" costs associated with fire, such as rehabilitation costs. While the WFSA analysts are free to take these costs into consideration in developing fire management objectives and in developing alternative fire management strategies, these costs are not specifically monetized in WFSA in the way that NFMAS values monetize impacts to the land management base.[13] However, the WFSA framework is sufficiently broad to potentially encompass appropriate rehabilitation costs, if available in a form compatible with WFSA.

[13] However, if rehabilitation costs are included in NFMAS, then they will be included in WFSA.

A difficult category of costs to represent in WFSA are those associated with the effects of "social factors." These are often among the most important factors that determine the strategies used to manage wildland fires, particularly when incidents occur at or near the wildland-urban interface. They include such things as the protection of high-valued resources, including private property and historical artifacts, as well as public concerns about both fire effects and the effects of fire fighting. However, they are the most difficult to represent in WFSA, because they are complex and difficult to quantify. To the degree that these factors are reflected in the WFSA objectives, they will potentially influence WFSA's evaluation and selection of alternatives. However, the current form of WFSA does not consider such cost effects systematically. Moreover, the economic values used by WFSA do not include the value of these non-agency, private resources. To the degree that these factors enter into a WFSA, they do so subjectively and indirectly.

Potential Enhancements to WFSA

This analysis suggests the following six opportunities to improve WFSA.

Emphasize strategic decision making in WFSA. Typically, users learn about WFSA through a process of training and practice. Most training has focused on the software and how to use it. Users may not need more such training in WFSA, but most do need education in the underlying principles and potentials for improving the analysis of fire management problems and making strategic decisions. Some steps have been taken in this direction, but more are needed. Using WFSA more effectively requires placing greater value on the role of analysis, planning, and development of strategic decision alternatives. As society places ever-increasing value on external accountability and a quantitative rationale for public decisions, the need to improve strategic analysis abilities of those involved in WFSA continues to grow.

Integrate WFSA with fire management and land management planning. One of the recurring recommendations for improving WFSA is to remove it from the three-hour performance environment, and place it in closer proximity to a unit's land and fire management plans. WFSA relies on the land management planning process for its guidance and direction. Without this guidance, there is no consistent relationship between planning for the unit and the actions taken on a fire. The practical way to achieve this goal is to "template" or "front load" WFSA by conducting the process for either hypothetical or historically significant fires on specific land units. This practice would lead the units to develop their own database of land management guidance within WFSA when they have the time and human resources to do so. Guidelines need to be developed and implemented for doing this in such a way that the practice WFSA can be readily modified to fit the details of an actual fire incident when it occurs.

Consider defining a larger, formal role for the IMT in improving and refining a WFSA. In many cases, WFSA is incomplete at the time an incident management team arrives. WFSA policy strongly implies that a WFSA will be completed as a basis for determining the level of team assistance required, and therefore implies that the analysis will be completed before the IMT arrives and will serve as a basis for the delegation of authority. In practice, incoming incident teams bring with them additional expertise in the analysis of fire management problems that could be used to develop higher quality WFSAs. Consideration should be given to defining a larger, formal role for the IMT in improving and refining the WFSA. This could include clarifying the current WFSA procedures to better identify how the local unit would work cooperatively with the IMT. In addition, the potential for periodic WFSA monitoring and evaluation, to incorporate preset cost "triggers," should be explored.

Develop standards for WFSA qualification and certification. At present, no training or proficiency standards exist for WFSA users. While the PC-WFSA improved the standardization of the document, standardization of the analysis remains to be attained. At one time, WFSA for a given fire had no life beyond the unit in which it was created. However, in recent years WFSA has taken on a greater role outside of its unit and even outside of the agency. For example, WFSA has been required to be appended to the final fire report. This opens the opportunity to conduct research on the relationship between fire parameters, suppression actions, cost factors, and the WFSA process. Some Forest Service regions are currently using WFSA as part of priority setting for suppression resource allocation, further accentuating the need for a standardized proficiency. The feasibility of developing a WFSA proficiency standard should be explored, including identification of the specific analytical skills required by WFSA and a program of education and training to support attainment of those skills.

Integrate WFSA with other decision support tools and processes, and to cost-relevant databases and models. WFSA is currently a "stand alone" decision support tool. Although it uses the NFMAS database and a suppression resource cost database to support its internal analysis, it is not directly linked to other computerized tools and processes that have relevant outputs. In practice, many of the computerized tools for fire and land management decision-making, such as fire behavior models, are developed for the PC platform. Although they can be operated independently, they do not directly link to one another, and so do not provide an integrated analytical capability. WFSA is supported by a very powerful analytical engine that can be adapted to a wide range of problems. In its current form, it can most readily accept new cost-relevant information through NFMAS. With modifications, it can incorporate additional cost-relevant databases. Other modifications could enable it to run more models in the background and utilize their outputs in its analysis. These modifications and extensions are all technically possible. Consideration should be given to research aimed at integrating WFSA with other analytical tools and databases that are relevant for fire management decision-making.

Conduct research to determine the relationship between WFSA estimates, assessments and judgments, and actual outcomes of WFSA fire incidents. Despite the central role that WFSA plays in setting the strategic direction for fire management, there is no systematic study of the relationship between the various judgments and estimates made in WFSA and the actual outcomes of the fire incidents in which it has been applied. Without such research, it is difficult to make good assessments of where the WFSA process needs improvement and how such improvements should be made.

WILDLAND FIRE EXPOSURE STUDY

FOR

TEN SITES IN THE WESTERN U.S.

Prepared for the Academy
by
The National Institute of Building Sciences
1090 Vermont Ave., NW
Washington, DC 20005

June 27, 2002

The National Academy of Public Administration
Washington, DC

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OVERVIEW

Wildland fires have recently become a significant problem for the wildland-urban interface as more people relocate to resort and remote areas of the Western U.S. To demonstrate the potential for fire damage, destruction and displacement, the National Institute of Building Sciences (NIBS) has prepared this study for the National Academy of Public Administration (NAPA) using HAZUS® to determine exposure of population, buildings and lifelines for four large and six small communities found in California, Montana, Nevada, Washington and Wyoming. Based on the analysis, the population exposure to wildland fire in the ten sites is 276,692. The value of private property in the study sites is $14.75 billion, and the value of public buildings is $877 million. Transportation lifelines are valued at $16.94 billion, and utility lifelines, limited by databases available in HAZUS®, at $3.48 billion.

HAZUS® is a standardized methodology for estimating potential losses from earthquakes in the U.S. HAZUS® is used by local, state, and regional officials for planning mitigation efforts to reduce losses, for preparing for emergency response before earthquakes occur, and in decision support following earthquakes. Additionally, the loss estimates are used for a nationwide assessment of earthquake risk to support allocating national resources for future disasters.

HAZUS® is developed by the National Institute of Building Sciences under agreements the Federal Emergency Management Agency (FEMA). In early 2003, an integrated multihazard loss estimation version with a new Flood Model and Preview Hurricane Model in addition to a revised earthquake model is planned for release. The Flood Model will be capable of assessing riverine and coastal flooding. The Preview Hurricane Model will be limited to Atlantic and Gulf Coast hurricanes.

HAZUS® contains a set of over twenty-five default national databases acquired from Federal agencies and private sector sources. The databases provide data on demographics and the numbers, types and locations of buildings, essential facilities, such as hospitals, roads and utilities. Prior to earthquake events, the data is used to formulate and evaluate policy programs to reduce earthquake loss, including general mitigation strategies, estimate required resources for disaster relief, estimate displaced households and shelter requirements, and improve emergency response planning through scenario analysis. The data is also used following an earthquake to plan response and recovery efforts and plan for debris removal and technical assistance.

THE STUDY SITES

The following ten sites in five states were chosen by the National Academy of Public Administration based on their proximity to sources of wildland fire. The ten sites are located on state maps in Figure H-1.

California

Mill Valley located just north of San Francisco in Marin County
Sierra Madre located east of Pasadena in Los Angeles County

Montana

Billings located in the southeastern part of the state in Yellowstone County
Missoula located in the western part of the state in Missoula County

Nevada

Elko located in the northeast part of the state in Elko County
Lake Tahoe Highway 50 Corridor located to the east of Lake Tahoe located in Douglas County

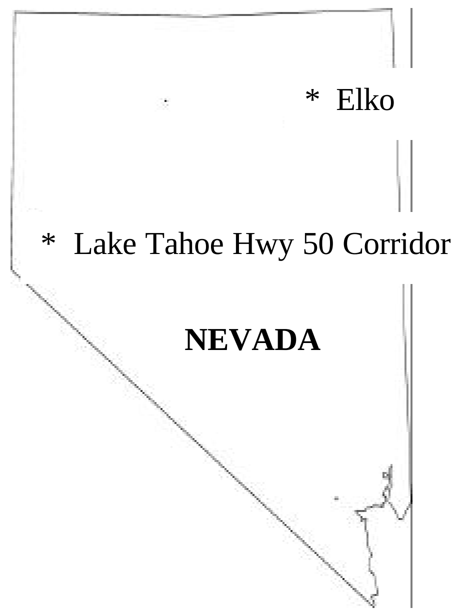
Washington

Okanogan located in the north central part of the state in Okanogan County
Richland located in the south central edge of the state in Benton County

Wyoming

Jackson located on the western edge of the state in Teton County
Casper located in the southeastern part of the state in Natrona County

For more detail on study site locations, see the Attachment A: Study Sites by County and Census tracts.



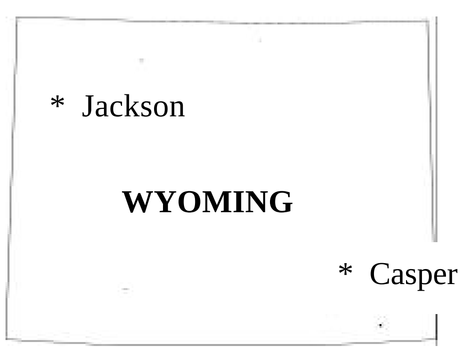


Figure H-1: Study Sites by State

Source of Maps: abcTeach Network at http://abcteach.com/index.html.

HAZUSÒ ANALYSIS OF THE STUDY SITES

Table H-1 summarizes the HAZUS®-generated number of people and the dollar exposure or value of buildings and lifelines for the ten study sites that may be affected by a wildland fire event. For comparison, the population for each community derived from community websites is listed next to the HAZUS® -generated population figure. Differences in the two figures reflect changes in the community in the last ten years, differences between the study site defined by HAZUS® and the corporate boundaries of the community, or both factors.

Tables H-2 and H-3 describe the value of privately owned and public buildings by the HAZUS® occupancy type classification system. Public facilities are represented by occupancy types for government buildings and schools. Private facilities are represented by the remaining occupancy types under the residential, commercial, industrial, agricultural and religious/nonprofit categories.

Tables H-4 and H-5 describe the value of transportation and utilities components for databases available in HAZUS®. Utility data tables do not necessarily describe the total value of these systems for any given area, since results are based only on publicly available data. Data held by utility companies, for example, the number and location of substations, are not publicly available for security reasons.

For these studies, NIBS used HAZUS®99-SR2, the most recent release, with the ArcView 3.2a GIS (geographical information system) platform available from ESRI. Exposure for population, public facilities, private properties, transportation lifelines and utility lifelines was derived from national databases contained in the HAZUS® inventory.

Population data in HAZUS® is based on the 1990 Census with 1998 updates (Census2000 data will be available in June-September 2002 and available in HAZUS® in February 2003.)

Building dollar exposure data in HAZUS®, representing the replacement value for structural and nonstructural components (ceilings, mechanical equipment, etc.), is based on *Means Square Foot Costs 1994 for Residential, Commercial, Industrial and Institutional Buildings*. The *Means* publication is a nationally accepted reference on building construction costs, which is published annually. In the multihazard version of HAZUS® to be released in 2003, *Means* data will be updated with the 2002 edition.

Transportation and utility lifeline dollar exposure data in HAZUS®, representing component replacement value, is derived primarily from *Means* data modified by lifeline studies that have been conducted during the development of HAZUS® and its releases. Transportation lifeline valuation data is available for highways, bridges, railway, light rail, bus and airport facilities if located in the study site. Utility lifeline valuation data is available only for water, gas, electrical and communication distribution lines with few exceptions, e.g., for Lake Tahoe, the valuation for communications facilities is included.

In addition to generating values using national level data sets that are included with HAZUS®, more accurate estimates of exposure can be acquired by modifying the national level data with local data. These modifications may be performed by editing the HAZUS® tables or by importing data collected with HAZUS® support tools, such as InCast and BIT. Incast (Inventory Collection and Assessment Tool) is used in windshield surveys and other forms of neighborhood-based data collection. BIT (Building-Data Import Tool) is used to import tax assessors files that contain local data on buildings and building valuations.

If a scenario analysis is run with HAZUS® for an earthquake event, losses resulting from building damage are generated in several more categories of valuation in addition to the cost of replacement of damaged structural and nonstructural components. These include the cost of damage to building contents and building inventory, relocation expenses of businesses, capital-related income loss from sales and services, wage losses and rental income losses. Transportation and utility lifelines losses are limited to the cost of repair and replacement.

Table H-1: Summary of Population and Value of Infrastructure at Risk

Community	Population[1]	Population[2]	Total Value	Public Facilities	Private Properties	Transportation	Utilities
Mill Valley, CA	9,464	13,038	$167,334,209	$4,473,000	$599,209	$4,000,000	$158,262,000
Sierra Madre, CA	15,037	10,762	$1,726,372,600	$838,600	$796,440,000	$892,600,000	$36,494,000
Billings, MT	88,252	90,000	$9,573,661,000	$58,833,000	$5,465,902,000	$2,716,950,000	$1,331,976,000
Missoula, MT	61,860	65,984	$6,465,546,000	$219,303,000	$3,283,662,000	$2,633,020,000	$329,561,000
Elko, NV	8,439	18,400	$3,087,182,000	$530,036,000	$13,971,000	$2,320,040,000	$223,135,000
Lake Tahoe Hwy 50, NV	6,105		$1,242,707,000	$3,819,000	$697,251,000	$443,600,000	$98,037,000
Okanogan, WA	3,730	2,484	$1,966,579,000	$3,084,000	$202,815,000	$1,702,200,000	$58,480,000
Richland, WA	27,192	38,708	$3,352,052,000	$20,289,000	$1,507,507,000	$1,212,150,000	$612,106,000
Jackson, WY	4,213	8,647	$1,246,170,000	$2,595,000	$258,131,000	$943,500,000	$41,944,000
Casper, WY	52,400	49,644	$7,226,565,000	$33,564,000	$2,522,303,000	$4,076,810,000	$593,888,000

Notes:

1 1990 Census data used for HAZUS

2 Current Population based on data from community websites

Table H-2: Economic Value of Privately Owned Buildings at Risk

Community	Residential	Commercial	Industrial	Agriculture	Religion
Mill Valley, CA	$459,868,000	$119,438,000	$10,022,000	$299,000	$9,582,000
Sierra Madre, CA	$702,207,000	$71,668,000	$11,468,000	$165,000	$10,932,000
Billings, MT	$3,532,908,000	$1,302,764,000	$169,950,000	$5,808,000	$454,472,000
Missoula, MT	$2,357,902,000	$773,753,000	$115,204,000	$2,640,000	$34,169,000
Elko, NV	$342,185,000	$165,247,000	$11,283,000	$368,000	$10,953,000
Lake Tahoe Hwy 50, NV	$594,621,000	$89,014,000	$8,349,000	$163,000	$5,104,000
Okanogan, WA	$160,393,000	$29,868,000	$2,848,000	$332,000	$9,374,000
Richland, WA	$1,147,280,000	$309,734,000	$25,687,000	$782,000	$24,021,000
Jackson, WY	$166,531,000	$74,214,000	$12,150,000	$453,000	$4,783,000
Casper, WY	$1,878,762,000	$487,065,000	$119,873,000	$4,406,000	$32,197,000

Table H-3: Economic Value of Public Buildings at Risk

Community	Government	Education
Mill Valley, CA	$1,489,000	$2,984,000
Sierra Madre, CA	$2,400,000	$5,986,000
Billings, MT	$14,086,000	$44,747,000
Missoula, MT	$14,218,000	$205,085,000
Elko, NV	$3,572,000	$10,399,000
Lake Tahoe Hwy 50, NV	$1,464,000	$2,355,000
Okanogan, WA	$1,651,000	$1,433,000
Richland, WA	$3,920,000	$16,369,000
Jackson, WY	$1,747,000	$848,000
Casper, WY	$6,111,000	$27,453,000

Table H-4: Economic Value of Transportation Infrastructure at Risk

Community	Highways	Railways	Light Rail	Bus Facilities	Ports	Ferries	Airports
Mill Valley, CA	$4,000,000						
Sierra Madre, CA	$892,600,000						
Billings, MT	$2,472,800,000	$120,150,000					$124,000,000
Missoula, MT	$2,381,400,000	$109,620,000					$142,000,000
Elko, NV	$2,108,800,000	$147,240,000					$64,000,000
Lake Tahoe Hwy 50, NV	$443,600,000						
Okanogan, WA	$1,702,000,000						
Richland, WA	$1,124,600,000	$23,550,000			$3,000,000		$64,000,000
Jackson, WY	$907,500,000						$36,000,000
Casper, WY	$3,983,200,000	$89,610,000					$4,000,000

Table H-5: Economic Value of Utilities Infrastructure at Risk

Community	Potable Water	Wastewater	Oil Systems	Natural Gas	Electric Power	Communication
Mill Valley, CA	$15,723,000	$129,435,000		$6,290,000	$4,717,000	$2,097,000
Sierra Madre, CA	$14,999,000	$8,997,000		$5,999,000	$4,499,000	$2,000,000
Billings, MT	$134,940,000	$80,963,000	$381,628,000	$53,973,000	$640,481,000	$39,991,000
Missoula, MT	$121,467,000	$72,878,000	$4,000,000	$48,582,000	$36,439,000	$46,195,000
Elko, NV	$14,439,000	$188,663,000		$5,775,000	$4,332,000	$9,926,000
Lake Tahoe Hwy 50, NV	$35,357,000	$21,215,000		$14,144,000	$10,607,000	$16,714,000
Okanogan, WA	$24,032,000	$14,420,000		$9,614,000	$7,210,000	$3,204,000
Richland, WA	$43,605,000	$26,163,000		$17,441,000	$513,082,000	$11,815,000
Jackson, WY	$15,593,000	$9,356,000		$6,237,000	$4,678,000	$6,080,000
Casper, WY	$86,382,000	$51,831,000	$367,688,000	$34,553,000	$25,915,000	$27,519,000

ATTACHMENT A: STUDY SITES BY COUNTY AND CENSUS TRACTS

Figures H-2 through H-27 locate the ten communities with a hierarchy of maps including: HAZUS®-generated study site maps, HAZUS®-generated county maps showing the study site within, and state maps showing counties developed by the National Association of Counties but downloaded from County Hunter at http://www.countyhunter.com/counties.htm.

