2001 LARGE-FIRE CASE STUDY REPORTS

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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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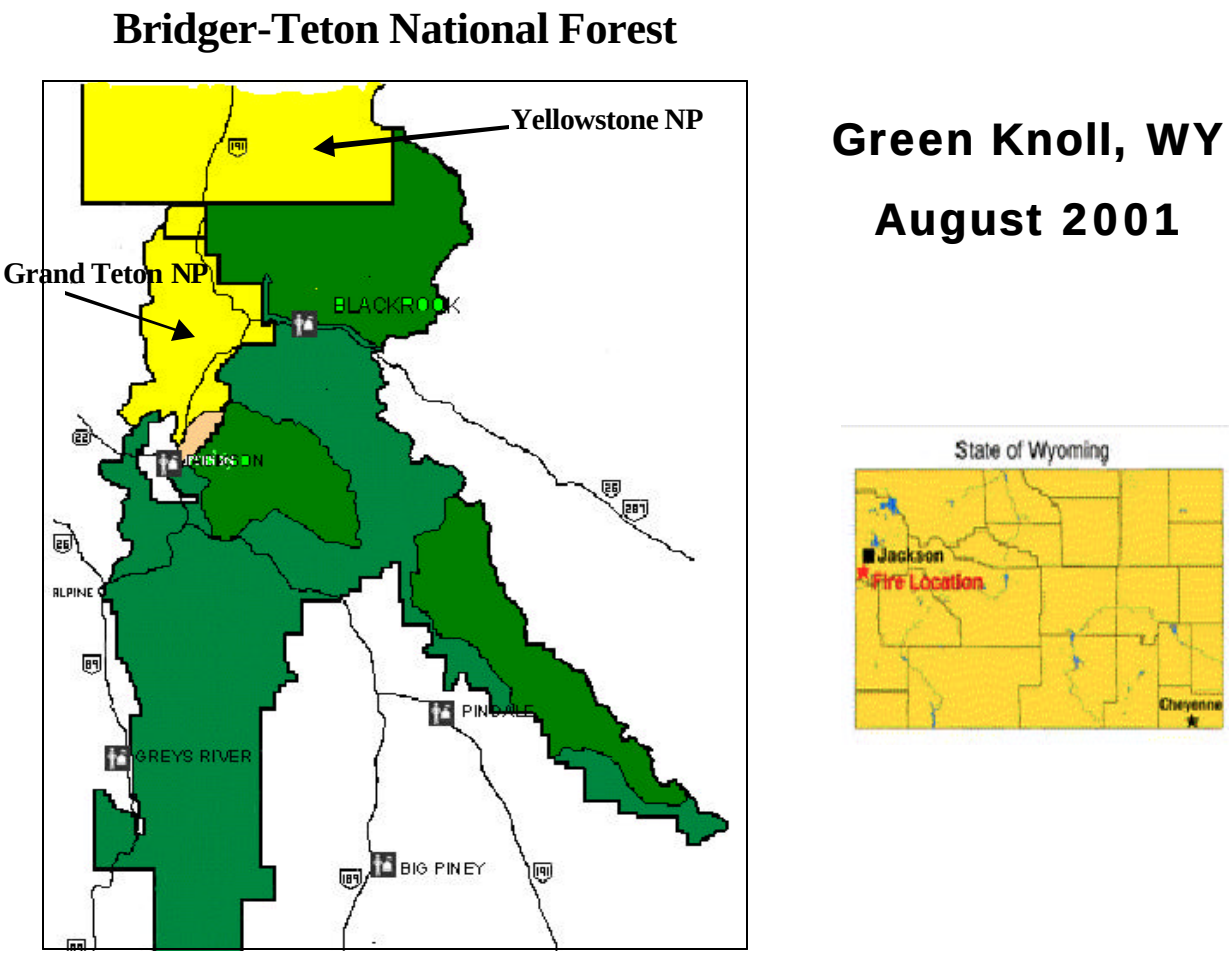
[1] Forest Service Manual, Fire Management (FSM), as amended.

[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



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.

[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.

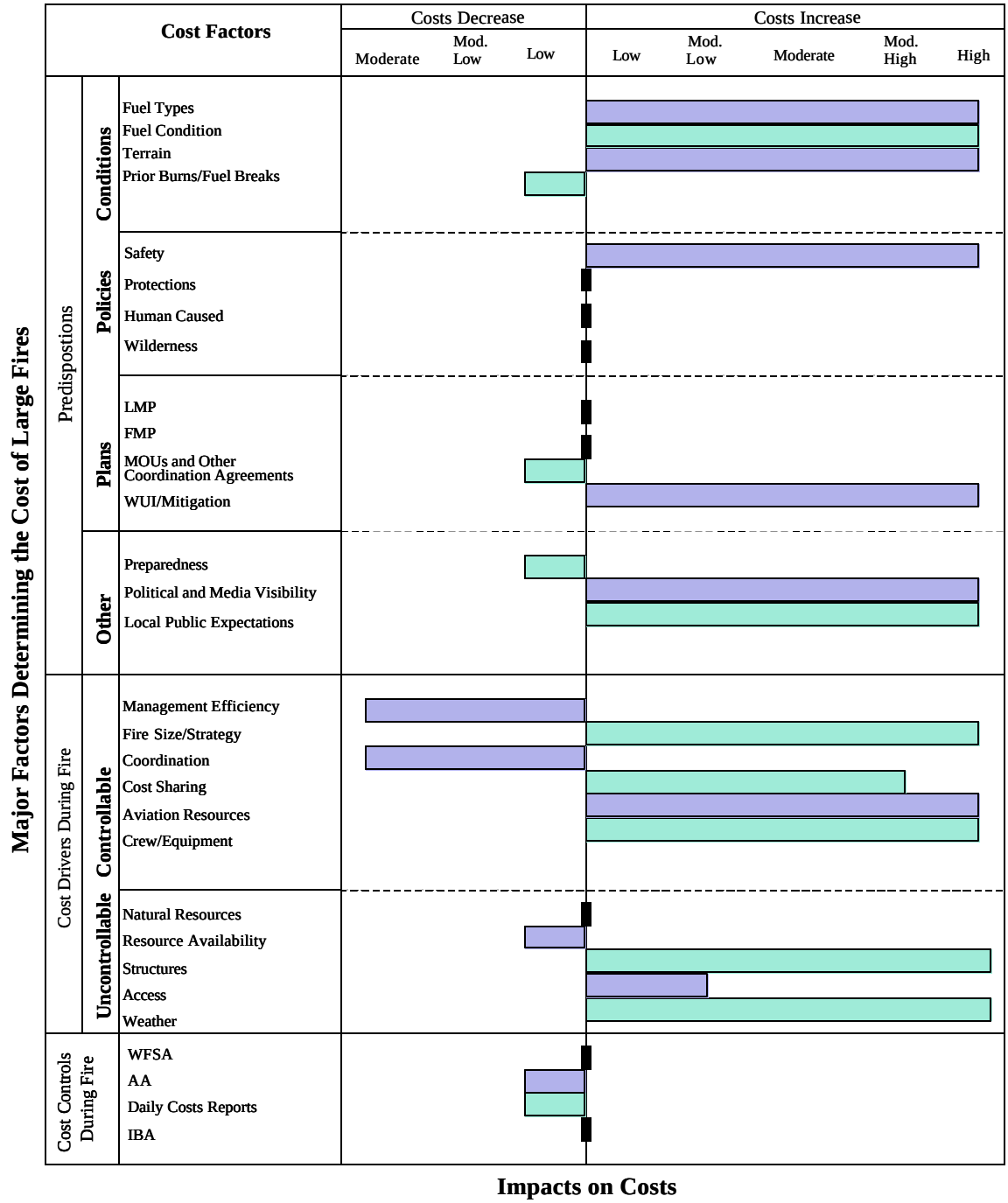
TCFD personnel focused on structure protection and meeting with each homeowner in the threatened subdivisions. They believed having a local face and a known individual are essential to providing the kinds of information residents want and need. They actively participated in the numerous public meetings 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.

