SPECIAL SESSION: THE YELLOWSTONE FIRES

BARK BEETLE—FIRE ASSOCIATIONS IN THE GREATER YELLOWSTONE AREA

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Abstract—The large forest tires in and around Yellowstone National Park in 1988 bring up many ecological questions, including the role of bark beetles. Bark beetles may contribute to fuel buildup over the years preceding a fire, resulting in stand replacement fires. Fire is important to the survival of seral tree species and bark beetles that reproduce in them. Without fire, seral species arc ultimately replaced hy climax species. Following fire, bark- and wood-boring beetles respond to fire-injured trees. Because of synchrony of the fires and life cycles of the beetles, beetle infestation in 1988 was not observed in fire-injured trees. However, endemic populations of beetles, upon emergence in 1989, infested large numbers of tire-injured trees. Of the trees examined in each species, 28 to 65 percent were infested by hark beetles: Pinus contorta (28 percent) by Ips pini; Pseudotsuga menziesii (32 percent) by Dendroctonus pseudotsugae; Picea engelmannii (65 percent) by Dendroctonus rufipennis; and Ahies lasiocarpa (35 percent) hy Buprestidae and Cerambycidac. Most trees infested by hark beetles had SO percent or more of their basal circumference killed by tire. Bark beetle populations probably will increase in the remaining tire-injured trees.

INTRODUCTION

Insects and diseases arc important in modifying the age structure and species composition of many forests. Their activities contribute to accumulation of dead fuels that make large-scale fires possible--resulting in new stands of the host tree. The stands arc then temporarily free of attack (Kilgore 1986). The mosaics of different-aged stands created as the result of fires assure survival of both trees and insects that infest them. However, fire is more important to the survival of some ecosystems than others. Following fires, injured trees arc susceptible to infestation by bark beetles. Subsequent buildup of bark beetle populations can result in killing of uninjured trees.

In this paper I will discuss bark beetle ecology (1) as it may contribute to fuel buildup and fire intensity and (2) as it relates to fire-injured trees in the aftermath of forest fires. Lodgepole pine (Pinus contorta Douglas), the most prevalent tree species in the Greater Yellowstone Area (GYA) and one that we know the most about with respect to bark beetle-tree interactions, will be discussed more fully than other species.

BARK BEETLES AS CONTRIBUTORS TO FUEL BUILDUP

Pfister and Daubenmire (1975) recognized four basic successional roles for lodgepole pine: minor seral, dominant seral, persistent, and climax. Large areas of lodgepole pine in the GYA have almost no spruce-fir component. Despain (1983) concludes these arc essentially self-perpetuating climax lodgepole pine stands that often exceed 300 to 400 years of age, with no evidence of fire since establishment.

Mountain pine beetle (MPB) infestation characteristics differ by lodgepole pine successional roles. In stands where lodgepole pine is seral and stands have been depleted by beetle infestations, lodgepole will be replaced by the more shade-tolerant species in the absence of fire. These shade-tolerant species consist primarily of Douglas-fir (Pseudotsuga menziesii [Mirb.] Franco) at the lower elevations and subalpine fir (Abies lasiocarpa [Hook.] Nutt.) and Engelmann spruce (Picea engelmannii Parry) at the higher elevations. Starting with the stand generated by fire, lodgepole pine grows rapidly and occupies the dominant position in the stand. Fir and spruce seedlings also become established in the stand but grow more slowly than lodgepole pine.

Once the lodgepole reach susceptible size, MPB infestations kill 30 to over 90 percent of trees 12.7 cm and larger diameter at breast height (Cole and Amman 1980; McGregor and others 1987). After each infestation, both residual lodgepole pine and the shade-tolerant species increase their growth (Roe and Amman 1970). Infestations are repeated as the residual lodgepole pines reach size and phloem thickness conducive to beetle infestation and survival (Amman 1977). This cycle is repeated at 20- to 40-year intervals, depending upon growth of the trees (Roe and Amman 1970). Although size and phloem thickness arc the variables necessary for beetle epidemics to occur, some authors (e.g., Berryman 1978) believe trees must be weakened before MPB can infest them. However, this has not been demonstrated, and will require detailed studies of beetle populations progressing from low level into the early phases of an epidemic (Schmitz 1988). Fuel levels and fire hazard continue to increase with each beetle infestation (Brown 1975; Flint 1924; Gibson 1943; Roe and Amman 1970) until lodgepole pine is

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eliminated from the stand, or until a fire occurs that kills most trees (including thick-barked, fire-resistant species), and the stand regenerates to lodgepole pine.