Each community is identified in the HAZUS® maps based on a representative set of census tracts. According to *U.S. Census for Demographic Information*, a census tract usually contains between 2,500 and 8,000 people, and should average approximately 4,000 people. Accordingly, the size of tracts varies widely, depending on the density of settlement. Census tracts are designed to be homogeneous with respect to population characteristics, economic status, and living conditions when delineated

The small communities, Mill Valley, Sierra Madre, Elko, the Lake Tahoe Hwy 50 Corridor and Okanagon, each have fewer than five census tracts. The larger urban areas of Billings, Missoula, Richland and Casper have seven or more. Census tracts do not necessarily correspond with urban boundaries for the actual cities. Because HAZUS® bases population and valuations on the centroid of a census tract, fire from a particular direction may or may not impact the actual locations of people and infrastructure within the census tract.

Where data is available in HAZUS®, the maps show rivers running adjacent to the communities. Fire departments that are shown are based on a national database and not on surveys of specific communities.

When the multihazard version HAZUS® is released in early 2003, mapping by census block, a much finer level of resolution than the census tract, will be available in the Flood Model for up to four to five counties at a time. As with census tracts, census blocks analysis will be available for all counties in all states. A manual will also be available for performing grid-based analysis for assigning population, exposure and other values to specific locations in large census tracts.

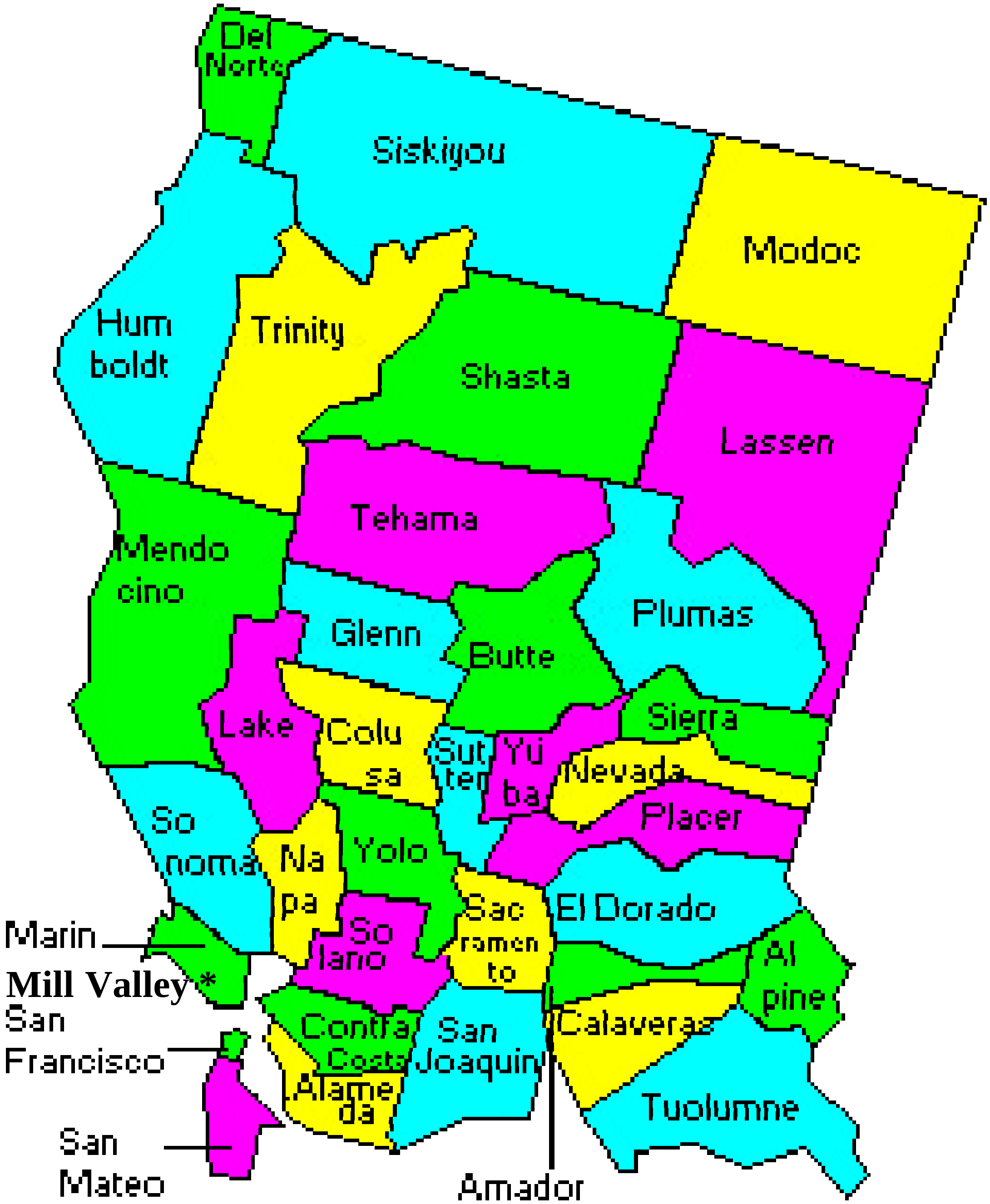


Figure H-2: Mill Valley Study Site, Marin County, Northern California

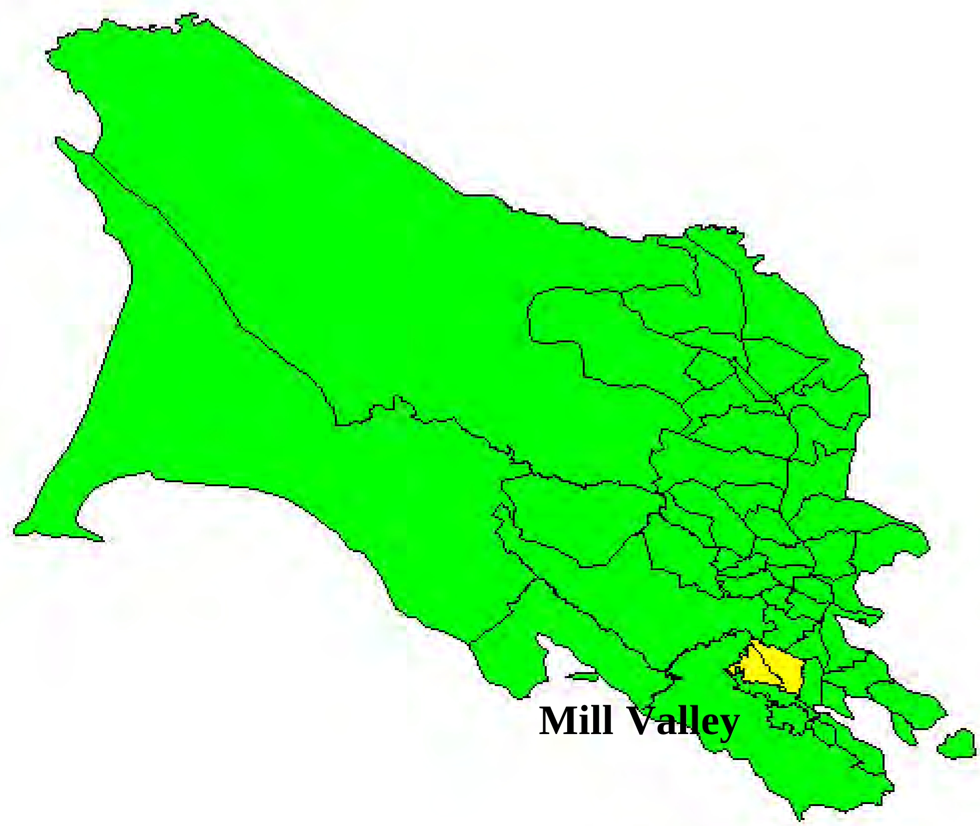


Figure H-3: Mill Valley Study Site in Marin County

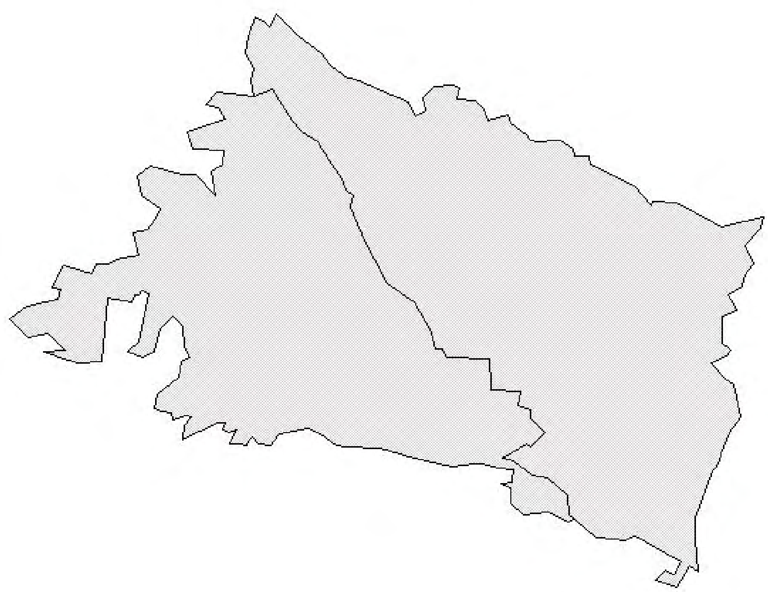


Figure H-4: Mill Valley Study Site

Figure H-5: Sierra Madre Study Site, Los Angeles County, Southern California

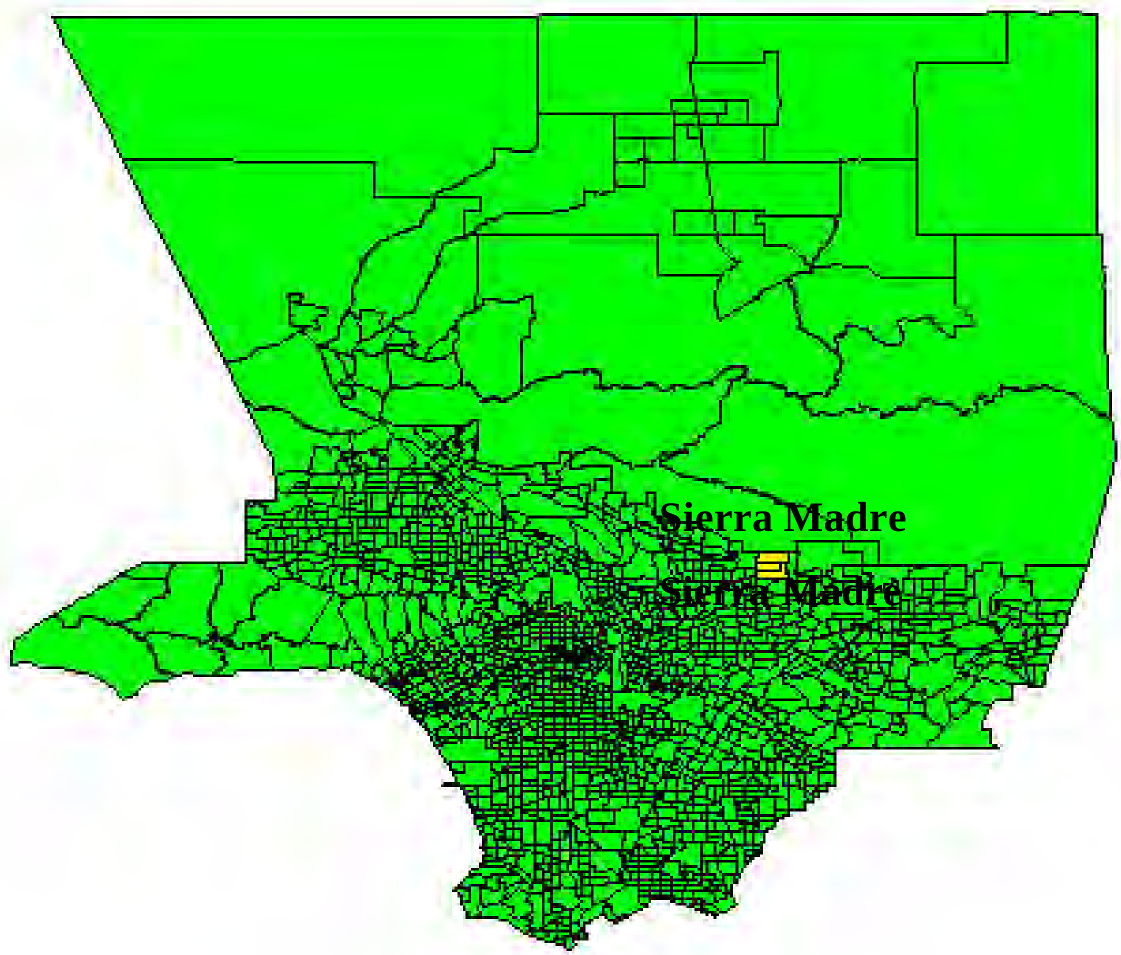


Figure H-6: Sierra Madre Study Site in Los Angeles County

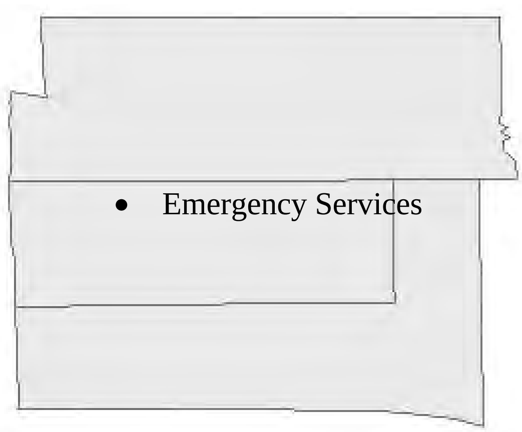


Figure H-7: Sierra Madre Study Site

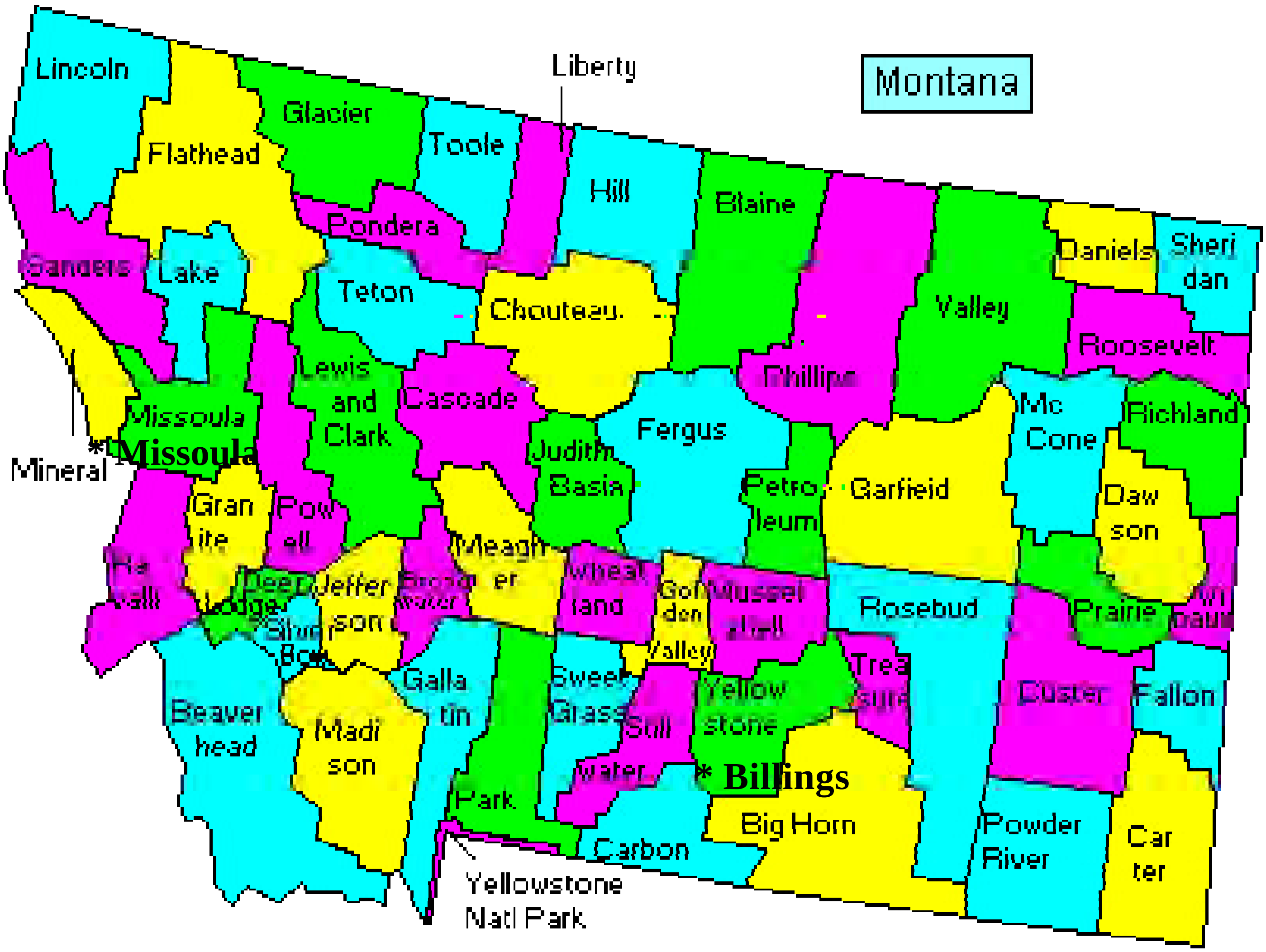


Figure H-8: Billings Study Site, Yellowstone County, Montana and Missoula Study Site, Missoula County, Montana