Aviation Resources—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.

[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.

[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

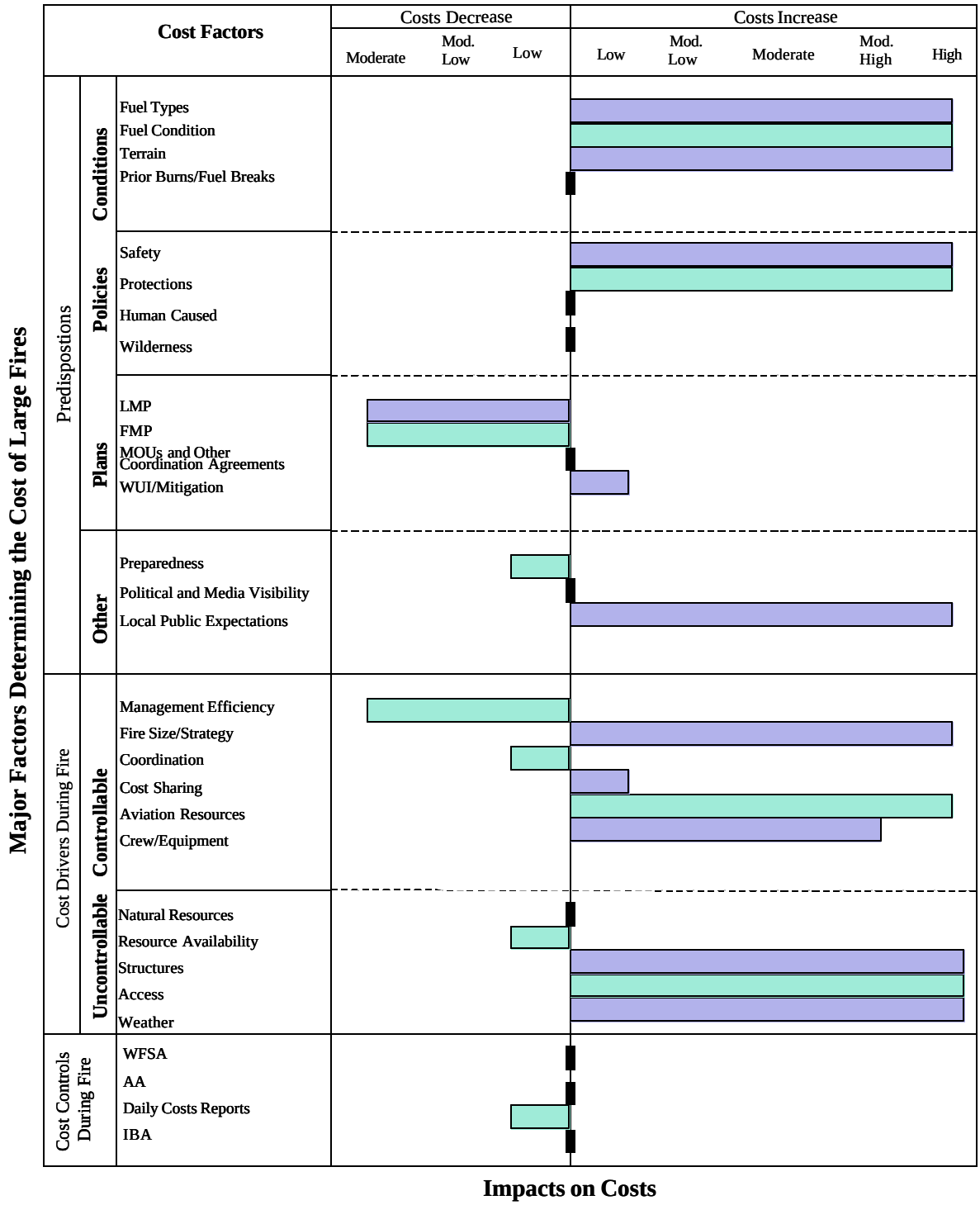
Dates	Activity
7/29-30/01 Days 1-2	The fire was reported at 12:45 p.m. Yellowstone assigned about 60 people who operated in conjunction with the Shoshone National Forest. Crews focused on structural fire protection at the Park's east entrance and evacuation of Park staff and their families. On day one, 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.

[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.

[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

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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).

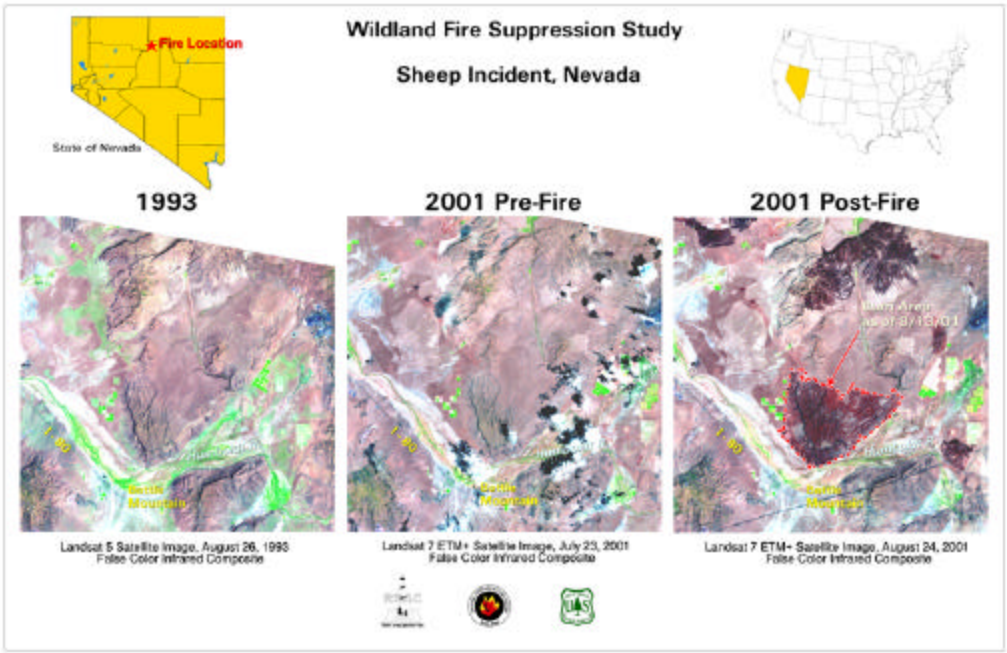
A Type 2 IMT assumed management of the fire at about 6 p.m. on August 11, 2001 after spending the majority of the day in transition with the initial action personnel. By this time, the fire had burned about 30,000 acres. Two days later, the fire was declared contained. A summary of the fire's chronology 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.