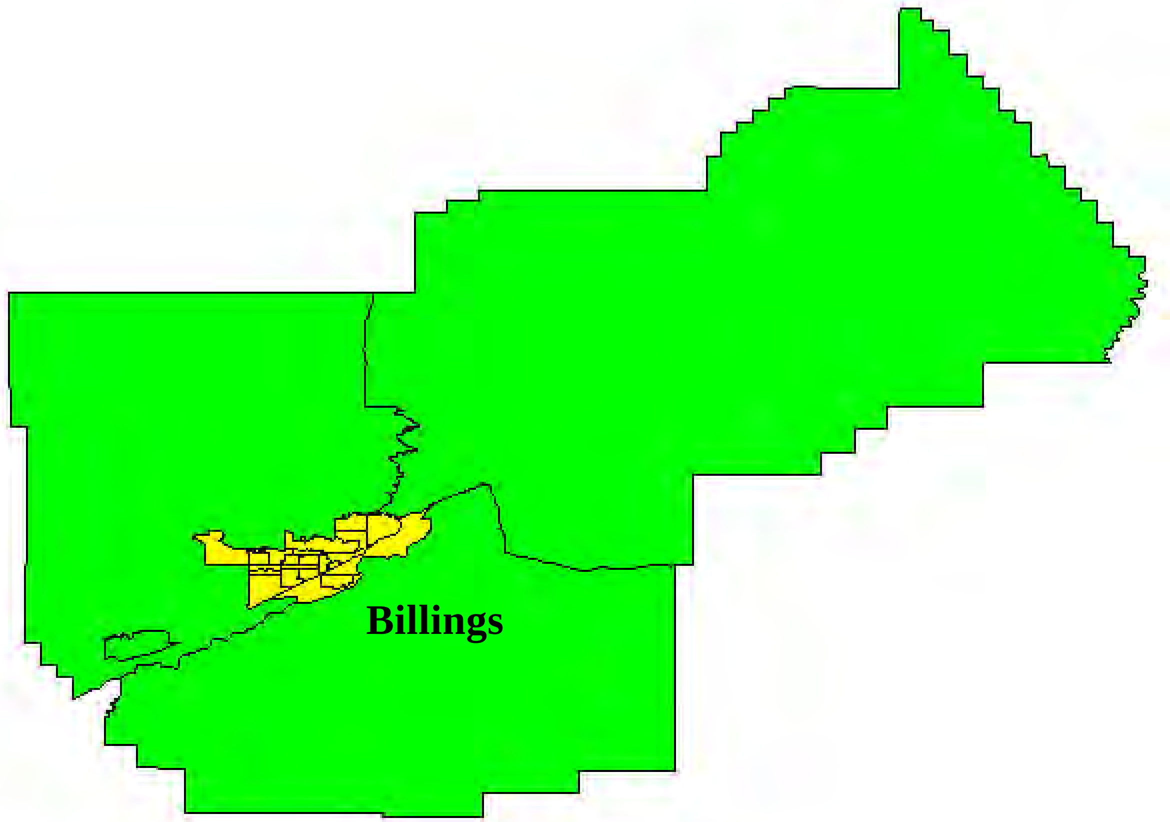


Figure H-9: Billings Study Site in Yellowstone County

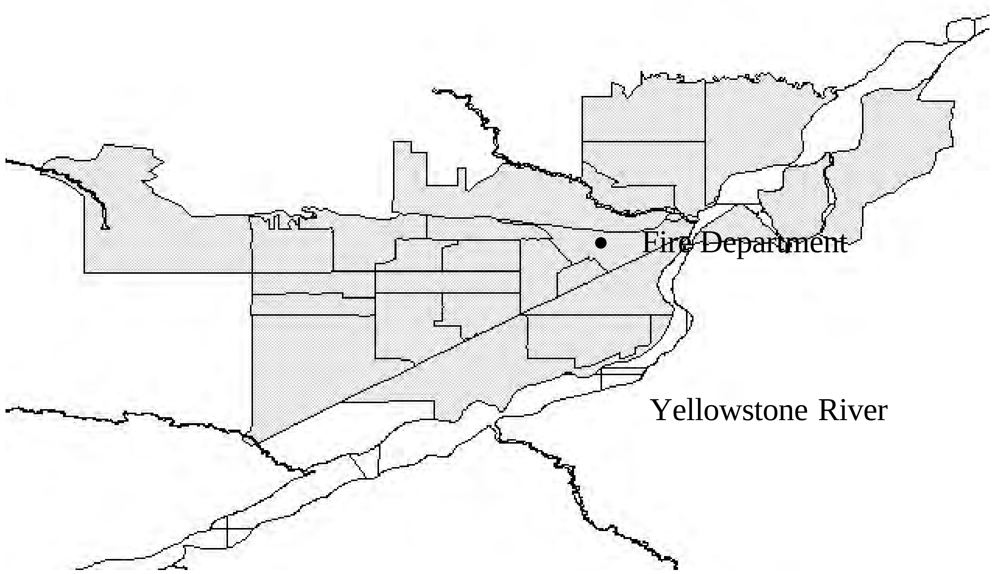


Figure H-10: Billings Study Site

Figure H-11: Missoula Study Site in Missoula County

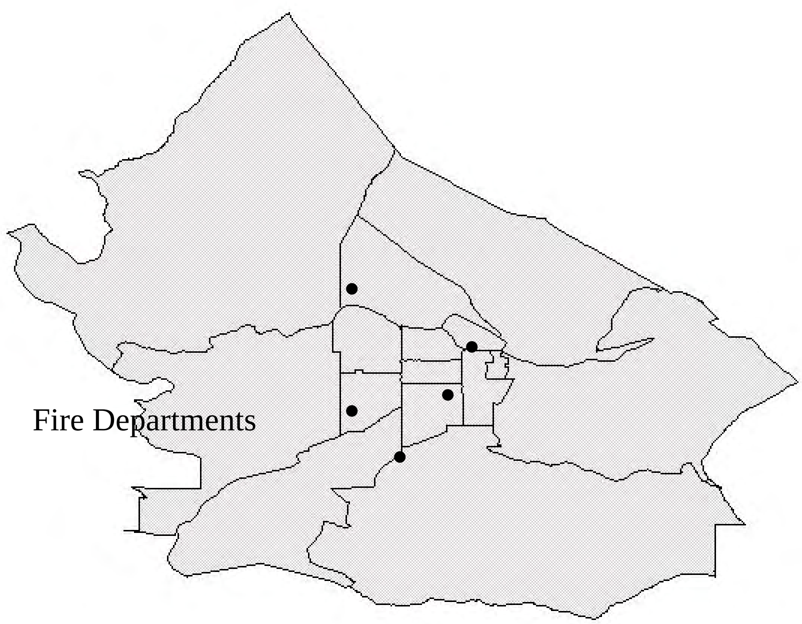


Figure H-12: Missoula Study Site

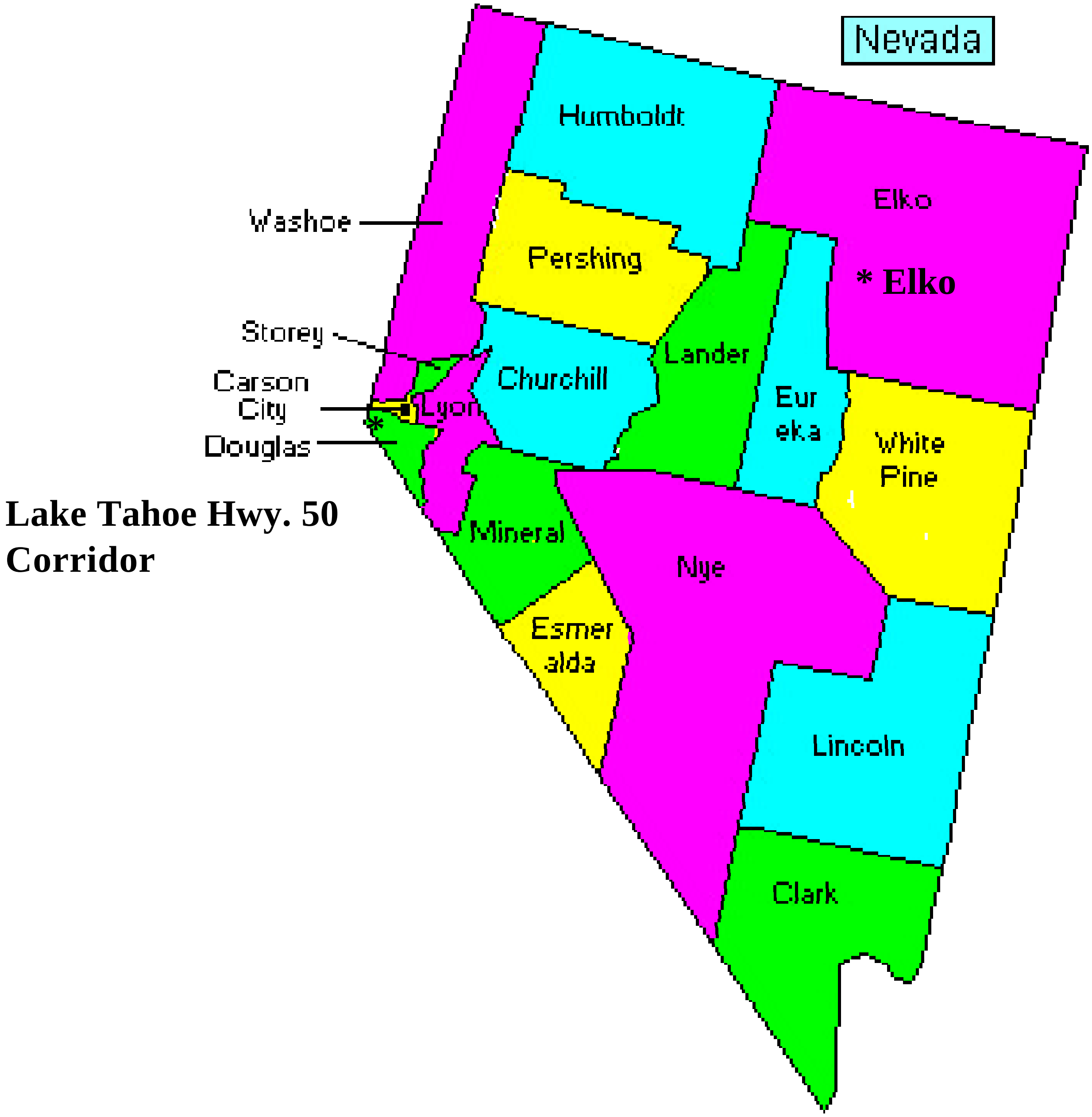


Figure H-13: Elko Study Site, Elko County, Nevada
Lake Tahoe Highway 50 Corridor Study Site, Douglas County, Nevada

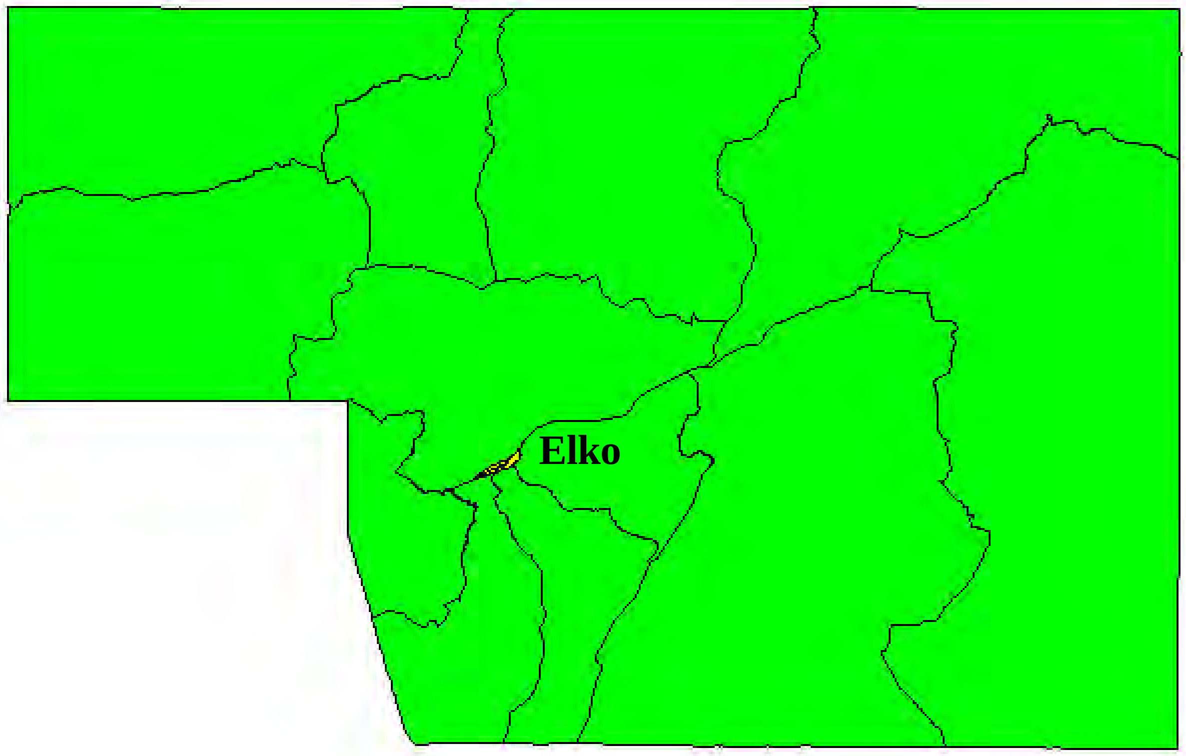


Figure H-14: Elko Study Site in Elko County

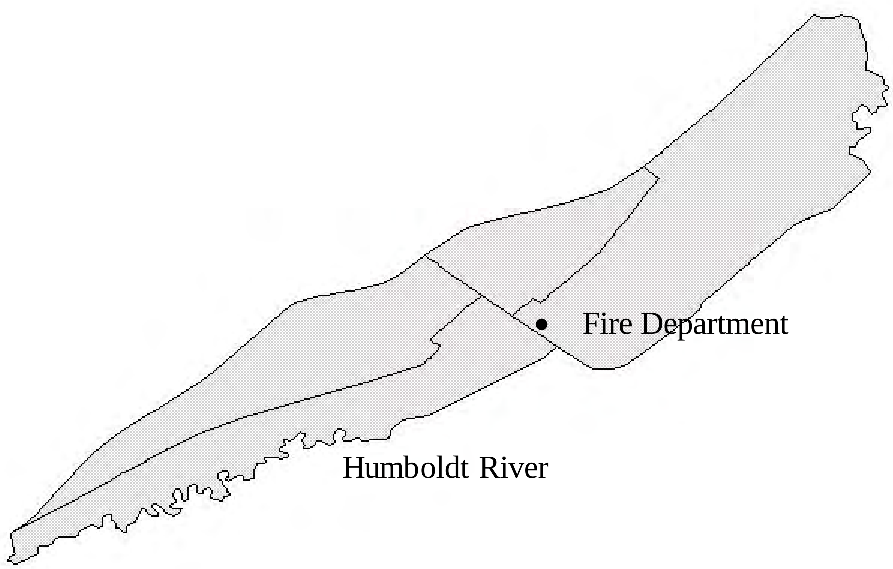


Figure H-15: Elko Study Site

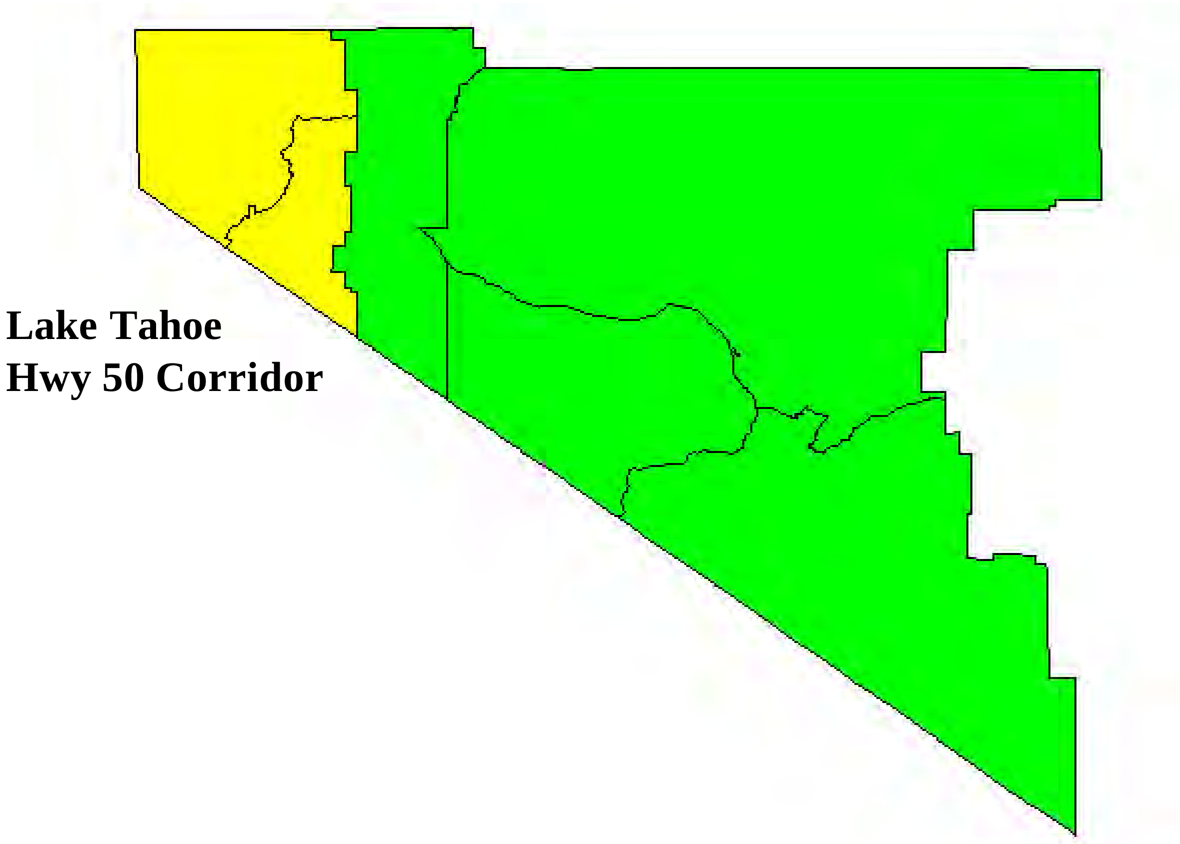


Figure H-16: Lake Tahoe Highway 50 Corridor Study Site in Douglas County

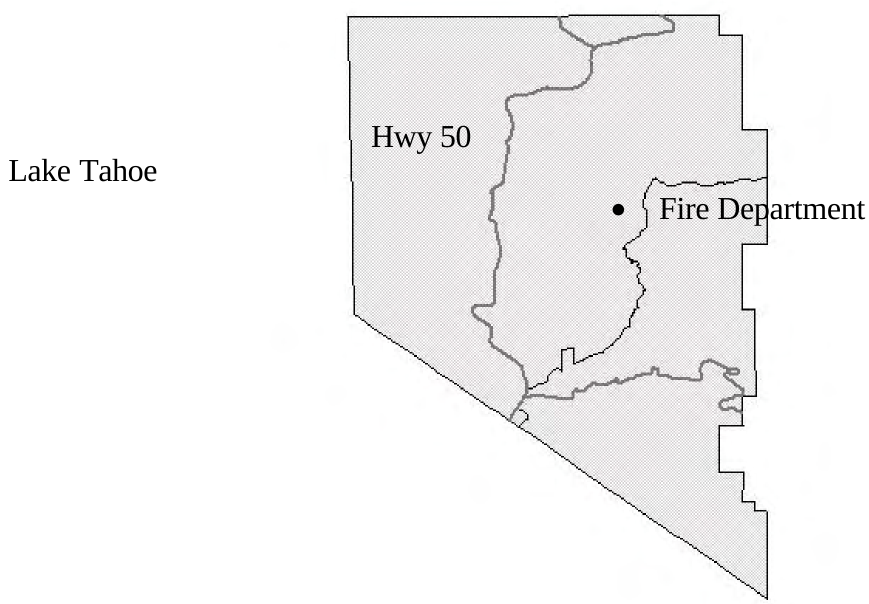


Figure H-17: Lake Tahoe Highway 50 Study Site

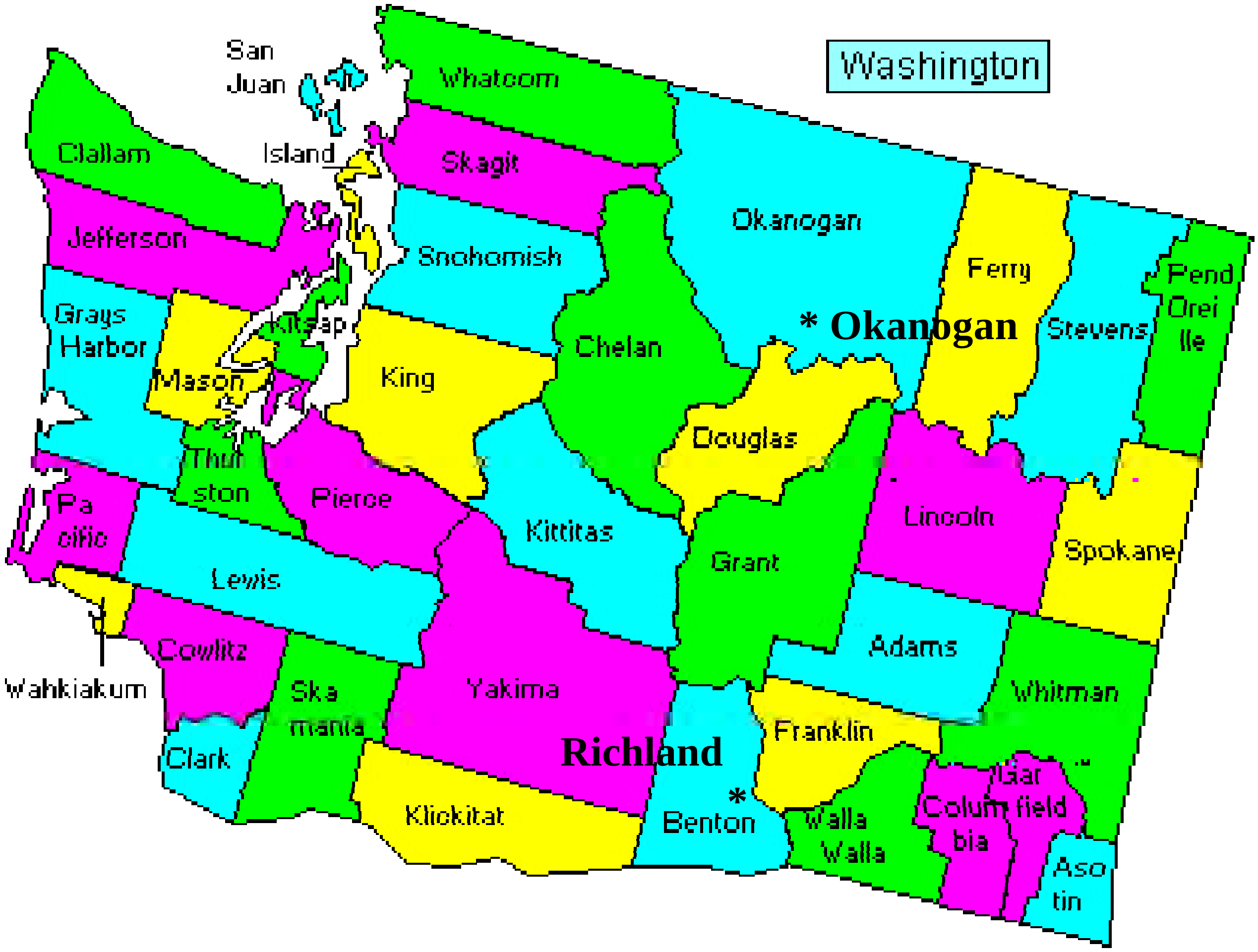


Figure H-18: Okanogon Study Site, Okanogan County, Washington and Richland Study Site, Benton County, Washington

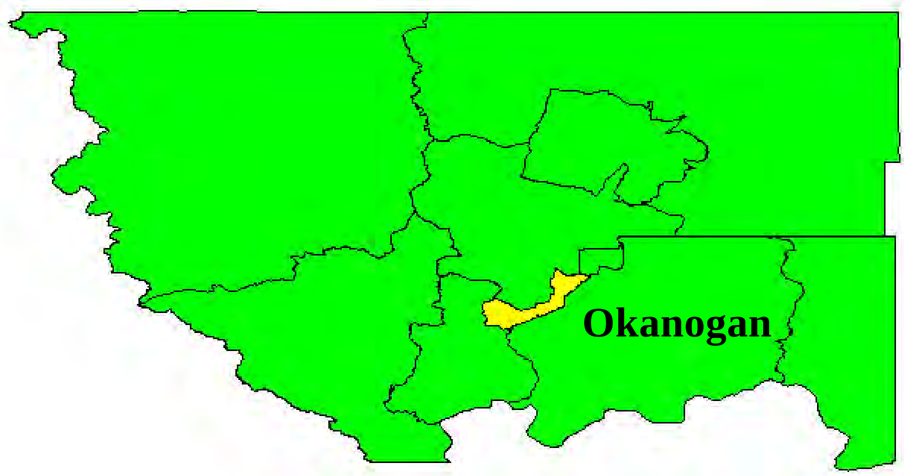


Figure H-19: Okanogan Study Site in Okanogan County

Figure H-20: Okanogan Study Site

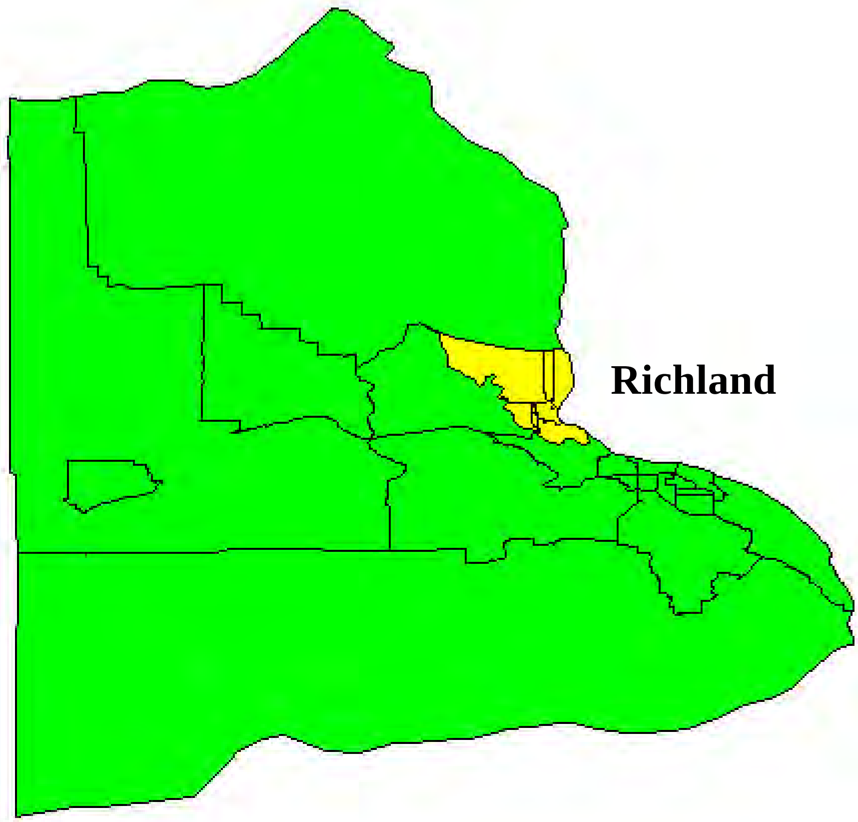


Figure H-21: Richland Study Site in Benton County

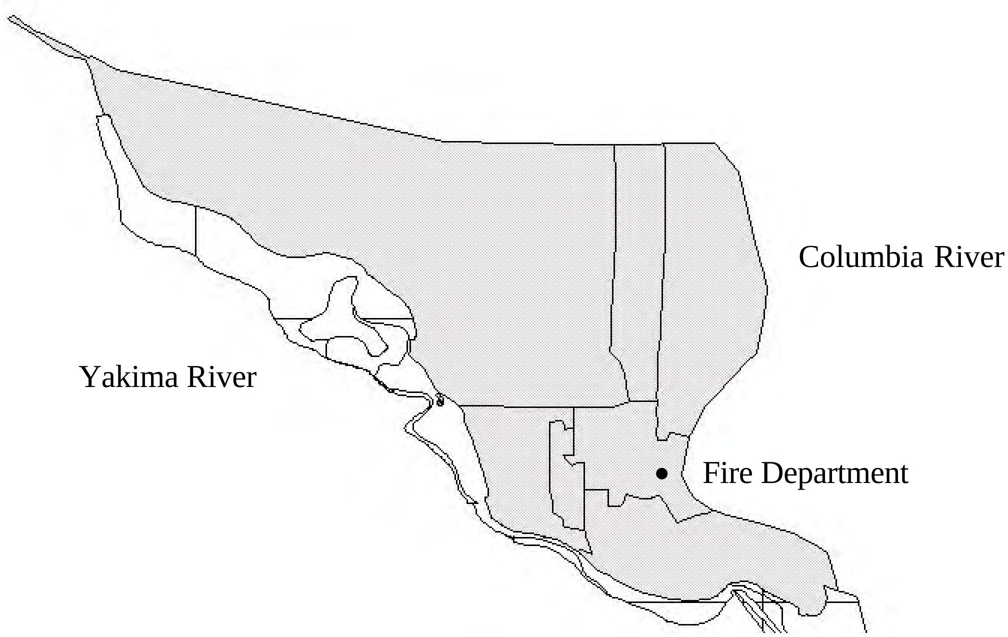


Figure H-22: Richland Study Site

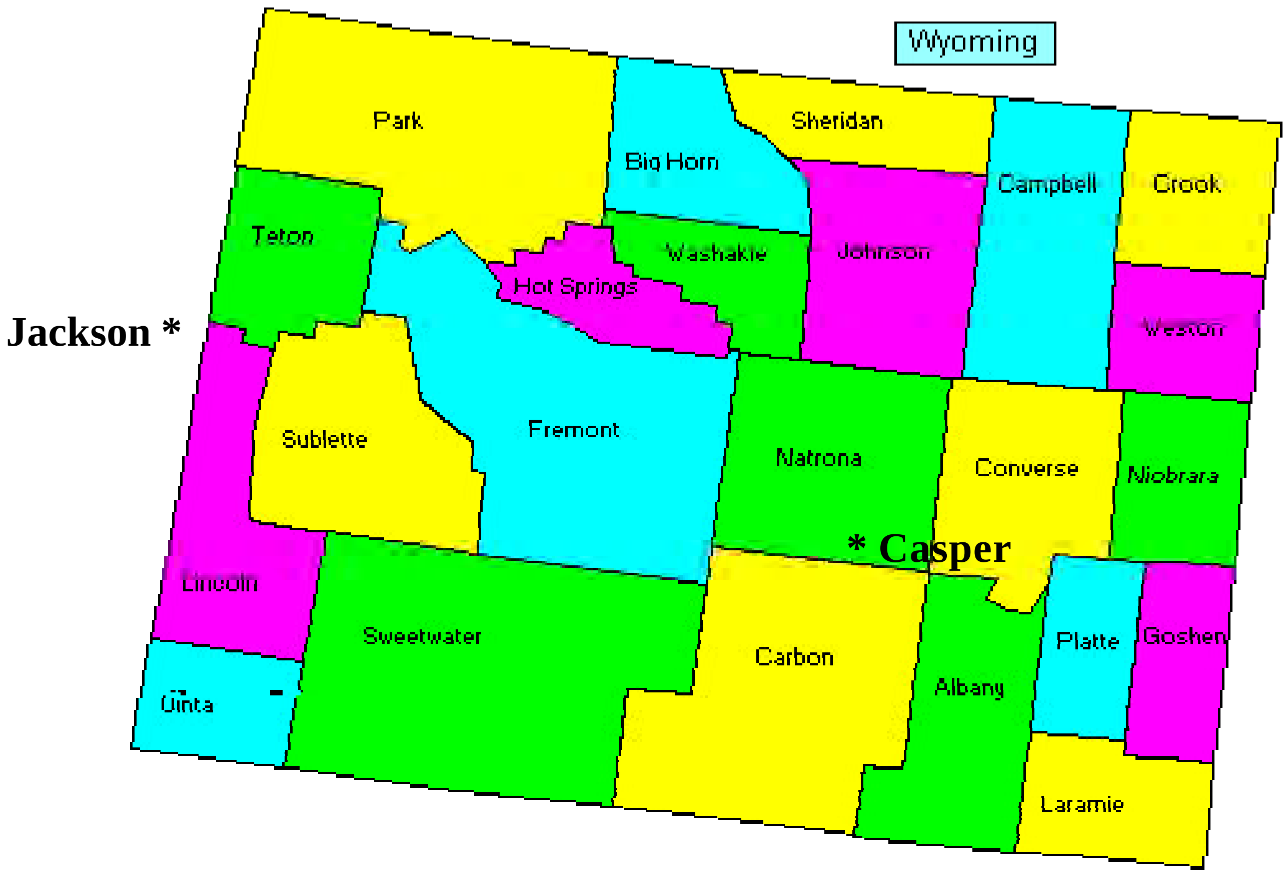


Figure H-23: Casper Study Site, Natrona County, Wyoming and Jackson Study Site, Teton County, Wyoming

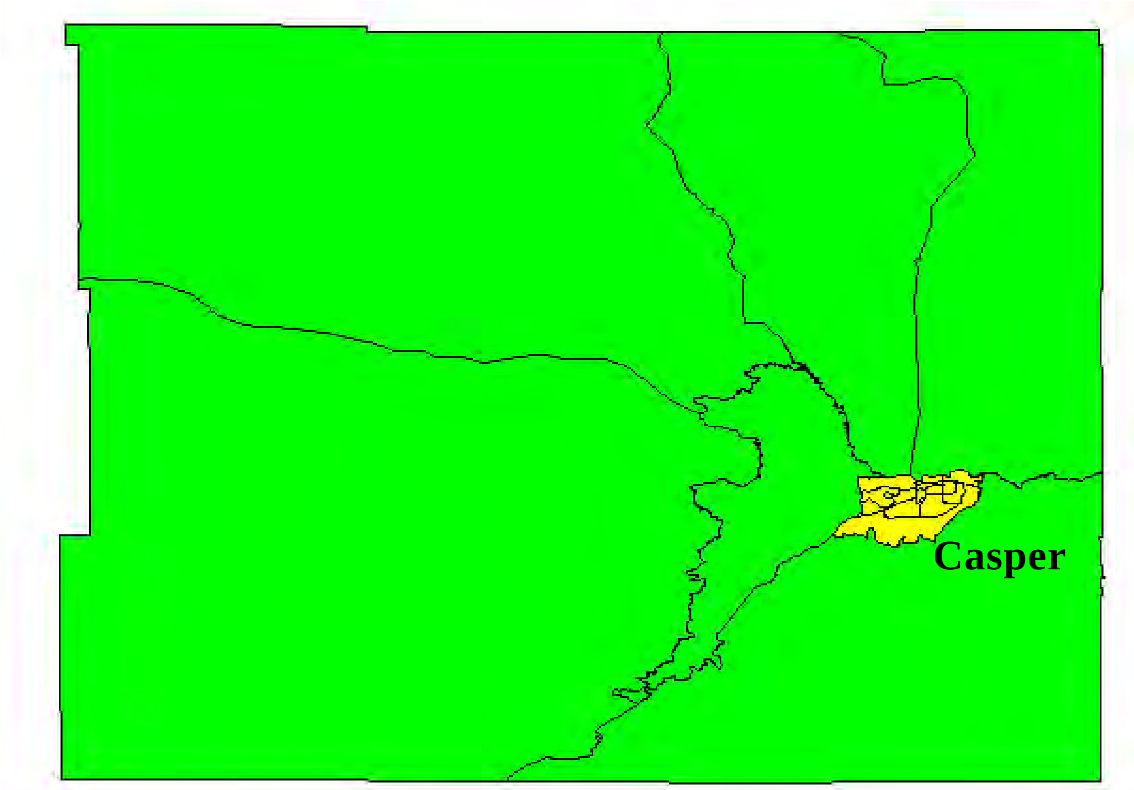


Figure H-24: Casper Study Site in Natrona County

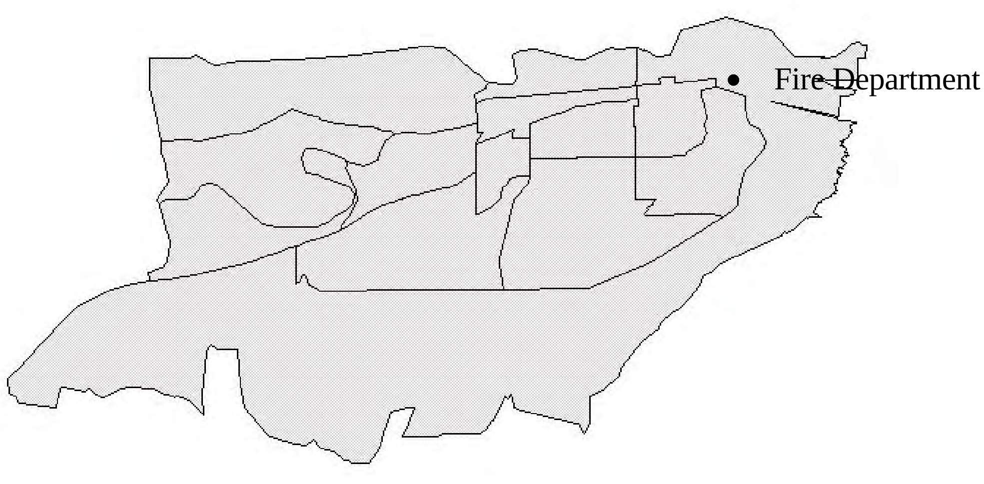


Figure H-25: Casper Study Site

Figure H-26: Jackson Study Site in Teton County

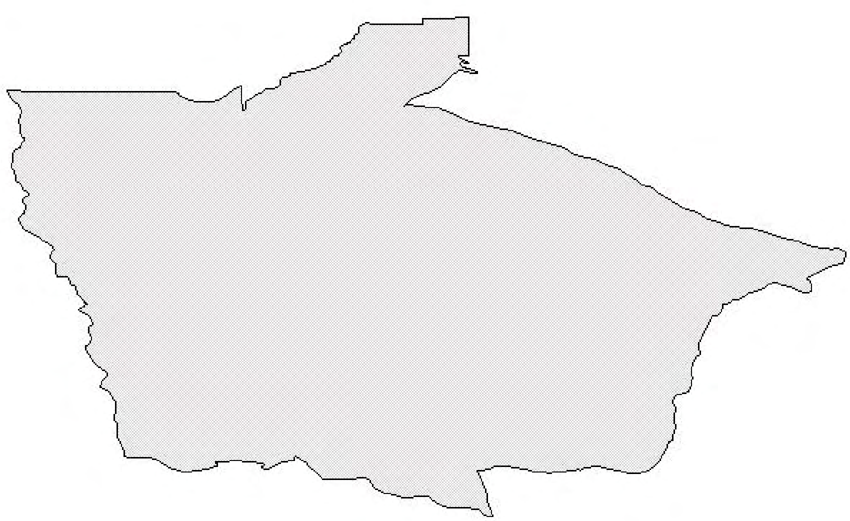


Figure H-27: Jackson Study Site

COMMUNITY INTERFACE ACTIVITIES

Three Cases
Prepared for the Academy
By D. Kathleen Hemenway
Snowflake, Arizona

National Academy of Public Administration
Washington, DC

CONTENTS

WILDFIRE RISK MITIGATION AND EMERGENCY PREPAREDNESS: FLAGSTAFF, ARIZONA

Located on the Colorado Plateau eighty miles south of the Grand Canyon, Flagstaff sits on gently rolling terrain. At an elevation of 7,000 feet, it is at the base of the 12,600 foot San Francisco Peaks. Flagstaff is at the northern end of the largest single-stand ponderosa pine forest in North America. The Coconino National Forest surrounds the town, and sections of the Kaibab and Prescott National Forests are nearby. The Navajo and Hopi Indian Reservations are in the desert to the northeast. Known for its intense blue skies, the area is regarded as having some of the clearest air in the continental United States.