[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.

[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.

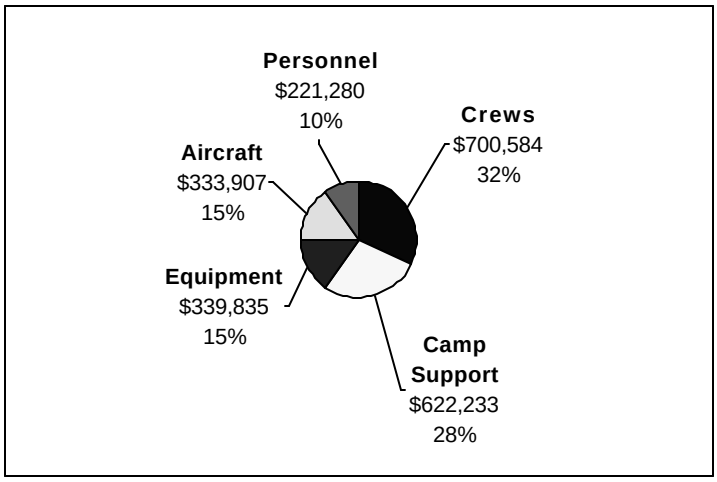
DATA RESOURCES, DECISION SUPPORT TOOLS, AND MANAGEMENT COST CONTROLS

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.

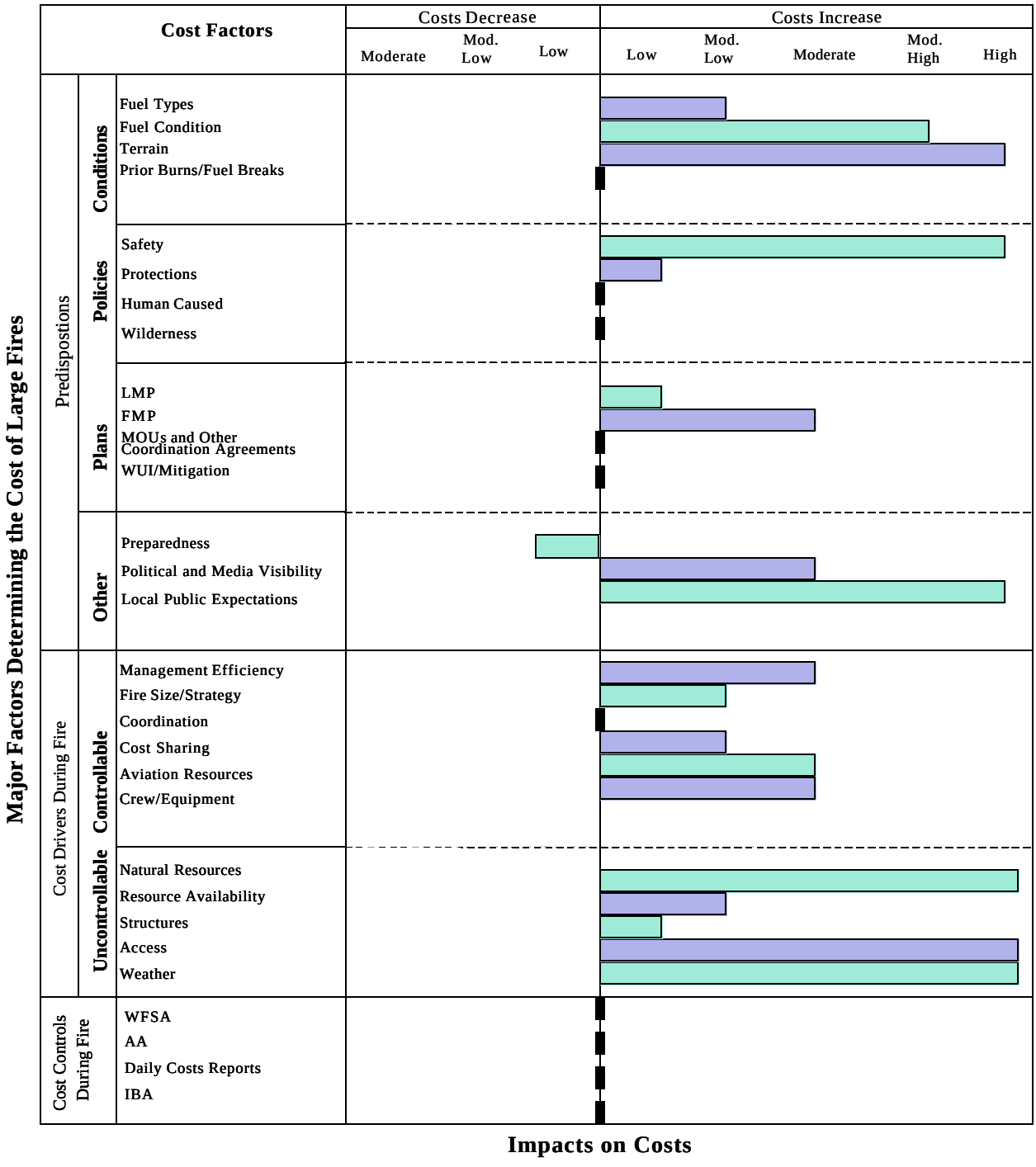
PRINCIPAL COST DRIVERS

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.

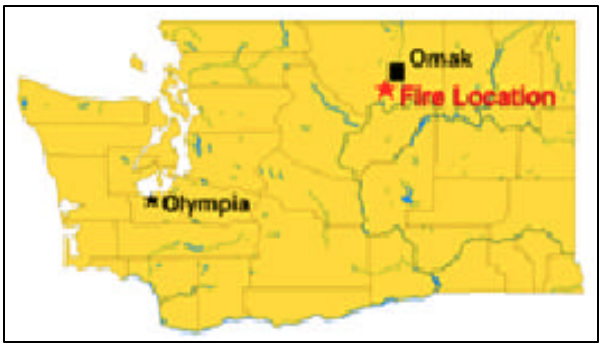
Box F-3. Contacts-Sheep Fire

Jim Ashley, *Fire Operations Supervisor, BLM, Ely District, NV*
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.