With a population of about 54,000, Flagstaff is the largest city in Northern Arizona and the regional trade center. It straddles Interstate 40 (a major east-west transportation corridor) and Interstate 17 (the route to Phoenix two hours away). According to the Chamber of Commerce, the top three employers are Flagstaff Medical Center, Northern Arizona University (NAU), and the State of Arizona. The median household income is about $35,000. The annual rate of growth is three percent.

NAU's sprawling red brick and stone campus in the heart of town is one of the dominant features of Flagstaff. NAU has nearly 20,000 students. The Southwest Forest Science Complex, home to the College of Ecosystem Science and Management, is prominent at the south end of campus. The Complex houses several departments and institutes involved in many biological, economic, and socio-political aspects of forest health. While drawing on the expertise and projects of researchers throughout campus, and more broadly throughout the Southwest, much of the work on forest health is driven by the College's School of Forestry and the Ecological Restoration Institute (ERI). The School of Forestry shares a partnership and facilities with the USDA Forest Services' Rocky Mountain Research Station.

Flagstaff's character centers around being both a mountain town and a university town. In a recent study of Flagstaff's restored historic district, NAU geography professor Tom Paradis found that businesses tend to choose names that reflect mountain themes and themes that draw on other environmental features of the region. Between hiking and rafting in the Grand Canyon and skiing at the local resort, Flagstaff draws people interested in outdoor adventures both summer and winter. Several environmental groups have offices in Flagstaff due to the areas' extraordinary landscapes, species diversity, and spectacular natural beauty.

General Approach to Wildfire Risk Mitigation

The primary coordinating group for work related to wildfire risk mitigation is the Greater Flagstaff Forests Partnership (GFFP), formerly called the Grand Canyon Forests Partnership (GCFP). The Partnership was formed in 1996 partly in response to the severe fire season that threatened the town. The Partnership was the brainchild of leaders from academia, the environmental community, and the Forest Service. A cooperative agreement between the Forest Service and the Greater Flagstaff Forests Foundation, a 501(c)3 non-profit corporation, is at the core of the organization. According to the agreement, the Forest Service maintains full decision-making authority over projects on lands it manages. Before the Partnership takes action or makes a recommendation to the Forest Service, there must be unanimous agreement among the 21 partners. The partners include Arizona Game and Fish, Arizona Public Service, Arizona State Land Department-Forestry Division, City of Flagstaff, Coconino County, Coconino Natural Resource Conservation District, Cocopai Resource Conservation and Development District, Ecological Restoration Institute at NAU, Flagstaff Chamber of Commerce, Flagstaff Native Plant and Seed, Grand Canyon Trust, Highlands Fire Department, Indigenous Communities Enterprises, Perkins Timber Harvesting, Northern Arizona Conservation Corps and Northland Youth Conservation Corps, NAU-College of Engineering, NAU-School of Forestry, Society of American Foresters-Northern Arizona Chapter, The Arboretum at Flagstaff, The Nature Conservancy, and the U.S. Fish and Wildlife Service.

The Partnership has a formal organizational structure, including a Board of Directors, Partnership Advisory Board, and a Management Team that oversees its collaboration with the Forest Service. The Partnership has two paid staffers, an office, and an annual operating budget of about $100,000. It has an extensive website (www.gffp.org). It is affiliated with roughly 70 research projects, including many that it funds, as well as eight forest treatment projects planned or underway, and many educational and small business stimulation efforts.

The Partnership's primary focus is on landscape-scale forest restoration. This emphasis is one that it that the two organizations share, along with other organizations in Flagstaff, is that the best and most cost-effective way to prevent catastrophic wildfire is to restore health to forests on a landscape-scale. In other words, the root cause of the fire problem is considered to be lack of forest health, and it's believed that restoring health will reduce fire risk as well as preserving precious natural and cultural resources and preventing many problems such as watershed damage, wildlife habitat damage, insect infestation, and so forth.

The philosophy, according to Paul Summerfelt of the Flagstaff Fire Department, includes the belief that reducing fuels around and near homes, although it is essential, is not enough. This belief stems from two observations. One is that while localized fuels reduction work will save houses in some cases, in other cases fire can easily breach an urban buffer zone and local defensible space when it burns into town rapidly, at high intensity, and with spotting ahead. The second observation is that even if homes are saved, a wildfire that incinerates a nearby forest will still be a catastrophe for the community. In addition to destroying the watershed, the fire may destroy real estate values, tourism, recreation, and spiritual and aesthetic values. According to Diane Vosick of ERI, this focus on the landscape reflects an attitude that's shared by the community. Whereas technically Flagstaff's urban interface is defined to be 180,000 acres, including 100,000 acres of Forest Service land, she says the community defines its urban interface to be "the postcard"—that is, the town, the surrounding forest, and everything up to the top of the San Francisco Peaks.

While ERI and the Partnership each play large parts in wildfire risk mitigation activities in Flagstaff, so does the Flagstaff Fire Department. It has an active and highly regarded fuels treatment program led by Fuel Management Officer Paul Summerfelt. The Flagstaff Fire Department participates with other area fire departments, law enforcement, and emergency management personnel in the Ponderosa Fire Advisory Council (PFAC). PFAC meets monthly to coordinate plans for fire suppression and emergency response.

Although the leadership of one environmental group, the Grand Canyon Trust, has been key to the success of the Partnership, projects have been stalled by administrative appeals filed by other environmental groups. While the latter groups have taken an extremely cautious stance with regard to active management of the forests, as this document was being written in June 2002, it became all too clear that active management is urgently needed in Northern Arizona. Flagstaff sits at the northern end of the ponderosa pine forest that lost much of nearly 500,000 acres to the Rodeo-Chediski Fire, the worst wildfire in Arizona history. As Wally Covington of NAU has argued for years, and as he said in Congressional testimony recently, we have a narrow window of 15 to 30 years to restore forest health. Flagstaff, like other towns in Northern Arizona, effectively sit in groves of matchsticks.

Funding Sources

ERI received $8.8 million in funding in an off-budget, emergency appropriation from Congress in FY2001 and $2.8 million in FY2002. These funds were acquired through the efforts of Dr. Covington in collaboration with former Secretary of the Interior (and Flagstaff native) Bruce Babbitt and Arizona Senator Jon Kyl. The funding, which came through the BLM, was earmarked for research, development, demonstration, and completion of ponderosa pine forest restoration work at the community level. It was also earmarked for developing operational-scale programs from prototype work, and for information transfer to land managers and the public. A final objective of the allocation was to develop recommendations for utilization of small-diameter timber and other vegetative by-products of forest restoration. In addition to these task orders that were issued to ERI, three other task orders were tied to direct transfers of funds to the BLM-Arizona Strip Field Office, Grand Canyon National Park, and the Coconino National Forest.

Prior to allocating the funds, ERI held a workshop to identify the research and practical management questions that needed answers. As a result of the workshop, ERI funded: 24 research projects; on-the-ground fuels treatment projects; public outreach; technology transfer projects; and a feasibility analysis for small-diameter timber utilization. The fuels treatment projects funded include crews run by: Flagstaff Fire Department's Fuel Management Program; the Arizona State Land Department and the University of Arizona Cooperative Extension; and Northern Arizona Conservation Corp. Funding and support, although it primarily went to organizations in Flagstaff, also went to several other communities throughout the Intermountain West.

While the appropriation that came through ERI has funded the vast majority of the restoration and fuels treatment work in Flagstaff, funding has also come to the Greater Flagstaff Forests Partnership from the Four Corners Sustainable Forests Partnership. Also, State Farm Insurance provided funds to the Flagstaff Fire Department Fuel Management Program to develop a website. With regard to funding from FEMA, the Flagstaff Fire Department has none of any kind. The emergency services coordinator reports that FEMA funding covers part of his salary.

Forest Restoration and Fuels Treatment Projects

The Forest Service together with the Partnership has completed restoration work on about 3,000 acres. This is far less than they feel is urgently necessary; the low rate of accomplishment to date has been a result of administrative appeals that have occurred in the process of obtaining environmental approvals. While the primary emphasis is on thinning, the restoration treatments also include closing unneeded roads and restoring meadows. Fuels treatment methods include both hand and mechanical thinning and prescribed burning. Some of this work was completed by the Northern Arizona Conservation Corp.

A list of other fuels treatment projects follows.

1. The Flagstaff Fire Department Fuel Management crew cleans up about 1,500 acres of public and private land in the city annually. They clean up private property at the owner's request.

2. The Arizona State Land Department and the University of Arizona Cooperative Extension run a correctional crew from a nearby prison that cleans up private property in the county. The crew cleaned up about 50 acres last year and it expects to complete 250 acres this year. They have worked in the Parks neighborhood and in Sherwood Forest Estates.

3. Member fire departments of the Ponderosa Fire Advisory Council recently have begun treatment projects.

4. Work will soon begin on state land.

Whereas in Prescott the removed material is largely brush that is put into chippers, in Flagstaff green waste is typically put into slash piles and burned. In areas where burning isn't an option, the materials are taken to a site where they are put into an Air Curtain (high-intensity fire). Also, small-diameter trees are made available for use as poles as well as for firewood. A cooperative project is planned with the Navajos to transport firewood to the reservation.

Utilization of Small-Diameter Timber and Other By-Products

Some of the funding provided to the Partnership by ERI was used for studies that evaluated the feasibility of developing an industry in Northern Arizona to utilize small-diameter timber. This work was completed by Mater Engineering under contract to the Partnership. Plans are underway to hire a full-time business development specialist and to coordinate with stakeholders involved with each of the national forests in Northern Arizona.

According to Brad Ack, Program Director at the Grand Canyon Trust and Partnership Board member, there are no technical obstacles and there's no obstacle with regard to markets. The problem is absence of infrastructure due to uncertainty about supply. Although markets exist elsewhere, transportation costs are prohibitive.

What is needed is active management of the supply-side by the Forest Service. Coordination is needed across local national forests in order to manage: volume and mix (i.e. proportion of logs in each diameter range); timing of delivery; and geographic location of delivery. As the NEPA process takes two years, planning and scheduling need to be put into place to keep projects flowing steadily through the NEPA pipeline. According to the Mater Engineering report, this coordination should at least include the three larger national forests in Northern Arizona—the Coconino, Kaibab, and Apache-Sitgeaves National Forests. Diane Vosick of ERI says it makes sense to coordinate across Region 3 (Arizona and New Mexico). In addition to providing an assured supply that would make small-diameter timber businesses viable and give investors confidence, the coordinated harvest would ease the costs of harvesting and provide the continuity and steady work that harvesters need to maintain their businesses.

The keystone of a small-diameter timber industry is a sawmill for logs that are five inches in diameter and larger. Ack reports that in tests run on the logs coming out of Northern Arizona's forests the logs produce lumber of sufficient quality. Likely markets for these boards include businesses that manufacture structural (glulam) beams and businesses that harden and compress lumber for flooring, among others. The waste—chips and sawdust—can be used to create molded products. To get the industry going, the government needs to get involved by developing infrastructure and providing financial incentives (e.g. making land available, providing low-interest or no-interest loans, etc). Currrently, Mater Engineering is conducting studies to identify the best locations for sawmills and work out related logistic and infrastructure issues.

Fire Safe Construction and Vegetation Management Regulations

The City of Flagstaff and Coconino County require developers of new subdivisions and individual homes (lot splits) to submit plans for wildfire risk mitigation and emergency response. For new developments in the city, the fire department creates Forest Stewardship Plans in collaboration with developers. A new regional plan, recently approved, specifies that vegetation must be managed on ridges and steep slopes. The same terrain that is too hard to build on is also very difficult to thin and clear, and very difficult to fight fire on. As such areas can serve as incubators for large fires, ignoring them is not an option.

One recent plan for a new development in the county, Flagstaff Ranch Golf Club, comprehensively covers topics such as fire safe construction, vegetation management, power lines, house address marking, water supply and fire hydrants, emergency access and egress, a safety zone and helipad, fire department response, and so forth. It specifies that vegetation management requirements will be including CC&R's, which will require the work to be completed prior to occupancy. The developer regards wildfire safety as a selling point, and advertises it in his promotional materials.

With regard to ordinances, Flagstaff has a Class A/B roofing requirement. It does not have brush clearance or vacant lot ordinances. The fire department reviewed the IFCI Urban-Wildland Interface Code and decided against adopting it because of the feeling that Flagstaff has the problem covered and doesn't need more regulations. It has not adopted the 2000 International Fire Code.

Fire sprinklers are required as determined on a case-by-case basis depending on access for fire trucks, distance to the nearest fire station, and water supply. According to Ed Larsen, Development Services Supervisor, owners of many of the more expensive residences install sprinklers voluntarily for the insurance break.

Public Outreach

Public education and outreach are provided by many organizations in Flagstaff, including the Greater Flagstaff Forests Partnership, Flagstaff Fire Department, NAU and ERI, environmental groups, and others.

A list follows.

1. Flagstaff Fire Department's Fuel Management Program hosts "Let's Talk Fire" talks in neighborhoods. While attendance at these meetings is usually small, the fire department feels they are effective because they lead to neighbors convincing neighbors. The Flagstaff Fire Department distributes the kinds of brochures and pamphlets that are commonly given out in communities in Northern Arizona, including information about fire safe construction, vegetation management, and so forth.

2. Recently the fire department started a program called "Firewise Neighborhoods." It was patterned after the NFPA's Firewise Communities program, but was customized to the Flagstaff community. The people of Flagstaff are considered generally to be more in touch with issues of forest health and fire risk than the kinds of people targeted by the Firewise Communities program.

3. The Partnership, the Nature Conservancy, and other groups lead interpretive hikes and walks in areas of the forest that have been restored. Hikes have also been offered by groups to areas of the San Francisco Peaks damaged by the Radio Fire 25 years ago.

4. Other public outreach events and materials are sponsored through ad hoc partnerships. One such event is the Grand Canyon Forests Festival that occurs in conjunction with Earth Day. Another such collaboration produced an informative and professional looking newspaper insert called "Living with Fire... 25 Years After the Mount Elden Burn."

5. The Partnership maintains an extensive website that describes in detail its structure, mission, philosophy, and the status and accomplishments of planned and ongoing treatment and monitoring projects, and of related research projects. The articles included are scholarly and include many references to the scientific literature.

6. Although the meetings of the Advisory Board of the Greater Flagstaff Forests Partnership are open to the public, generally all of the attendees represent professional organizations. A typical meeting includes several representatives from the Forest Service, the Flagstaff Fire Department, Northern Arizona University, the Grand Canyon Trust, and others. Discussions often focus on details of treatment prescriptions for projects planned and

underway, and on ideas for developing a small-diameter timber industry. The meetings are professionally run and they have an academic tone with lots of discussion of strategies and tactics for resolving trade-offs among ecological, economic, and socio-political considerations. One recent discussion, for example, was about how to best resolve conflicting considerations with regard to the issue of diameter caps (that is, restrictions on cutting trees above a certain diameter threshold). In general, diameter caps cause a lot of impassioned discussion among the partners and, in fact, throughout the Flagstaff community.

Outstanding Challenges

While this report was being written the Rodeo and Chediski Fires merged creating a 50-mile fire line and devouring much of the ponderosa pine forest on the Mogollon Rim southeast of Flagstaff. The need for landscape-scale restoration could hardly be more urgent.

In a July 29th report the Governor's Forest Health/Fire Plan Advisory Committee proposed many steps to be taken.[1] These steps address problems such as: inadequate funding for community-based programs and inability to meet federal matching-funds requirements; lack of coordination of the small-diameter timber supply and absence of incentives for restoration-based businesses; delays imposed by the environmental review process; inadequate coordination across communities, with tribes, and across programs; and inadequate focus on monitoring and evaluating forest treatment prescriptions. The Advisory Committee recommended: adoption of Firewise construction and vegetation management standards;[2] expanding the Firewise program in the state; increasing funding of post-fire rehabilitation efforts; increasing funding for community-based programs; and developing educational materials for citizens concerned about smoke from prescribed fire.

According to Jim Golden, Supervisor of the Coconino National Forest, the key is to treat the forest health problem as an emergency. Our current forest management regulations and practices assume that we have an infinite amount of time, whereas in fact we urgently need to treat more acres in less time, more efficiently and more cheaply. Whereas now it seems as if "the process is the product," we need to evolve to a process that enables us to get broad-scale work done on the ground, quickly. This will entail a paradigm shift. The new paradigm will be one that doesn't put the science of restoration on trial with every project. It will be one that is sensitive to local conditions but that enables Forest Service employees and other restoration workers to get a lot of work done in a safe, effective, and efficient manner. It will be one that allows work to proceed under monitoring and quality control protocols rather than delaying the work with "analysis paralysis" as we strive for perfection in resolving tradeoffs among conflicting priorities.

Finally, in the new paradigm we will need to assess the risks and costs of proceeding against the risks and costs associated with delay. As the Rodeo-Chediski Fire, as well as fires in Oregon and

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[1] The report is titled "Recommendations for Reducing Unwanted Wildfire Risk and Restoring Forest Ecosystems in Arizona."
[2] Specifically, the NFPA's Firewise program recommends NFPA 1144, "Standard for protection life and property from wildfire," an update to NFPA 299.

Colorado made all too clear during the 2002 fire season, the costs of delay can be very, very high.

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WILDFIRE RISK MITIGATION AND EMERGENCY PREPAREDNESS: PRESCOTT, ARIZONA

Background

Prescott is a city of 34,000 located 96 miles northwest of Phoenix and 90 miles southwest of Flagstaff. For many years Prescott was primarily a community of summer cabins, but now 90 percent of the residents are full-time. It is highly regarded as a retirement community. According to the Chamber of Commerce, the three largest employers are Yavapai County, Yavapai Regional Medical Center, and Sturm Ruger and Company, a firearms manufacturer. The median household income is about $34,000 and the mean cost of a home is $185,000. The annual growth rate is 2.5 to 3.0 percent. On average one new house permit is issued per day.

The downtown area is in a mile-high basin, while many of the neighborhoods are nestled in the surrounding mountains. The typical mountain home is set among ponderosa pine trees and chaparral. Many homes have panoramic views. It is not uncommon for large, new homes with views to sell for over $500,000. An urban-interface assessment in 2000 classified neighborhoods by vegetation (fuel type), access, infrastructure, and topography, and identified as at-risk 14,000 houses that are homes to 30,000 people. The assessed value of property at risk is $1.7 billion.

On its south and west sides the town shares 19 miles of border with the Prescott National Forest. In addition to homes and clusters of cabins, there are 28 youth camps in the forest that have a cumulative maximum occupancy of 12,000. Due to the mountainous terrain, dog hair thickets, chaparral, and prevailing winds from the southwest, the south and west sides of town are most at risk. The predominant vegetation type is ponderosa pine with an understory of oak, manzanita, and New Mexico locust. After several years of drought, there are many dead and dying pine trees.

Prescott is dealing with the aftermath of the Indian Fire, the first fire to significantly affect the town in 25 years according to Al Bates, chairman of the Prescott Area Wildland-Urban Interface Commission. It started at about two in the afternoon on May 15, 2002 three miles south of town in the forest. The ignition source is unknown. The fire burned from its origin to the edge of town as a catastrophic, crown, stand-replacement fire. Thirteen hundred acres of federal land, 30 acres of private land, five homes, and two outbuildings were burned. Portions of the watershed in the burned area received significant damage.

Following the first burn period, in addition to sunset arriving and the wind dying down, the protection of two thousand houses at risk and ultimate containment of the fire were attributed to: fuel reduction treatments in the forest adjacent to neighborhoods; defensible space work completed within the neighborhoods; a very well coordinated emergency response; and a speedy air attack mounted by the Forest Service. Located at the municipal airport, Prescott National Forest's Prescott Fire Center is part of the national emergency response system.

Community reaction to emergency management of the fire was overwhelmingly positive. Individuals, groups, and organizations posted banners and signs throughout town thanking the hotshots and other firefighters. Following the fire 2,000 people attended a celebration that was held to honor and thank the professionals and volunteers who helped out.

Due to the unprecedented fire danger, the entire Prescott National Forest was closed temporarily following the Indian Fire. During the closure, violations were an ongoing concern of the Forest Service.

General Approach to Wildfire Risk Mitigation

The primary coordinating group for handling wildfire risk mitigation is the Prescott Area Wildland-Urban Interface Commission (PAWUIC). The Commission was founded in 1990 by the city manager, the chairman of the county board of supervisors, and the forest supervisor. Its formation was partly a response to the Dude Fire that burned 24,000 acres near Payson (60 miles east-southeast of Prescott) and took the lives of six firefighters.

Formed by joint agreement between the city and county, the Commission is a 501(c)3 non-profit organization that is citizen-driven. Currently the cooperating agencies include the Central Yavapai Fire District, Arizona State Land Department, and the Forest Service (Prescott National Forest), as well as the city and county. The Commission is tasked with addressing wildland-urban interface issues through: advising the public agencies; promoting public awareness; and pursuing implementation of remedies on private land. The membership includes representatives of the cooperating agencies as well as representatives from other interested organizations and private citizens who are volunteers. Al Bates, the current chairman, is a retired computer software developer who volunteers his time. The Commission has no paid staff, no office, and no website.

Many of the volunteers began helping out because of concerns about their own neighborhoods, and they serve as unofficial representatives of their homeowners associations. Roughly half of the volunteers are retirees. Attendance at monthly meetings has grown to a recent high of about 40. Participants include, in addition to several representatives from the cooperating agencies and volunteers: a representative of the Prescott Yavapai Tribe; the director of the county branch of the University of Arizona Cooperative Extension; the director of a church camp; the owner of a waste hauling and salvage business; and occasionally an insurance agent and a realtor. APS, the local electric utility, is a long-time supporter providing equipment and funds.

The Commission is well run and effective and its accomplishments are impressive. An early success was the formation of the Interagency Fire Emergency Management Group (IFEMG). This partitioning into two organizations—one to focus on fuels treatment and forest restoration and a second to address suppression and emergency response—matches the organizational structure used in Flagstaff as well as in the White Mountains of northeastern Arizona.

The IFEMG has held emergency response drills since 1990 to work out issues of interagency cooperation, teamwork, assignment of responsibility, and the logistics of transitioning from a single-unit to a multi-unit effort over the course of an emergency. These drills have been frequent and comprehensive, and they are regarded as having been the reason for the well-organized and effective response during the Indian Fire.

Prescott places a greater emphasis on preparing for emergency response and evacuation than do other Northern Arizona communities. This may be attributed to the strong leadership of several agencies, including: Prescott Fire Department; Central Yavapai Fire District; the Forest Service, Prescott National Forest; Arizona State Land Department; and Yavapai County Office of Emergency Management. Other causes likely include concerns about: ensuring the safety of youth in the camps; protecting the large population living in homes at risk; and defending homes on steep hillsides, often with limited access for firefighting equipment.

Another major success of the Commission has been the cleanup of the Kingswood Estates neighborhood where 90 percent of the lots have been treated. A newer project in a second neighborhood, Timberridge, is at 60 to 70 percent. These projects were advocated and coordinated by volunteers from the neighborhoods, who acted as liaisons between homeowners and the chiefs of the cleanup crews.

The Commission has received recognition nationally from the Firewise Communities program as a model for interagency and inter-jurisdictional cooperation and citizen involvement. The Commission is featured on the Firewise website (www.firewise.org). As a twelve-year-old group, it is by far the most long-standing among such organizations in Northern Arizona.

Funding Sources

Funding sources for the Commission include:

1. A National Fire Plan (NFP) 2002 State Fire Assistance Grant of $230,000 with a 50/50 matching funds requirement. These funds are being used for the continuation of ongoing brush removal projects in the city, with matching funds provided by the fire department and the fire district. These funds also are to be used for clearing around youth camps, camp emergency evacuation plans, and for clearing state lands to the east of the city (with matching funds provided by the state). The corresponding grant for 2001 was for $168,000.
2. An NFP 2001 Community Planning for Fire Protection and Economic Development Grant for $29,000, with a 75/25 matching funds requirement. This money supports research into ways to use woody material generated as a result of forest thinning and efforts to create defensible space.
3. Over the past two years FEMA funding was approved for two wood chippers. This grant had a 50/50 cash-only matching requirement.

Other FEMA funding received by Yavapai County Office of Emergency Management includes funds for a chipper to be used by the county on clearing rights-of-way (50/50 cash-only match), and a State and Local Assistance (SLA) benefit of $43,000 annually. The expenses for the Indian Fire were roughly $70,000, to be reimbursed by FEMA at a 100 percent rate.

Fuels Treatment and Forest Restoration Projects

Treatment projects are ongoing on Forest Service land, private property, and along county roads. Work on state land will begin soon.

Descriptions of the individual projects follows.

1. The Prescott Fire Department and Central Yavapai Fire District run a brush-removal crew and two two-man chipper crews that are partially funded by an NFP grant to the Commission. The brush-removal crew works primarily with hand tools such as power saws and rakes. The chipper crews can work faster than the brush removal crew, so they handle a variety of brush piles where they find them. As yet homeowners have not been charged for work on their properties, although the Commission is considering a small charge with waivers for elderly, disabled, and low-income people.
2. When brush crushing equipment and crews are available after completing work with the Prescott National Forest, the Commission uses them for clearing large acreages.
3. Individual contractors are available for hire by private landowners. Advertisements for these services appear in the local newspaper.
4. Yavapai County has a crew that clears away brush from roadsides.
5. The Forest Service has a project that was approved in 1998 for restoring forest health and reducing wildland fire risk on 12,000 acres around the city. A second, 30,000 acre project—the Boundary Project—is currently going through the NEPA process. It is intended to achieve 60 to70 percent thinning through the use of mechanical and hand thinning and prescribed fire. The Forest Service estimates that the Boundary Project may cost up to $8 million and take ten years to complete. The reasons for the protracted time frame are: constraints on equipment use; limitations on prescribed fire due to impacts on the airshed and effects on smoke-sensitive people; and impacts on wildlife.

   The Forest Service's fuels treatment efforts are credited with helping to save two neighborhoods, Timberridge and Mountain Club, during the Indian Fire.

Utilization of By-Products

Removal of the by-products of restoration and thinning work is one of the biggest obstacles for Prescott as it is for other towns in Northern Arizona. While the city and homeowners primarily face brush removal issues, the Forest Service also has small-diameter trees to deal with. To date the only outlet has been a firm in Phoenix that uses timber for pallets and sells wood chips for decorative landscaping in Los Angeles. As that firm's need for these materials is limited, finding businesses to buy and remove both trees and chips is critical to defraying the costs of the fuels reduction and forest restoration efforts. The pulp and paper mill in Snowflake, Arizona, a major market for small-diameter timber in the Southwest since 1959, stopped using the timber in the late 1990s due to the Forest Service's inability to continue providing long-term contracts. Lack of confidence about long-term supply is a major problem for new businesses considering using small-diameter timber, as it was for the pulp and paper mill.

The Commission has a grant for research into by-product utilization. Also, a Commission member who owns a waste hauling and salvage business—Kuhles Services—recently received a grant for business development from the Forest Service. It is expected to help significantly with the disposal of green waste, however, the funds have been delayed as part of the freeze on spending that occurred due to the high suppression costs of the 2002 fire season.

The Commission is in discussions with the Greater Flagstaff Forests Partnership (GFFP) about ways to address the utilization of by-products, as it is a major obstacle for GFFP as well as for the Natural Resources Working Group (NRWG). The NRWG coordinates fuels reduction projects in the Apache-Sitgreaves National Forest in northeastern Arizona (i.e., in the White Mountains).

Fire-Safe Construction and Vegetation Management Regulations

Less than a month after the Indian Fire, the Prescott City Council adopted the 2000 International Fire Code (IFC) and the 2000 Urban-Wildland Interface Code (UWIC), with amendments. Prior to passage of these codes, Prescott did not have the kinds of vegetation management ordinances that some communities in other states such as California have used to curb wildfire risks (e.g., brush clearance, vacant lot, and tree cutting ordinances).

The UWIC places fire-safe construction requirements and vegetation management requirements on new homes in at-risk neighborhoods. For new subdivisions, it places requirements on water supply and roads (for emergency access and egress) as well. Lots in new subdivisions will have to conform to vegetation management requirements before vertical construction begins (that is, before walls are erected on the foundation).

Although the UWIC makes these requirements official for the first time in Prescott, the fire department has been working with subdivision developers over the past year on requirements of this type. Pre-thinning and vegetation management are beginning to be used as selling points, as they are in other towns such as Flagstaff, Payson, and Durango. According to Prescott Fire Marshal Ted Galde, in the Hassayampa Village subdivision lots that have been treated sell more quickly and for more money than untreated lots.

For existing subdivisions the UWIC overrides Codes, Covenants, and Restrictions (CC&R's) on lots. The affected covenants are those that prohibit cutting trees and those that require a replacement tree for each tree removed during construction.

A controversial amendment to the IFC was the addition of a sprinkler requirement for single-family residences over 5,000 square feet and all multi-family dwellings (regardless of square footage). With the current threshold the sprinkler requirement will naturally only apply to a fraction of residential construction. The fire department would like to see sprinklers required in all new residences eventually. Whereas the primary motivation is safety in the case of a structure fire, sprinklers can be valuable also in preventing a structure fire from igniting adjacent structures and vegetation, causing a wildfire. In some cases, the fire department already requires sprinklers due to inadequate water supply or inadequate access for fire trucks. Some homeowners, particularly owners of larger residences, install sprinklers voluntarily. One incentive is reduced insurance rates.

Public Education

The Indian Fire, as well as the Rodeo-Chediski Fire in Arizona's White Mountains and other large fires in Oregon and Colorado, increased—perhaps temporarily—awareness, concern, and homeowner action. However, the Commission feels that educational efforts are still essential, and always will be. There will always be new residents who are unaware of the need for defensible landscaping. There will be people who are aware, but who don't take action on their own properties due to inertia or concerns about aesthetics. There will be people who won't cut a tree—any tree.

The Commission's educational efforts initially centered around neighborhood meetings, but they weren't particularly effective. More recent educational efforts have expanded to include a broad range of techniques for getting the message out and involving the public.

A summary of outreach efforts follows.

1. In April the Commission held its fourth annual town hall, featuring a couple who lost their home in the Cerro Grande Fire. Four hundred people attended. Another town hall was scheduled for June 27th to leverage the increase in public concern following the Indian Fire. That town hall was by far the most successful to date, with 800 in attendance. The town halls include speakers representing many facets of fuels reduction and forest health work, as well as emergency response personnel. Representatives from the fire departments, Forest Service, police department, and Red Cross are typical speakers.
2. One neighborhood, Timberridge, is a pilot community in the Firewise Communities program. Signs are posted prominently at the entrance to the neighborhood as well as at participating homes (although the neighborhood board will only allow five signs to be displayed at a time, so they are passed around).
3. Brochures and pamphlets on fire-safe construction, defensible landscaping, and evacuation procedures are handed out at many meetings, festivals, and other events.
4. Three volunteers who work with the Prescott Police Department developed a 15-minute video in collaboration with the fire department.
5. The Texas Forest Service Wildland Fire trailer, that contains exhibits and a computer program for assessing your home's risk, visited Prescott schools and was also available to the general public.
3. Plants for defensible landscaping are identified and available at a local nursery.
4. A poster contest for school children was held.
5. The local newspaper often runs articles about defensible landscaping and construction practices and about the progress of the fuels reduction projects. Coverage of the Indian Fire and the role of fuels reduction in saving homes were extensive in both the Prescott and the Phoenix newspapers.

Plans are underway for a cleanup demonstration event at the Highland Center for Natural History, as well as for a "Regional Alert" emergency information web site.

Plans for a website notwithstanding, web access is a notable weakness in the Commission's public information campaign. Little information is posted by the city, county, and fire agencies. The Forest Service provides more information, although most documents are not posted. The Forest Service did post updates at least once a day during the Indian Fire.

Outstanding Challenges

The most significant problems facing the Commission are the lack of a market for wood chips and small-diameter timber, and public attitudes and inaction. A third problem is the lack of an office and paid staff, resulting in dependence on volunteers for completion of many projects and ad hoc coordination (e.g., meetings are often held in a local coffee house).

If a market for chips and timber were developed, it could help defray the costs of removing brush and timber from both private property and public land; it could alleviate logistical problems with transporting and accommodating material at the landfill; and it could prevent the waste of natural resources.

With regard to public attitudes and inaction, Prescott faces an ongoing battle pitting safety against aesthetics and inertia.

Because of these problems and others, progress is slow. Like leaders in other forest towns the Commission is in a race against time. It has been estimated that it may take a decade to clean up all the neighborhoods and a decade to make one pass through the national forest. As the Indian Fire and the nearby Rodeo-Chediski Fire have demonstrated, this is time Prescott doesn't have.

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CALIFORNIA'S APPROACH TO MITIGATING WILDFIRE RISK TO COMMUNITIES—WITH EXAMPLES FROM SAN DIEGO COUNTY

In late October of 1993, Santa Ana winds blew west across the mountains and into the Los Angeles Basin and the San Diego metropolitan area. Over a ten-day period the combination of winds and dry, flammable brush ignited 22 major fires. Dubbed the California Firestorm of 1993, these fires burned nearly 200,000 acres, killed four people, and destroyed more than 1,200 structures, valuable watershed, and wildlife habitat. Emergency response included 15,000 fire service personnel and 1,500 fire engines. Costs were estimated at one billion dollars, including response and damages (Governor's Office of Emergency Services, no date).

This firestorm followed just two years after the Oakland-Berkeley Hills Tunnel Fire, California's worst wildland-urban interface disaster. The Tunnel Fire destroyed about 2,500 homes and killed 25 people, including both emergency workers and residents, many of whom were trapped in their cars on steep, narrow, windy roads as they tried to evacuate (USFA, no date). In a U.S. Fire Administration report, the risk factors identified for this fire were: lack of defensible space around structures; wood shingle roofs and siding; steep terrain with homes overhanging hillsides; narrow roads with limited access; and limited water supplies. Coupled with Diablo winds and low humidity, the natural vegetation was highly combustible due to drought and freezing weather that had killed large amounts of eucalyptus and brush, leaving a blanket of dead fuel. Eucalyptus trees were common in the area, having been imported from Australia after the native trees were harvested during the 1800s for construction lumber and railroad ties.

With $1.7 billion in insured losses and $2.5 billion in total losses, the Tunnel Fire attracted a great deal of attention from the insurance industry, and was the beginning of problems for many homeowners with obtaining and keeping insurance coverage (ISO 1997). From an insurance industry perspective, however, this disaster was soon overshadowed by the 1994 Northridge Earthquake that caused about $15 billion in insured damages, making it one of the three most costly catastrophes in United States history (ISO 2002a).

The Tunnel Fire and the Southern California Firestorm are just the two most dramatic examples of what is widely considered to be one of the worst wildfire risk environments in the world. California's history of major wildland-urban interface fires dates back almost 80 years to a wildfire that destroyed nearly 600 structures in Berkeley in 1923, although the problem has escalated in recent decades due to population growth, drought, and decades of fire suppression. Together with California's hot, dry summers, an overgrowth of vegetation and dead and dying plants have created a highly volatile situation. In addition to insect infestations in the imported eucalyptus trees, California's native oak trees are suffering from a plague of Sudden Oak Death Syndrome. With three million new residents in the 1990s alone, many of whom settled in wildland areas, there has been a dramatic increase in dollar damage and structures lost to wildfire. Since the 1960s, acres burned per year has been stable while costs and losses skyrocketed. According to the California Fire Plan, population growth and encroachment into wildland areas have led to the most acute problems in the central Sierra (e.g., El Dorado County) and in the Southern California counties of Riverside, San Bernardino, and San Diego.

Of California's 30 million people, eight million own homes and businesses in wildland areas. Thirty-five of the state's 100 million acres have been classed as flammable mixed interface (i.e., one house for every five to 160 acres) and nine million acres have been classed as developed environments subject to conflagration from wildfire (CDF 1995). Over 1,200 communities have been identified as being subject to moderate or high threat, and 843 are listed as at threat from wildfire on federal lands.[3] According to the California Fire Plan, there are an estimated one million housing units at risk with a replacement value of $107 billion for structures only. From 1985 to 1994, an average of 703 homes were lost annually, with an average loss of $232,000 per home, for an annual average loss of $163 million (CDF 1996).

Wildland fire is a concern in each of California's five vegetation communities: non-native grassland, coast live oak woodlands, coastal and purple sage scrub, chaparral, and forested lands (coniferous pines and firs). Coastal scrub and chaparral are a particular problem in Southern California where they occur on steep slopes in areas with hot, dry fall winds (the Santa Anas) and where the intermix neighborhoods of the urban fringe are extensive (UCFPL, no date). Although the fire season in Southern California is officially from spring to fall, in fact many major fires have occurred in winter—making the fire season effectively nearly continuous.

General Approach

Due to the Tunnel Fire, the Southern California Firestorm, and many other wildland fire disasters, the state has put in place legislation, organizations, and research and development groups all addressing the problem of wildfire risk mitigation. While some such efforts date back decades, there has been a lot of progress since the mid-1990s. Below are descriptions of the lead organizations and programs, followed by a case study of the efforts on-going in San Diego County.

California Department of Forestry and Fire Protection (CDF)

The leader in setting up many of the wildfire risk mitigation programs is the California Department of Forestry and Fire Protection (CDF). CDF has fire protection and stewardship responsibility for over 31 million acres of wildland, or about one-third of the state (i.e., the "State Responsibility Areas" or "SRAs"). It also has responsibility for emergency services in 35 counties through contracts with local governments. It responds to an average of 6,400 wildland fires per year that burn an average of 148,000 acres, as well as responding to about 275,000 non-fire emergencies. It has a budget of $600 million and nearly 18,000 personnel including permanent, seasonal, and volunteer workers, inmates and others. It operates more than 600 fire stations and over 1,000 fire engines. The Office of the State Fire Marshal is part of CDF, as is the Fire and Resource Assessment Program (FRAP). CDF also has responsibility for reviewing the Timber Harvest Plans that are required for all commercial timber harvesting on non-federal lands (CDF 2002).