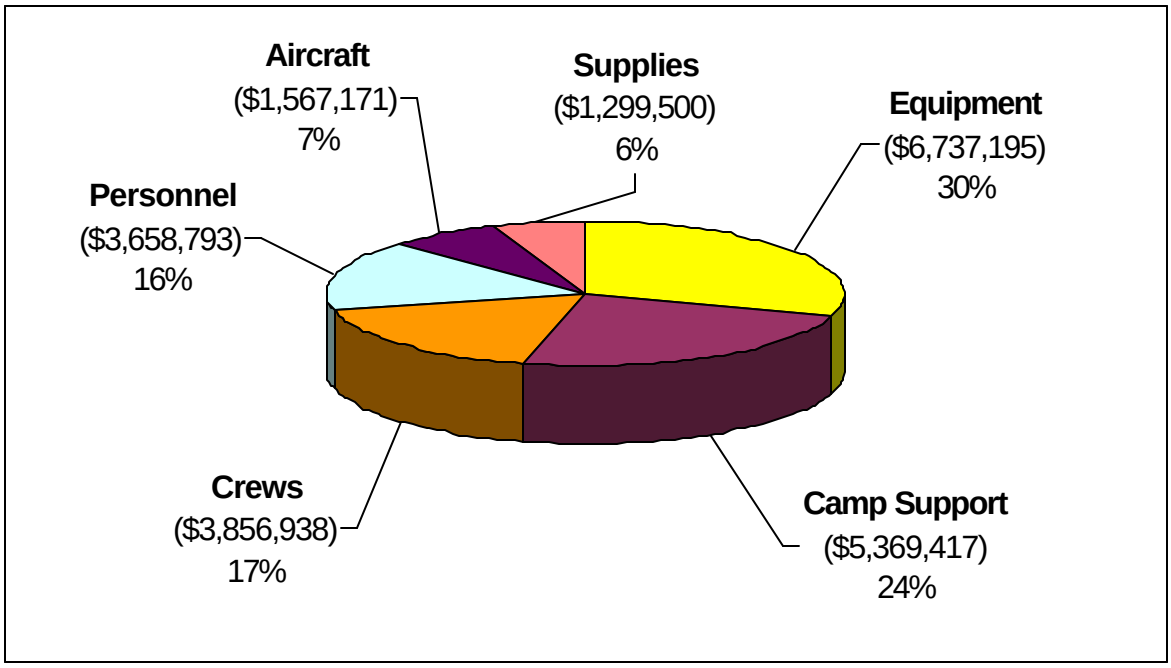
Table F-7. Virginia Lake Fire Complex Chronology

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.

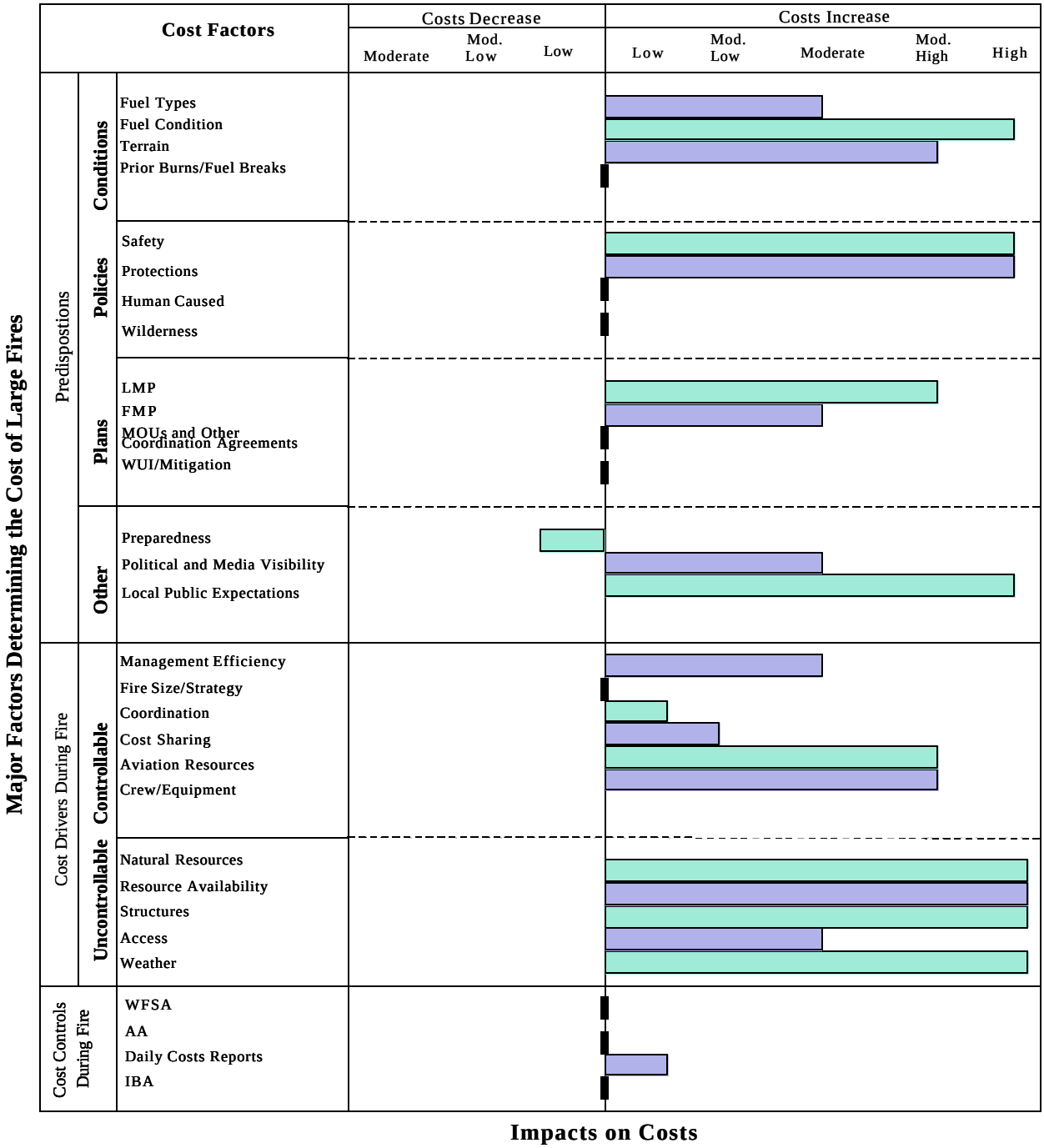


The conditions and events that occurred before and during the Complex reveal that a number of factors affected the cost of suppression efforts. Except for the preparedness level of the Agency, which enabled it to control the majority of the fires that ignited on August 13 and thereby limit the number 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.

[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.

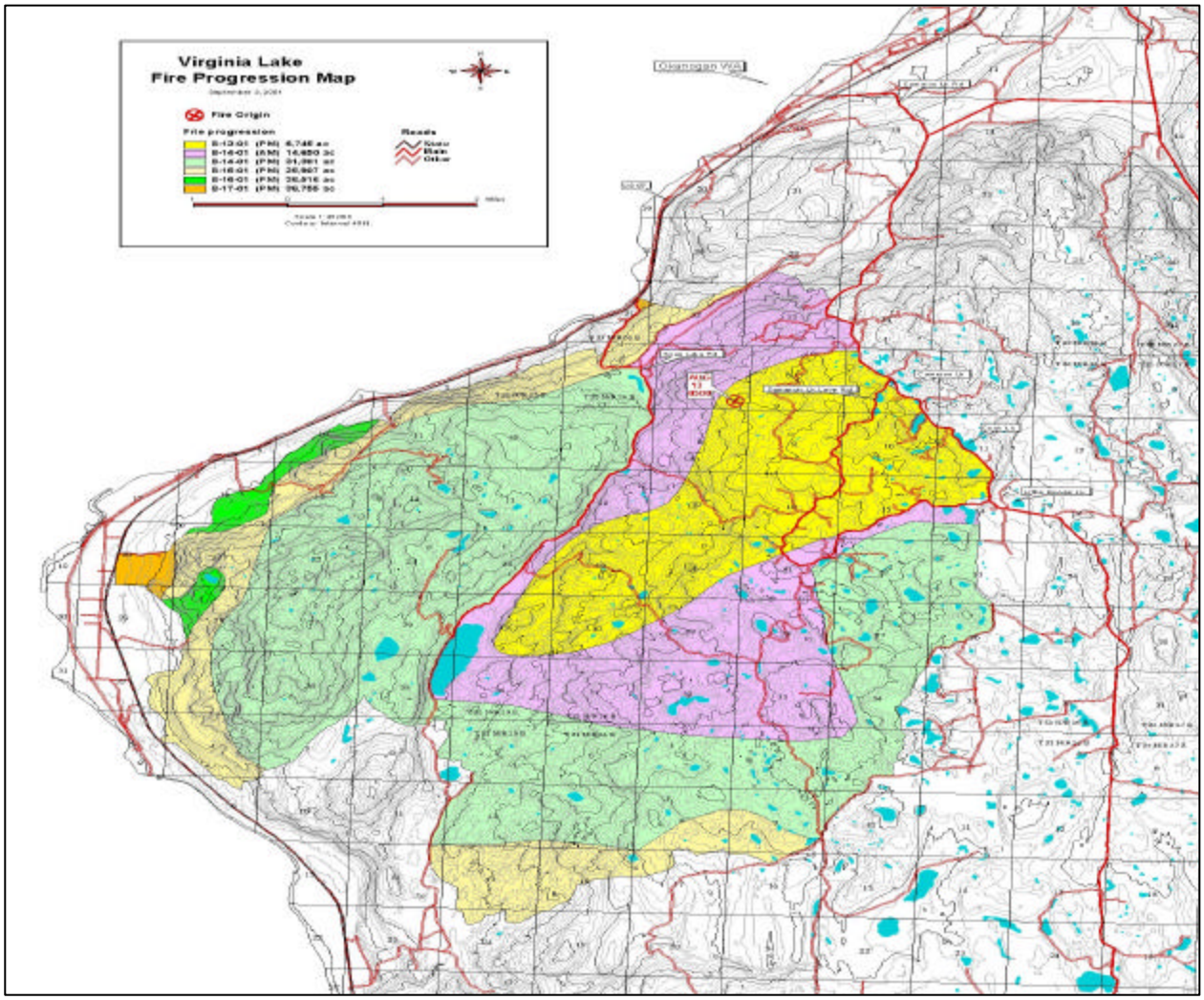
By the 17th, the Complex had moved up in priority and more resources started to arrive. Area Command was ordering and prioritizing resources for the fires it was managing and the Complex' resources grew steadily. The Area Command Air Operations Chief also brought in aircraft inspection teams to Red Card 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 20th, 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 21st. 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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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.

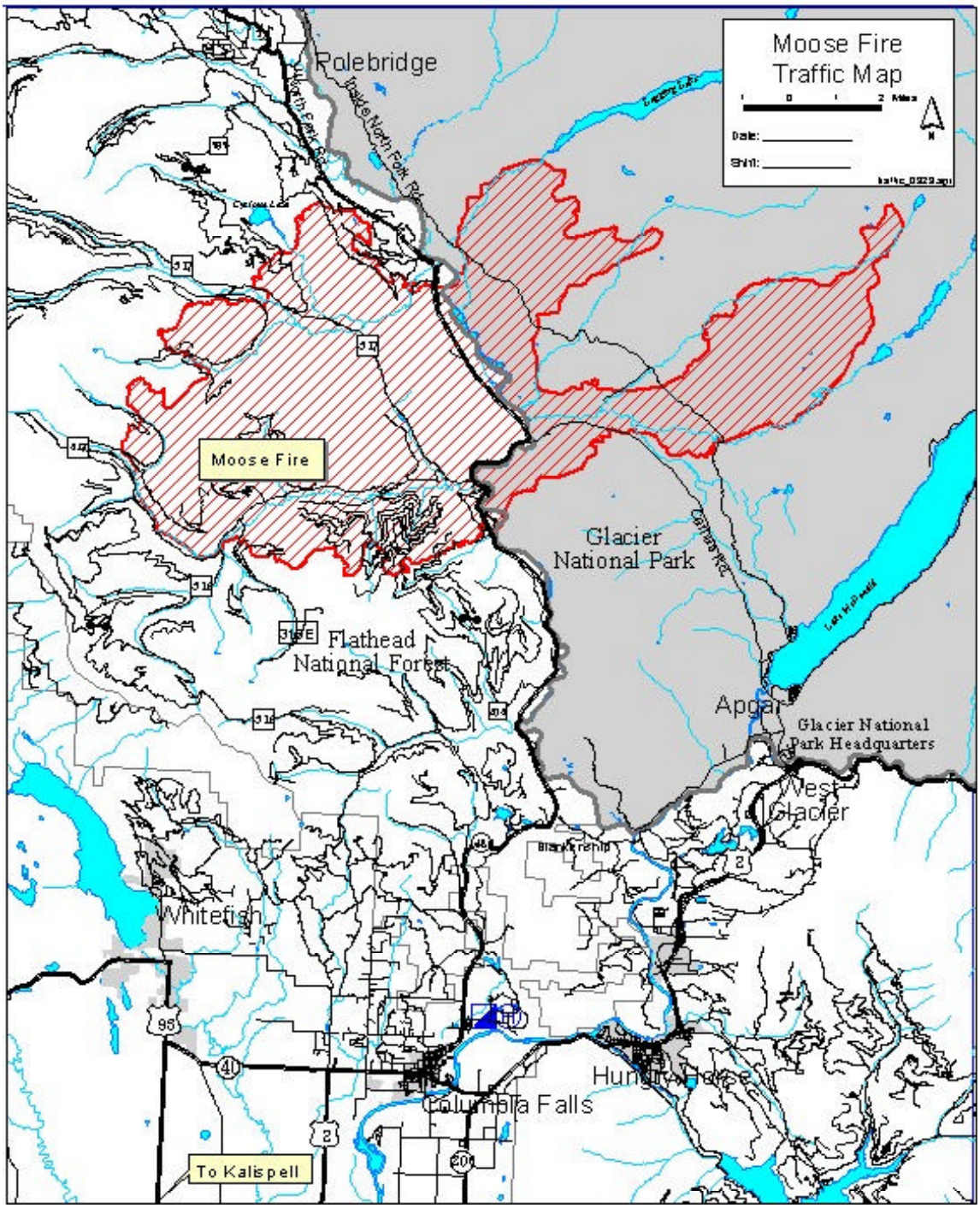
The forest manages 1.1 million acres of designated wilderness, and that includes almost 1 million acres in the Bob Marshall Fire Management Plan, which allows for wildland fire use. Over 6,000 acres were burned in FY2000 for wilderness resource benefits in the fire use program. The forest also manages 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.