CDF has a prominent public profile due to the lead role it takes in firefighting. Although its mission is to protect the wildland rather than structures in State Responsibility Areas, in wildland-urban interface situations it more and more frequently is involved in structure

[3] See www.firesafecouncil.org/about/communitiesatrisk.html for a listing.

protection, despite an often awkward and confusing division of responsibility with local fire districts. It also is highly visible to homeowners because it does inspections of private property to ensure compliance with a state law requiring 30 feet of clearance around homes in SRAs. In 2001 in San Diego County alone, CDF conducted 22,000 inspections. While other states such as Arizona are focused on the creation of defensible space and fuelbreaks, in California the expense and effort of on-going maintenance are also major concerns.

Fire Safe Councils

In 1993 CDF started the Fire Safe Council (FSC), now the primary organization involved in coordinating community-level mobilization. The FSC was initially a means of expanding the capability of CDF's fire prevention public education program to educate the public about fire safety by enlisting the participation of industry groups and other public- and private-sector organizations with a vested interest in minimizing wildfire damage. This consensus building partnership organization soon became the means of obtaining input from communities for the California Fire Plan through formation of local Fire Safe Councils. Today there are 50 partners, including 15 from the insurance industry. Other partners include public utilities, nurseries and landscapers, government agencies, construction industry organizations, environmental groups, and others.

Having received significant funding since 2001 due to the Bureau of Land Management's Community Assistance Grants associated with the National Fire Plan ($1.3 million in 2001 and $2.6 million in 2002), FSC programs have moved beyond public education to include proactive efforts such as chipping programs (i.e., programs that provide a chipper to chip and remove brush that's been cut from around homes and along roadways). There are FSCs or similar organizations in nearly all of California's 58 counties. There are more than 90 local FSCs statewide, concentrated in the population centers of Southern California and the central Sierras, with a scattering of councils in the San Francisco Bay Area. Among the councils there are approximately a dozen staff people and a half-dozen offices, and a comprehensive web site that serves as the communications hub for the network of councils.

The state FSC's primary roles are: to build consensus among public- and private-sector organizations as a way to build support for fire safety programs statewide; to deliver common educational messages statewide, educating Californians about how to make their homes, neighborhoods and communities fire safe; to get local councils started by bringing stakeholders to the table and helping them get the educational resources they need; to facilitate communication and collaboration among councils; and to coordinate with state agencies on behalf of the councils. It also has an action group that tracks legislation, facilitating discussion among stakeholders and encouraging coordinated positioning on key issues. According to Erica Bisch, managing director of the state FSC, the most important accomplishment of the FSCs has been to develop trust and individual relationships among stakeholder groups with competing interests.

The state FSC meets monthly at different locations throughout the state. Attendees include representatives of government agencies, as well as leaders from county, community, and neighborhood FSCs. At a recent meeting, the state FSC reported on obtaining nonprofit status, setting up a board of directors, dividing the state into three regions for representing local FSCs to the board, and looking into obtaining a group policy for liability insurance for FSCs and a group arrangement for legal counsel. As a nonprofit, the state FSC plans to obtain funds for statewide and local fire safety programs. Representatives from the local chapters present at the meeting reported on a variety of activities, including: obtaining nonprofit status, difficulties with liability insurance, homeowners' problems with insurance cancellations, difficulties keeping water available for fire emergencies, the overwhelming popularity of chipping programs, the need for more funding, and the inefficiencies involved in navigating a wide variety of grant application processes. The Ojai Valley FSC representative reported that a popular local youth program—"CREW"—has been doing pre-fire fuels treatment work. The CREW leadership has been asked to set up similar organizations throughout the state.

California Fire Alliance

Another organization leading the coordination of wildfire risk mitigation is the California Fire Alliance. Started in 1997, this group coordinates pre-fire management activities of local, state, federal, and tribal agencies. Member agencies include: CDF, USDA Forest Service, Fire Safe Council, Bureau of Indian Affairs, Bureau of Land Management, Governor's Office of Emergency Services, Los Angeles County Fire Department, National Park Service, and U.S. Fish and Wildlife. The Alliance coordinates its monthly meetings with the state FSC meetings.

The Alliance has no discrete funds or authorities, rather members share information to coordinate and integrate their pre-fire projects. Among the pre-fire projects are efforts directed at creating defensible space, fire safe landscaping, fuelbreaks, and forest management (involving both prescribed fire and mechanical thinning). Projects completed in 2001 by members with the support of the Alliance included: distributing \$3.8 million in federal funding to 101 community projects, many through the FSC; distributing FEMA and Forest Service funds to fire districts; and distribution of funds by the BIA to 20 tribal wildland-urban interface projects. Pre-fire treatments of member agencies included: 3,000 acres treated by the NPS; 5,500 acres treated by the BLM; 23,000 acres treated by CDF; and 149,000 acres treated by the Forest Service (CFA 2001). In a recent FSC meeting, the Alliance reported on plans for conducting Firewise workshops and on efforts directed toward streamlining the environmental approvals processes.

Together the Alliance and the FSC provide an efficient organizational structure for mobilizing wildfire risk mitigation activities. The Alliance provides a single point of contact for the FSCs with the agencies, while the FSCs in turn provide the Alliance with a single point of contact for coordination with communities.

The California Fire Plan and Local Fire Management Plans

Since the 1970s CDF's Fire and Resource Assessment Program (FRAP) has conducted periodic assessments of California's forests and rangelands. The third assessment in 1995 focused on wildfires, the most limiting natural factor. Published as the California Fire Plan in 1996, its goal is "to reduce total costs and losses from wildland fire in California by protecting assets at risk through focused pre-fire management prescriptions and increasing initial attack success." The plan defines a framework for: assessing level of service in wildland areas; identifying assets to be protected and their degree of risk from wildfire; setting pre-fire management priorities to reduce costs and losses; and developing a model for financial responsibility. Some counties that have CDF fire suppression forces are developing fire management plans that address the same issues. The plans are developed through collaborative processes with FSCs taking a lead role.

In Butte and Plumas counties in northeastern California, FSCs have effectively coordinated development of a Fire Management Plan for the two counties, and facilitated coordination with Forest Service treatment programs associated with the Herger-Feinstein Quincy Library Group Forest Recovery Act (HFQLG Act)[4]. The Act specifies pilot-project treatments over a five-year period on 2.5 million acres of national forest, including Plumas, Lassen, and part of the Tahoe National Forest. The cornerstone of HFQLG treatments is the creation of Defensible Fuel Profile Zones (DFPZs)—or shaded fuelbreaks—that isolate watersheds and communities, and limit the potential for spread of catastrophic crown fires. The significance of both the QLG work and the county Fire Management Plan for this area can't be overestimated, as the area encompasses national forests that have historically been the lifeblood of local communities and their lumber industries. The area also contains precious watersheds, such as that of the State Water Project that provides water to 10 million Southern Californians, as well as critical wildlife habitat, and so forth.

According to Frank Stewart, forester for the Quincy Library Group, county-level plans together with financial and regulatory incentives for hazardous fuel reduction are the keys to achieving landscape-scale and wildland-urban interface treatments on a broad scale. Assemblyman Firebaugh has introduced legislation—AB 2993—to provide incentives for landowners to implement pre-fire treatments.

Building Codes, Zoning, and Vegetation Management Regulations

Since the 1960s, governments at all levels in California have enacted a long series of regulations related to protecting communities from wildfire. The focus of many of the laws is either roofing or vegetation clearance—the two major causes of structure loss during wildland fires. Frequently, these laws are passed immediately following a major fire, and then repealed later, and then sometimes re-enacted, and so on. Roofing regulations in wildland-urban interface communities such as Berkeley and Los Angeles have histories of this sort due to recurring fires alternating with pressure from the wood products industry. Today, due to state law, Class A roofs are required in areas designated as having a severe fire hazard, and Class B roofs are required in all other parts of the state. However, according to assessments by the University of California Forest Products Laboratory, compliance by local jurisdictions with these and other fire mitigation regulations is far less than universal (UCFPL 2000).

California's vegetation management regulations began with legislation following the Bel Air Fire of 1961 that destroyed nearly 500 structures. Now embodied in Public Resources Code 4291, the law requires a minimum of 30 feet of clearance around structures in State Responsibility Areas (that is, roughly speaking, the areas where CDF has responsibility for fire protection). Regulations also require a minimum of 30 feet of clearance in areas designated Very High Fire Hazard Severity Zones (VHFHSZs) in Local Responsibility Areas (that is, areas under

[4] See www.r5.fs.fed.us/hfqlg/.

the responsibility of local governments). Additional clearing of up to 100 feet may be required in the most severe conditions.

Natural Hazard Disclosures (NHDs) in real estate transactions have been required for wildland fire hazards since 1990, but they were not widely put into effect until the late 1990s. NHDs are required in VHFHSZs in Local Responsibility Areas and in all areas of state responsibility, regardless of fire hazard. However, as is the case with local municipalities and roofing regulations, compliance has been spotty both with identifying VHFHSZs and with enforcing NHD requirements (UCFPL 2000).

Fire hazard rating and fire severity zoning have been issues in California for decades, and there are a variety of different techniques in play, all of which are controversial and work better for some purposes than others. The need for adoption of an effective zoning method is becoming increasingly acute, due both to fire protection costs and due to the difficulties of insuring homes in high hazard areas. One fire danger rating system, FireLine, was developed by ISO for the insurance industry in California. In addition to vegetation management, fire hazard zones are subject to requirements for fire safe construction (e.g., Class A roofs), emergency access and egress, and water supply.

Although again implementation is nowhere near as universal as many feel is urgently necessary, in California wildfire risks are often considered in planning and land-use decisions. Each county is required by law to have a General Plan and to update it at least once every ten years. The plans include seven mandatory elements that meet content requirements specified by the Governor's Office of Planning and Research. Wildland-urban interface issues are appropriately addressed in six of the seven elements (that is, in Land Use, Housing, Circulation, Conservation, Open Space, and Safety – all but Noise), however the recommendation is that they be addressed primarily in the Safety section. Specifically, in the Safety section counties are required to address fire safe standards, including: evacuation routes, water supplies, road widths, and clearance around structures. Although this information was required to be included in General Plans by 1974, compliance is still not universal (OSFM 1999).

Specific guidelines were laid out recently in a document by the Governor's Office of Planning and Research called "Hazard Mitigation: Fire Hazard Planning and the General Plan." The purpose of this document is to help organizations such as local and county FSCs to develop fire plans that can be easily included in the county General Plan. According to Scott Morgan of the OPR, the intention is to include policy statements in the General Plan that will provide a legal foundation for the more detailed, often tactical information in the fire plans. This document is presently out for review.

The I-Zone Document Series

A hazard mitigation grant from FEMA awarded in response to the Southern California Firestorm was used to fund a variety of research projects and the development of an extensive series of documents on the wildland-urban interface wildfire problem. In addition to FEMA, sponsors included: CDF, the Governor's Office of Emergency Services, Office of the State Fire Marshal, and the University of California Forest Products Laboratory. Collectively known as the "I-Zone

Series," the documents provide general information about California's wildland-urban interface and constitute what is probably the most extensive set of documents about the wildland-urban interface available anywhere. The documents cover a wide range of topics, including: fire safe vegetation, ignition resistant construction, biomass utilization, fire hazard assessment, community programs, fire behavior modeling, hazard mitigation grant programs, the history of wildland fire in California, and training materials for fire safe inspectors. These documents have been published periodically since 1996, and are available on the University of California Forest Products Laboratory website.

Case Study: San Diego County

As one of the most rapidly growing counties in California, and one of the most severely impacted by the current drought, San Diego County is regarded as having among the state's worst wildland-urban interface problems. The third largest and second most populous of California's 58 counties, with a population of almost three million, the county is home to nearly one in ten Californians. With Interstate 8 heading east from the city, I-15 to the north, and I-5 up the coast, the extensive freeway system provides routes into the city for commuters who have increasingly chosen to migrate into the more remote, less dense areas. Today communities such as Fallbrook to the north, Ramona and Julian to the northeast, and Alpine and Descanso to the east provide "country living" for people seeking large, "horse lots." Development is so extensive that with 140,000 acres of in-holdings within its 427,000 acres, one study classified over 90 percent of the Cleveland National Forest as intermix (i.e., one house for every five to 160 acres; CDF 1995).

San Diego County extends 65 miles north from the Mexico border almost to the southern end of the Los Angeles metropolitan area. With a total of more than 2.5 million acres, it extends from the highly urbanized Pacific Coast 86 miles east across the Peninsular Ranges to the desert. Much of the county is hilly or mountainous, with elevations rising from sea level to 6,500 feet on eastern mountain peaks. Averaging ten to 14 inches of rain per year, the county is very dry, with irrigated residential and agricultural areas standing out in contrast to the native chaparral. As well as residential uses, irrigation supports many avocado and citrus groves, which share the central part of the county with several Indian reservations. Although it is dotted with reservoirs for catching natural run-off and also filled by wells, the county is not able to provide for its water needs. It depends on the Colorado River and the State Water Project.

The government owns 54 percent of the land in the county, and more than half of that is federally owned, much of it either military bases or the Cleveland National Forest (CNF). While at higher elevations the CNF has stands of cedar, fir, and Jeffrey Pine, much of the forest is chaparral.

Wildland-Urban Interface Regulations

The county has been progressive with regard to wildland-urban interface regulations. In the mid-1990s a wildland-urban interface standard was developed as an amendment to the County Fire Code. Included were requirements for fire resistive construction, setbacks, and vegetation clearance of 100 feet around structures in fire prone areas. These requirements were incorporated into the county's Consolidated Fire Code in 1999. The Consolidated Fire Code is a method of collating and encouraging consistency among the county's 17 fire protection districts.

As of this year, CDF began enforcing the 100 foot county clearance law rather than the 30 foot state law, specified in the Public Resources Code, on the 1.5 million acres of the county it is responsible for. According to Cliff Hunter, Fire Code Specialist for the San Diego County Department of Planning and Land Use, this agreement between the state and the county was a landmark accomplishment. It represents a significant recognition at the state level of the severity of the wildland-urban interface problem, and a willingness on the part of the state to cooperate with the county in doing what the county has determined needs to be done to protect life, property, and natural resources.

Another landmark accomplishment associated with brush clearance is a Memorandum of Understanding (MOU) with the wildlife agencies. To more effectively implement the 100 foot clearance requirement, in 1997 CDF and the fire chiefs in the county signed a MOU with the U.S. Fish and Wildlife Service and the California Department of Fish and Game.[5] The two wildlife agencies had objected to the clearing on the grounds that it could destroy habitat for rare, threatened, or endangered species. According to the MOU, landowners who have been notified of a species sensitivity on their property must notify the agencies in writing at least ten days before clearing. Failure of the agencies to respond within ten days gives the landowner the right to proceed.

The wildland-urban interface is also being addressed in the planning process, both by the county in its "General Plan 2020" process and by communities. For example, in Alpine, an unincorporated community of 16,000 in eastern San Diego County, prohibiting single-access subdivisions and developing alternative access routes for ones that exist is a high-priority of the planning commission. Having experienced the nearby Viejas Fire in 2001, and remembering back to the Laguna Fire that swept through the town in 1970, the commission considers evacuation inevitable. As a consequence, emergency access and egress are high-priority issues.

Firefighting Capability

San Diego County has no county fire department, which creates inefficiencies and in mutual aid situations it causes ambiguities and problems of incompatibility. In addition to the 17 fire districts, there are six volunteer fire departments, 15 to 17 CDF stations, CNF fire stations, tribal fire departments, and fire stations that serve the military bases. Also in San Diego County there are organizations that provide firefighting resources and services for ships.

In addition to problems in mutual aid situations, the lack of coordination among the fire services leads to other problems, such as inconsistent restrictions during fire season between public lands under different ownerships with regard to campfires, smoking, and so forth. The lack of coordination also causes problems with regard to clearance around structures. While some

[5] Signed in February, 1997, this document is titled "Memorandum of Understanding Between the Fish and Wildlife Service of the United States Department of the Interior, the California Department of Fish and Game, the California Department of Forestry, the San Diego County Fire Chief's Association and the Fire District's Association of San Diego County."

jurisdictions require 30 feet, others require 60, and others require 100 as is required in unincorporated areas. This makes it difficult to do public education as it isn't possible to advertise a standard requirement; it confuses people; and it causes credibility problems for the fire service. Cliff Hunter considers the lack of a coordinated, county-wide fire protection capability to be the most significant fire protection problem in the county.

One very successful cooperative effort in the county is the Border Agency Fire Council (BAFC 2001). In the southeastern section of the county it coordinates activities of 24 member organizations, including fire services, land managers, natural resource managers, elected officials, border patrol, and others. The Council was started in 1996 as a collaboration between the U.S. and Mexico when investigators determined that campfires lit and improperly extinguished by undocumented immigrants were causing a dramatic increase in wildfire ignitions. Through collaborative efforts, the BAFC has improved access to the wildland for emergency responders, created an international fuelbreak, enhanced communications, and set up mutual aid agreements with Mexico.

Fire Safe Council of San Diego County

Although the county has had a Fire Safe Council for several years, it gained significant momentum in 2001 due to an influx of over $300,000 in National Fire Plan funds. With a total budget of about $500,000, the Council has an office and one staff person. Funding for the coming year is uncertain, however, as the National Fire Plan grant was not renewed.

One highly successful early accomplishment was the creation of a newspaper insert called "Living with Wildfire" that was developed in cooperation with the Burn Institute of San Diego and Imperial Counties and the San Diego Fire Chiefs' Association. Co-sponsored by many agencies and organizations, several hundred thousand copies of the insert have been given out since May 2001. Along with many other public education efforts, five Fire Safe Demonstration Gardens have been set up in the county. They are accompanied by displays and brochures that describe fire safe landscaping and fire resistant plants.

Since January 2002 more than half a dozen local councils have been started, including several councils in the east county (in the neighborhoods of Mount Laguna, Descanso, Sherilton Valley, Carveacre, and Cuyamaca). The councils have been very well received, getting a lot of media coverage both in newspapers and on television, and often getting an enthusiastic reception from the local communities. Particularly in the east county where many small neighborhoods are isolated within Cleveland National Forest and lack municipal services such as water, sewer, and maintained roads, residents are eager to address the problem.

The county's FSC coordinator, Dean Harris, says that when he approaches a community he meets with leaders and, if they want to start a council, he provides organizational guidance and support, but lets them set their own agendas. Typically one of the first things a new council will do is develop accurate maps of the community, as the publicly available maps are often seriously out of date. When a fire occurs, it is critical for fire service personnel, who will likely be from out of the area, to have accurate maps so that they don't waste time and resources investigating roads that go nowhere, searching for water sources, and so forth. Along with the maps, residents are encouraged to make sure their homes have large, easily visible address markers and to make sure that all intersections are marked with road signs.