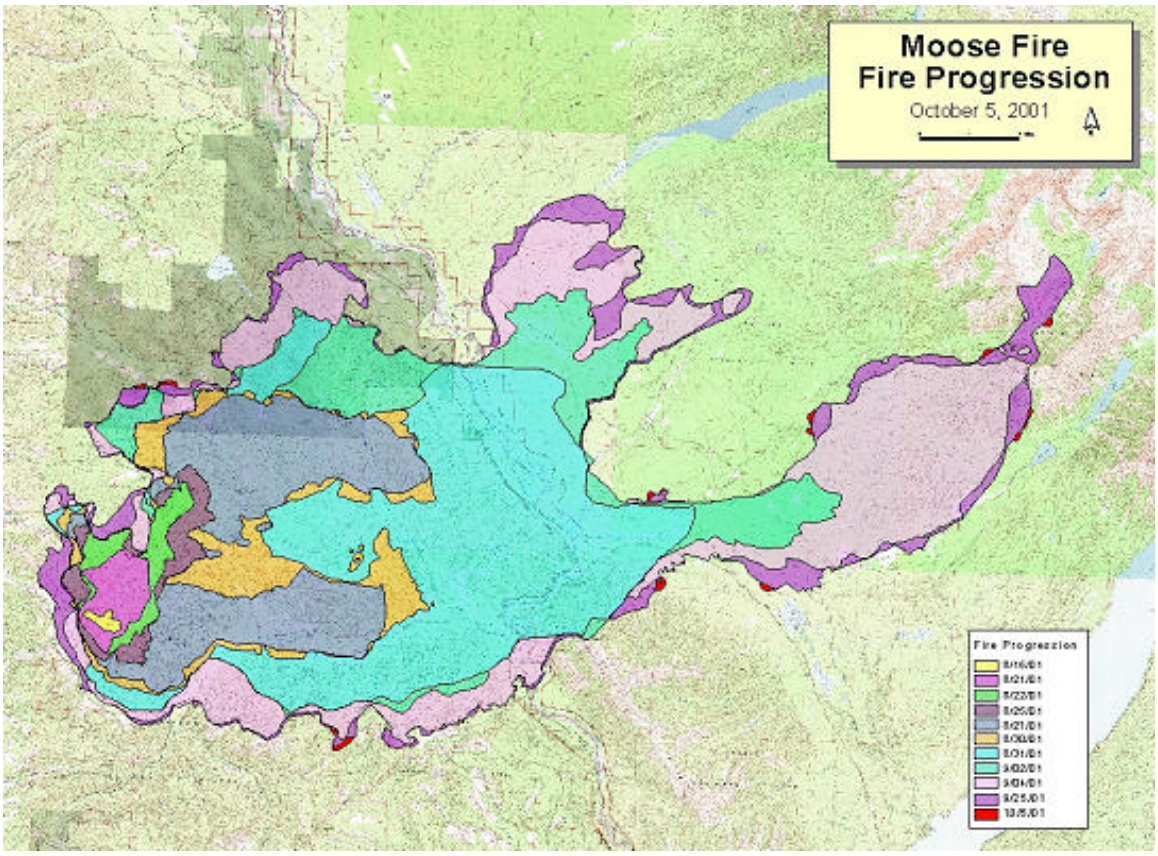
Rockies coordination Center had prepositioned a Type 2 IMT (Houseman) in Missoula. Because of Houseman's availability to deploy to the Flathead within 6 hours (compared to 24-36 hours required to mobilize and transport an out-of-area team), Houseman's team was ordered for Moose. This national competition 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

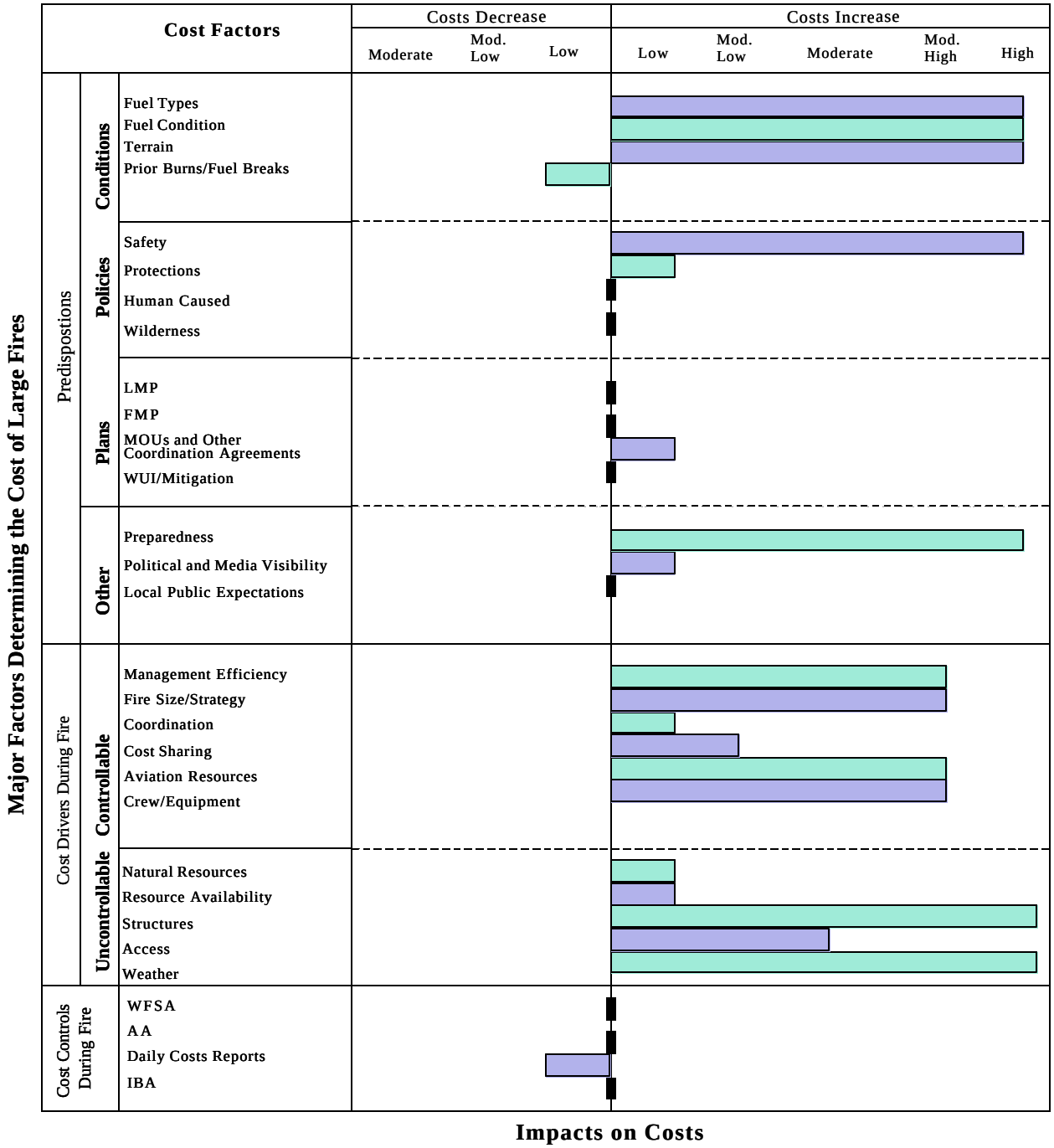
important contributor to the total cost was the escape of the fire from initial attack and the inability of any of the incident management teams to contain the fire in its early stages.

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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Steve Brady, *Fire/Fuels Resource Staff, Flathead National Forest, Kalispell, MT*
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Jack Cohen, * *Research Physical Scientist, USDA Forest Service, MT*
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James R. DuPont, *Sheriff, Flathead Sheriff's Office, MT*
Scott Emmerich, *Park Ranger, NPS, Glacier National Park, Kalispell, MT*
Tom Esch, *County Attorney, Flathead County, MT*
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Gary Mahugh, *Incident Commander/IMT, Flathead County, MT*
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Chris Ourada, *Fire Management Officer, Three Forks Zone, Flathead National Forest, MT*
Jane Parker, *Finance Section Chief/Support Services Supervisor, Hungry Horse District, Flathead National Forest, Kalispell, MT*
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Fred Vanhorn, *Fire Management Officer, Glacier National Park, NPS, West Glacier, MT*
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.

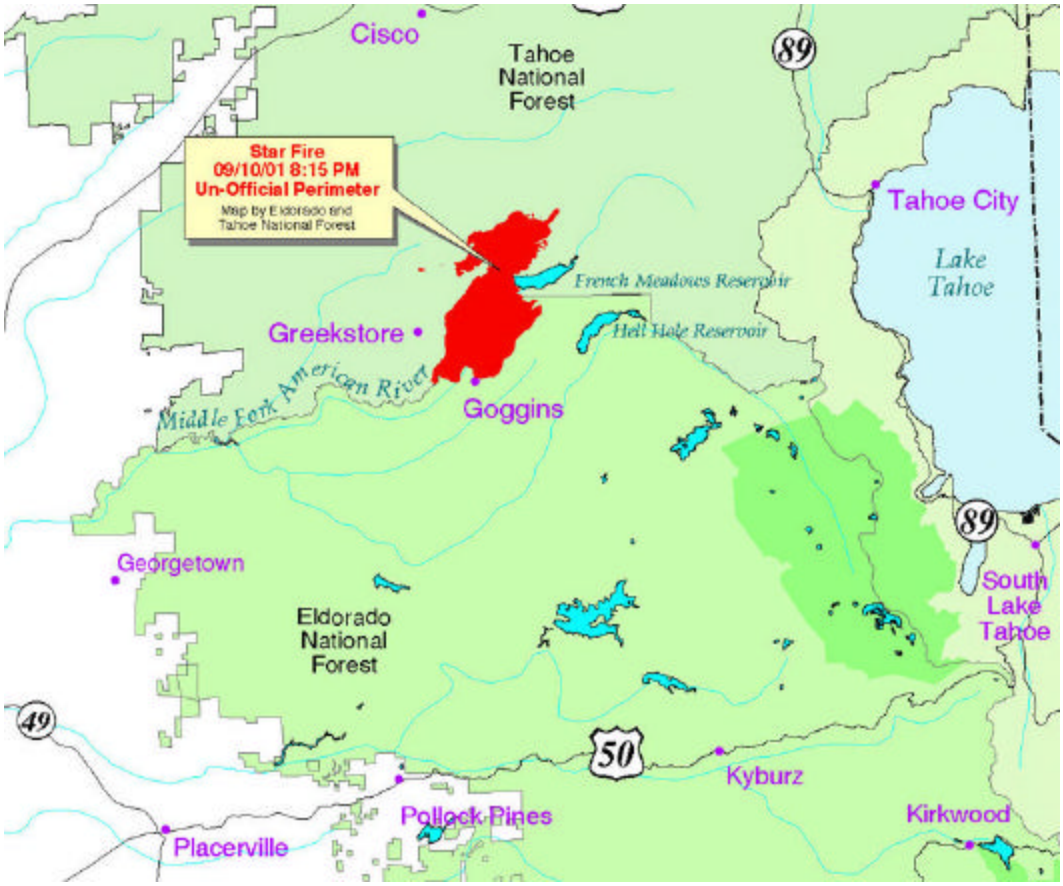
The principal vegetative types are woodland, hardwood (chaparral), mixed conifer, true fir, and subalpine. The major commercial forest species are white fir, red fir, Ponderosa pine, Jeffrey pine, sugar pine, Douglas fir, and incense cedar. A wide variety of hardwoods, brush, grasses, and forbs are mixed 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