A second effort that FSCs typically undertake right away is clearing brush away from roadways and homes. A chipping service that was offered by the county FSC earlier this year (until funds were exhausted) was extremely popular. In the absence of that service, some communities such as Carveacre have made plans to privately fund chipping. They have also received help from CDF and CNF.

Regarded as having one of the most effective, citizen-driven FSCs in California, Carveacre is a hilly enclave of 70 houses on one unimproved dirt road amidst chaparral and beautiful granite dells in the Cleveland National Forest. This spring manzanita and grease bush were clear-cut from along the road, and when the county chipping program wasn't able to chip and remove the brush, CNF stepped in and chipped brush adjacent to their land, but much drying brush remained. As of early August, residents were worried about having to evacuate with a fire along the roadway. Having watched the 10,000 acre Viejas Fire sweep through the canyon below their neighborhood in 2001, many residents felt that clearing brush was an urgent issue, as were other problems with emergency access and egress. All it would take is one horse trailer going into the ditch or having a flat tire to block the road. Residents would like to see the road widened and turnouts put in, and an alternative emergency access route opened up.

Although the drought makes the wildfire problem worse and worse, the issue has been with Carveacre since houses were built there following the 175,000 acre Laguna Fire in 1970. Houses built after the 1996 Harmony Grove Fire were required to have enclosed eaves and sprinklers and to put in 10,000 gallon storage tanks. New houses are no longer going in, as homeowners can't get insurance coverage. Existing policies are frequency canceled after the insurance company sets requirements that residents can't meet, such as clearing 1,000 feet from their homes (in many cases that would mean going beyond the property line, as well as violating the Endangered Species Act). Many of the residents are emergency responders (policemen, firefighters, INS Border Patrol Agents, and so forth) and they would like to have their own volunteer fire department to protect their homes and families.

Carveacre's experience of having brush cut and left drying along the roadway has made some other communities wary about starting projects they can't finish. For example, at the north end of the county in the unincorporated community of Fallbrook, Fire Chief Ed Burcham urges residents to have a plan for brush removal before they clear the brush. He says there is a shortage of chipping vendors, so that there aren't services available for everyone who needs to meet the 100-foot clearance requirement. Fallbrook got a wake-up call earlier this year, when the 5,700 acre Gavilan Fire swept up the Santa Margarita River Canyon and through an upscale neighborhood, destroying 45 homes and 37 outbuildings. After the fire, the fire department contracted for a comprehensive fire hazard assessment in order to identify specific points of vulnerability. The county FSC expects the Greater Fallbrook Area to start up three FSCs in the coming months.

In contrast to the extreme concern for preservation of lives and property apparent in Carveacre, in Rancho Santa Fe the tradeoffs between safety and aesthetics are an issue. Recently having made headlines as the wealthiest town in the U.S., Rancho Santa Fe was built on a eucalyptus grove. The Santa Fe Railway planted the grove in an attempt to use eucalyptus for railroad ties. When the experiment failed, the area was subdivided into large lots and it became a heavily wooded community of large, multi-million dollar homes, many with horse pastures. In recent years the stress of drought and infestation with the red gum lerp psyllid and other insects has created an epidemic of dead and dying eucalyptus trees. In the 42 square mile fire district, Fire Chief Erwin Willis estimates that there are 400,000 dead and dying trees. This has dramatically increased the fire threat to the community.

Under Chief Willis' leadership over the past decade, the Rancho Santa Fe Fire Protection District has been at the forefront in the county with regard to risk mitigation. Of 42.5 fire service employees, the district has 6.5 assigned to prevention. The top ten fire hazards in the district have been identified and efforts are underway to abate risks in those areas. Ahead of the county, in the mid-1990s the area enacted a non-combustible roofing requirement (stricter than Class A) and a universal sprinkler requirement. It also enacted a 100 foot clearance ordinance around structures and a 30 foot road clearance ordinance. It recently passed an ordinance requiring the removal of all dead and dying trees within the district's boundaries. Although the fire district has a grant program available, offering up to $2,000 per property for tree removal, getting arborists to remove the dead trees and green waste is a major issue due to the quantity of trees involved. In addition to its pre-fire work, the district has made large investments in specialized wildland firefighting equipment for its engines, such as compressed air foam that can blanket structures, reducing structure loss.

The Rancho Santa Fire Protection District is also progressive in introducing Geographic Information System (GIS) technology. The district recently commissioned an infrared photo fly-over to gather data on vegetation type, roof type, and structure outlines. These data will be used to overlay existing maps showing roads, parcels, fire hydrants, topology, past burns, and so forth. The combined maps are intended to reduce losses from wildland fire by enabling the district to perform several different functions. First, using the GIS the district can run an analysis to identify high risk areas and evaluate the sources of risk (e.g, fuels adjacent to structures, long engine response times, fire hydrants more than 500 feet from structures, tree canopy over structures, etc.). This analysis can be used to focus prevention work. Second, during a fire, colored maps can be printed for strike teams, giving them detailed views of the areas they are to protect. The maps show the roof types of structures, locations of hydrants, driveways that access structures, distances from structures to wildland fuels, and fuel types and topography. With this information the strike team leader can make more intelligent decisions about how to deploy resources. Third, the information can be fed into a fire area simulator (FARSITE) to simulate fire movement (path and speed) through the district given differing weather conditions and fuel moistures. These simulations can be used to train firefighters. Also, during a fire, simulations can be run to project the path and speed of the fire, helping the Incident Commander direct the placement of resources. Finally, fire simulations can be used at public education sessions to show homeowners how quickly their homes could be affected by a wildland fire.

While the unincorporated community of Rancho Santa Fe is part of a fire protection district that's very progressive, and that plays a lead role in the county FSC, there isn't the groundswell of grassroots activism that's apparent in the small, isolated neighborhoods of the east county.

According to Chief Willis, many people fundamentally don't believe that wildland fire can affect them. Unlike the neighborhoods in the east county, in the Rancho Santa Fe area, although the homes are large and on acreage, the area is just a few miles from the ocean and it's highly urbanized. One explanation for complacency is that in urbanized environments where municipal services are available (and, in fact, in this case there is a highly progressive local fire department) there is the expectation of being taken care of by the public agencies. Another explanation is that in Rancho Santa Fe, with irrigation resulting in lush foliage and beautiful gardens, and where the area is often blanketed in coastal fog, it is much harder to imagine catastrophic wildfire than it is in the dry, barren hills to the east. It should be noted also that in east county communities such as Carveacre, in fact there is no tradeoff with aesthetics, as clearing brush from around homes and roadways has little or no negative effect on the natural beauty of the area. By contrast, in Rancho Santa Fe there is a lush tree canopy over roads and enveloping houses.

Chief Willis' worst nightmare is an evacuation through "tunnels of fire"—roadways surrounded by tree canopies that are on fire. While the newer neighborhoods were built to shelter-in-place standards, shelter-in-place is something that Chief Willis hopes some of the older neighborhoods may move toward. Whereas the typical concern with regard to wildfire is for emergency vehicle ingress coincident with resident egress, research in Australia has shown that the two-way traffic problem is much more extensive than that. When residents hear of a fire in their area, typically members of each family make several trips in and out. Particularly during the daytime, when wildfires are most active, family members are at different locations and will converge at home to retrieve possessions and pets. Then multiple trips out may be required to move out family members, pets, livestock, possessions, and vehicles (Brennan, no date; Saunders 1998). The problem becomes particularly acute in areas such as Rancho Santa Fe where people often have horses that need to be relocated. In San Diego County there is a company that will respond to emergency calls and do horse evacuations for communities.

Chief Willis is interested in shelter-in-place both because of the danger people may face on the roads, but also because research has shown that homes that are actively protected by residents have a better survival rate than ones that aren't (Foote 1996). One danger of shelter-in-place, however, is that people will decide to evacuate at the last minute. The research in Australia has shown that that behavior tends to lead to fatalities, both for residents and fire personnel.

Outstanding Challenges

During the recent 60,000 acre Pines Fire near Julian, a woman told CDF personnel about returning to her home after the fire had passed through. She said she watched oak trees fall on ashes and explode. She used drinking water from the Red Cross to try to put the fires out, as she had no other water. The phones weren't working. Cell phones weren't working. Near tears, she asked CDF officials what she should have done.

This is just one example of the desperate situations faced by residents in the midst of a wildfire disaster. In Southern California, dealing with problems like this has become a fact of life. In particular, keeping water available for fighting fires is a constant struggle for officials, as they conduct a delicate juggling act, draining one reservoir while another is refilling. The problem is becoming worse in the east county, where many neighborhoods are beyond the limits of the water district. The water table is going down and people's wells are going dry. With several tribes putting in resort hotels adjacent to their casinos, all on wells, the problem will get worse yet.

In Laguna Beach in Orange County (between Los Angeles and San Diego), one response of the city to the 1993 fire was to put in two new reservoirs for a total of 18 million gallons. This not only helps with availability of water for fighting a wildfire, but it no doubt has helped with the ISO grade of the local fire district, which in turn can help reduce homeowners' insurance premiums (ISO 2002b).

In addition to the water problem, there are a variety of other serious challenges faced by those who live in hazardous fire areas in California. For homeowners, obtaining and keeping insurance is a big issue. Many have turned to the state's FAIR Program, but they say it is expensive and provides minimal coverage. According to Dennis Gage of the Insurance Services Office and Jerry Davies of the Personal Insurance Federation of California, the best thing that communities can do is to coordinate with local insurance company representatives and do what's needed to make their communities better insurance risks. Many of the FSCs in California have been successful in doing this, and as a consequence residents have been able to keep their insurance and to keep rates reasonable. The most notable example of success in this area was the work of residents in Laguna Beach and Emerald Bay following the 1993 firestorm. Under the leadership of resident David Horne, the community began holding semi-annual meetings with insurance industry representatives to tell them about steps the city and the neighborhoods were taking to make the community fire safe. The insurance industry response was very positive, and as a result in most cases people have been able to keep their insurance. Companies have kept writing insurance for new homes and after home sales. According to both Gage and Davies, this is the way to go for the near term, as a more coordinated insurance industry response is not likely in the near future. From the industry's perspective, programs such as are in place for flood insurance and earthquake insurance aren't justified for wildfire because the threat to life and property (and consequent claims) to date have been much smaller for wildfire than for flood and earthquake catastrophes. For example, whereas the most costly wildfires run to about $2 billion in insured losses (in today's dollars), insurers expect that a major earthquake in Los Angeles could run to $100 billion.

For those wanting to clear their properties, removing green waste is often a problem. Chippers could be kept busy, constantly, in every wildland-urban interface community in the state. In California as in other western states, finding ways to utilize biomass is a high priority. It is the subject of several research projects at the University of California Forest Products Laboratory (UCFPL, no date).

Another problem for those wanting to clear their properties is environmental regulations. Part of many properties in a typical subdivision is set aside as an open space, conservation easement. In those areas homeowners can't use mechanical means to clear, and must get permission from wildlife agencies to clear by hand. As has occurred in Arizona and other states with major wildfires, many people are frustrated and angry about the bureaucratic hurdles and legal challenges resulting from environmental regulations. However, as was pointed out at a recent planning meeting in Alpine, for many people the regulations and bureaucratic hurdles are a twoedged sword. On the one hand, when you want to subdivide or clear your land, they can be maddening. On the other, to the extent that development and population growth are kept in check, regulatory and bureaucratic hurdles are to be thanked.

Another recent development in California is an emphasis on developing fire plans. According to Frank Stewart of the Quincy Library Group, the plans are key to achieving a coordinated, landscape-scale approach to fuel reduction. While interest in systematic hazard assessments and analytic planning processes varies considerably from one group to another, and one FSC to another, the interest in plans and associated hazard assessments has increased with National Fire Plan funding. The Bureau of Land Management grant applications ask whether the proposed work is associated with a fire plan, and the funds can in fact be used for creating fire plans. According to Scott Morgan of the Governor's Office of Planning and Research, FEMA's emphasis on state multi-hazard mitigation plans is also a motivation.

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DEFINITIONS OF WILDLAND FIRE COST FACTORS

(In the case of an individual wildland fire, the following factors may tend to increase, decrease, or have a neutral effect on the cost of suppressing the fire.)

PREDISPOSITIONS (factors that are determined before the fire begins)

- **Conditions** (existing on wildlands before the fire begins)

  - **Fuel Types—**The various types of vegetation in forests, rangelands, and other wildlands have different burning characteristics and require different fire models to predict the behavior of fires that start in them. They exhibit differences in such characteristics as rates of spread, different intensities, and resistance to control.
  - **Fuel Condition—**Weather and climatic conditions, such as high temperatures, low humidity, and lack of rain, make areas more likely to burn out of control. There is a Fire-Danger Rating System that documents this condition.
  - **Terrain—**Steep and rocky terrain makes firefighting more difficult, increases firefighter safety risks, and makes it more likely that a fire will grow and take longer to control.
  - **Prior Burns and Fuel Breaks—**Intentional prescribed burns, wildfires that are allowed to burn naturally, logging, mechanical and chemical thinning, biomass harvesting, green striping, large plantations, and other activities that break up large uninterrupted wildlands provide opportunities to slow, redirect, or stop wildfires.

- **Policies** (generally applicable laws or federal agency regulations and policies that affect how fires may be fought)

  - **Safety—**A level or priority of safety established for protecting firefighters and the public.
  - **Protections—**Certain types of infrastructures on federal lands that need to be protected, restrictions on how fires may be suppressed in order to protect environmental, threatened and endangered species, historic, cultural, and natural resource values.
  - **Human Caused—**When wildland fires are caused by unauthorized human action, they raise specific legal liabilities that may affect how the fire may be managed and what its cost may become.
  - **Wilderness—**This is a specific legal designation that carries with it a minimal-impact approach to managing the fire to keep its effects as natural as possible.

- **Plans** (developed by the federal agencies, perhaps with the cooperation of others for a specific land unit)

- **Land Management Plan (LMP)—**This plan establishes the desired future condition for the land unit. In doing so, it identifies the locations and nature of the specific values to be protected from fire, and the areas where fire would be a valuable tool in achieving ecological and safety benefits.
- **Fire Management Plan (FMP)—**This plan is linked to the land unit's LMP, and it may be expected to establish methods, schedules, funding, and other means of using the fire management program to achieve the fire-related goals and objectives in the LMP.
- **MOUs and Other Coordination Agreements—**These agreements, established before a fire begins, establish mutual-aid protocols, differentiated responsibilities, and cost-sharing arrangements. Such agreements may facilitate smoother firefighting by diverse units and reduce or eliminate jurisdictional distractions during the course of the fire. The lack of such agreements may have the opposite effect.
- **WUI Mitigation—**The growth of structures and urban communities in and near wildlands increases the values at risk of damage or loss from wildfires. However, pre-planning and commensurate action can reduce these risks. Wildfire-resistant communities may have an effect similar to fire-breaks, compared to unprepared communities that may become just another source of fuel for the fire.

- **Other Factors**

  - **Preparedness—**The level of readiness of nearby firefighting forces when the fire begins helps to determine whether the fire can be controlled during initial attack. If this force is at reduced levels, either because of inadequate budget or draw-downs of the resource to fight fires elsewhere, fires have a greater chance of escaping initial attack efforts and becoming larger and more expensive.
  - **Political and Media Visibility—**Wildfires that become widely publicized and gain political attention may become more expensive to suppress because of pressures to mount the maximum suppression forces available without regard to cost.
  - **Local Public Expectations—**Increasingly, the local public expectation is that the firefighting forces will put the fire out while minimizing the damage or destruction of private structures and other resources. These expectations are sometimes implicit, but often are explicitly expressed during the course of a fire incident. This local social climate may affect the strategies and tactics that the firefighters choose to use, which may increase suppression costs.

COST DRIVERS DURING THE FIRE

- **Controllable Factors**

  - **Management Efficiency—**The capabilities of the teams assigned to fighting the fire, including initial attack forces and national incident management teams (IMTs), the appropriate identification of the type of team needed (Type I or II) based on the fire's complexity, and the efficiency of the transitions between teams on long-duration fires may affect the total costs of the fire.

- **Fire Size/Strategy—**The strategies chosen to fight the fire may have various cost implications. Alternative strategies may have different combinations of fire size and fire costs.
- **Coordination—**Many fires, especially large ones, are fought with forces consisting of units from different federal agencies, states, local governments, and other cooperators. How well these forces work together may have cost implications. A well-coordinated effort is likely to produce greater efficiencies than one where cooperators are not working together in a coordinated fashion.
- **Cost Sharing—**Cost-sharing agreements between the federal land management agencies and state/local governments establish the respective costs each party will bear for wildland fire suppression efforts. In some cases, the costs are equitably split based on acres burned or level of effort. However, in cases where no agreements exist, the federal government may bear the entire cost or a very large portion of the costs to protect private structures.
- **Aviation Resources—**Helicopters and tanker planes are often needed to effectively fight wildland fires. However, they are very expensive resources.
- **Crews/Equipment—**Many different types of crews and equipment are available to choose from. Together these items account for a large portion of the costs of a fire. The choices made, and the availability of the ordered items (see below), determine the total cost of this factor.

- **Uncontrollable Factors**

  - **Natural Resources—**When natural, archeological, cultural resources, other such features are threatened by a wildland fire, more costly fire suppression strategies and tactics may be needed to protect them.
  - **Resource Availability—**When firefighting resources that have been ordered are not available, firefighting effectiveness may be adversely affected and the fire may grow larger and more expensive. Sometimes orders are filled with more expensive resources because they are the only ones available.
  - **Structures—**When structures are in the path of the fire, firefighting efforts are directed toward avoiding their loss. Generally, suppression costs for protecting structures is more expensive than fighting a natural resources fire.
  - **Access—**Roadless and rough terrain can make it difficult or impossible to access some fire sites except by using costly aviation resources. High wind conditions may limit or reduce aviation access as well. These conditions may allow a fire to grow larger and more expensive.
  - **Weather—**The weather conditions (especially wind, heat, and moisture level) encountered during a fire impacts the rate of spread and intensity of a fire, and can have a major impact on fire costs.

COST CONTROLS DURING FIRE

- **Wildland Fire Situation Analysis (WFSA)—**This computerized decision support tool is to be prepared on all federal fires that escape "initial and extended attack." It provides an analytical method for evaluating alternative strategies for fighting the fire and choosing appropriately among them. Part of the process includes estimating the suppression costs of the suppression alternatives being considered, and their economic impact on the natural resources base. The WFSA is jointly developed, amended, and verified daily by the Agency Administrator (AA) of the land unit and the IMT assigned to the fire. As such, it provides a communication vehicle between the AA and the IMT. The effective development and utilization of the WFSA as a decision support process may decrease the cost of the fire, or may have little or no effect.
- **Agency Administrator** —The quality of participation by the AA throughout the fire is thought to have an effect on the cost of the fire.
- **Daily Cost Reports—**Each day, a daily report on the fire's cost is reviewed by the IMT, the AA, and other participants in the daily briefings. The extent to which this report is well prepared and used effectively to monitor resource costs, and demobilize unneeded or expensive resources in a timely fashion influences the cost of the fire.
- **Incident Business Advisor (IBA)—**Many large fires have an IBA assigned to the AA to help keep track of the controllable costs of the fire. The quality of any IBA that may be assigned to the fire, and the extent to which the IBA is involved in significant cost-influencing decisions, may affect the cost of the fire.

Credits

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