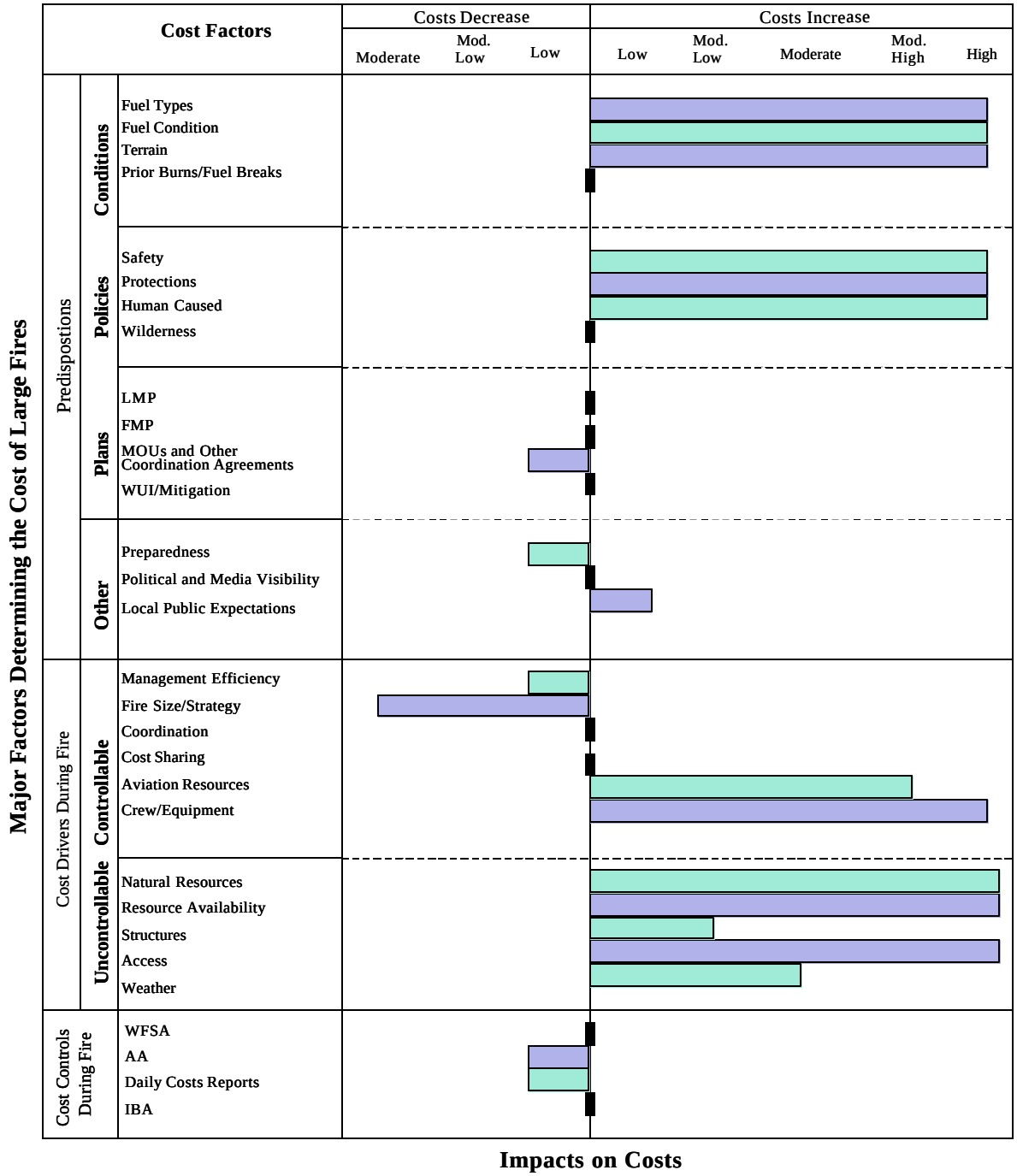


PRINCIPAL FACTORS DRIVING THE COSTS OF THE STAR FIRE

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*

STAR, Eldorado and Tahoe National Forests, CA, 8/25/01-9/21/01



* 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.

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.

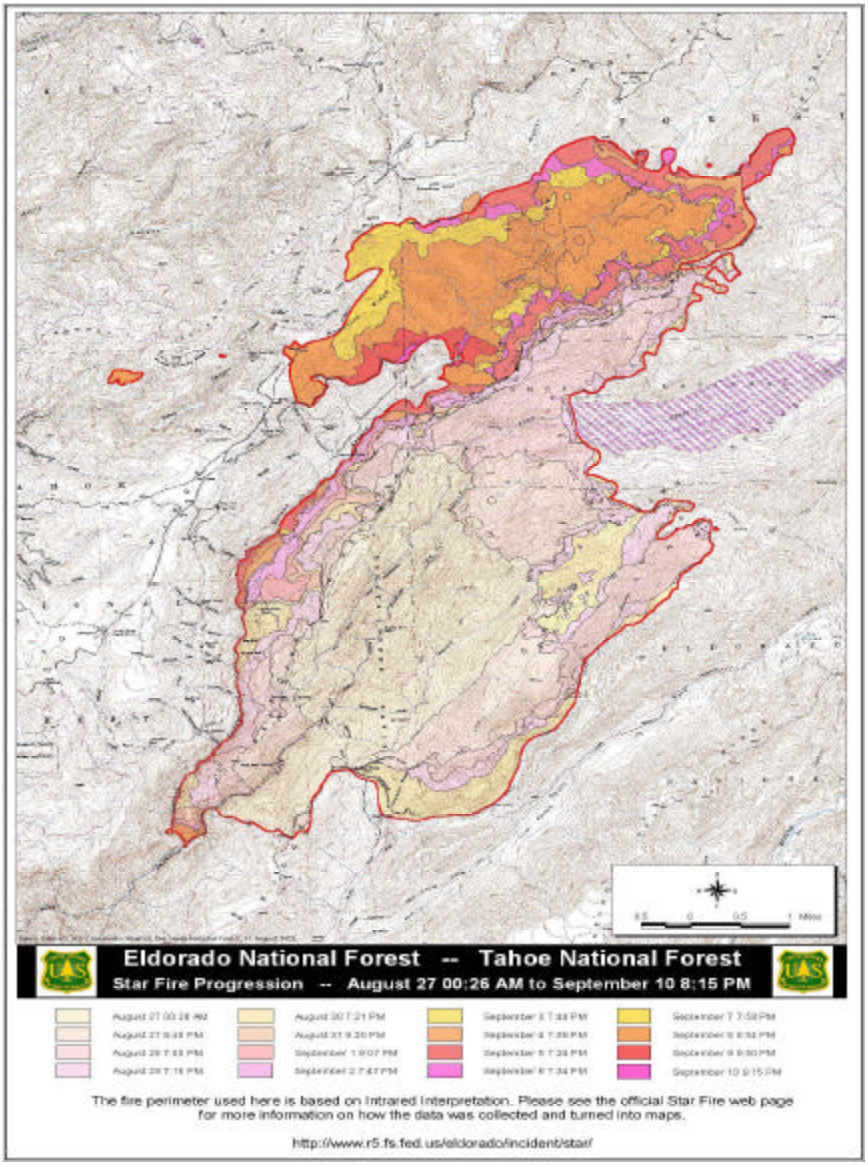
Almost half of the Eldorado forest (46 percent) is now in Fuel Model 10, which represents areas that are timbered and have a heavy downed fuel component. A large fire occurs on the Eldorado typically once every 7 to 14 years, usually during periods of very high fire danger for several days, low or no 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]

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[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.

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[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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