Where lodgepole pine is persistent or climax (Pfister and Daubenmire 1975), the association of lodgepole pine and mountain pine beetle is somewhat different. In these cases, the forest consists of lodgepole pine of different sizes and ages, ranging from seedlings to a few overmature trees. In these forests, MPB infests and kills many of the pines as trees reach large size. Openings created in the stand, as a result of the larger trees being killed, are seeded by lodgepole pine. The cycle is then repeated as other lodgepole pines reach sizes and phloem thicknesses conducive to increases in beetle populations (Amman 1977).

Amman (1977) hypothesized that periodic MPB infestations continue the multi-aged nature of the stands. A mosaic of small clumps of different ages and sizes may occur. The overall effect is likely to be more chronic infestation by the beetle because of the more constant source of food. Beetle infestations in such forests may result in the death of fewer trees per hectare during each infestation than would occur in even-aged stands (caused by stand replacement fires) and in those stands where lodgepole pine is seral. Fires in uneven-aged persistent and climax lodgepole pine forests should not be as hot as fires where widespread epidemics of beetles have occurred because smaller, more continuous deposits of fuel are added to the forest floor under chronic beetle infestations. Thus, with lighter accumulations of fuel, tires tend to eliminate or weaken some of the trees but do not cause total elimination and complete regeneration of the stand. An example is the situation described by Gara and others (1985) in south-central Oregon, where lodgepole pine forms an edaphic climax. Here, fires are slow moving, and the heat of smoldering logs scorches roots and sides of trees. Later these injured trees are invaded by fungi that work their way up the roots into the trunks. Subsequently, mountain pine beetles are attracted to and kill these trees. As the dead trees rot and fall over, the stage is set for another fire.

Most fires that occur in lodgepole pine are either slow and smoldering or are rapidly moving, intense crown fires (Lotan and others 1985). High-intensity tires tend to favor lodgepole pine over such species as Douglas-fir (Kilgore 1986) and would likely occur following epidemic beetle infestations. Brown (1975) states that the major vegetation pattern found in lodgepole pine today was caused by stand replacement fires, although many uneven-aged lodgepole pine stands result from lower intensity surface fires.

In south-central Oregon, Stuart and others (1989) have related lodgepole pine regeneration pulses to mountain pine beetle and fire disturbances. They observed that (1) stands that experienced periodic MPB epidemics accompanied by a fire had an even-aged structure; (2) stands that had periodic MPB epidemics and no fire had a storied, bimodal size structure; and (3) stands that experienced mortality by low level MPB populations, with or without low intensity fire, had multi-aged structure.

Romme and others (1986) examined the effects of beetle outbreaks on primary productivity in forests dominated by lodgepole pine in northwestern Wyoming. They concluded that the mountain pine beetle does not regulate primary productivity. Even though MPB has drastic effects upon stands (considering the forest landscape comprises a mosaic of stands in various stages of succession), annual productivity for the landscape is relatively constant despite continual fluctuations of individual stands. The sudden and massive death of a large proportion of the biomass leads to only a brief drop in primary productivity and to a more equitable distribution of biomass and resources. Therefore, the primary function of large MPB infestations and the death of large numbers of lodgepole pine appears to be survival of host and beetle by creating large amounts of fuel for fire that, when ignited, eliminate competing vegetation and regenerates lodgepole pine (Amman 1977; Roe and Amman 1970; Romme and others 1986).

The mosaic of stands of different ages created by the action of MPB and fire is ideal for MPB survival. Because stands are coming into sizes conducive to continual MPB infestation and survival, a continual supply of food is provided. However, an ideal mosaic for MPB probably did not occur following the 1988 GYA fires because fire behavior was influenced more by drought and wind than by fuels. Virtually all forest age and fuel categories burned (Christensen and others 1989).

Romme and Despain (1989) state that the mosaic created by the 1988 fires will be more homogeneous than the mosaic created by fires in the early 1700's, and few ecological consequences will be incurred because succession is slow. One consequence is likely to be a major MPB infestation in 80 to 120 years because at this age many lodgepole pine stands sustain their first beetle outbreak, again creating a large amount of dead fuel in a relatively short period, setting the stage for another stand replacement fire (Roe and Amman 1970). The timing of MPB infestations, when lodgepole pine are mature in seral stands, not only assures large amounts of fuel from the dead trees for a stand replacement fire but also adequate seed to regenerate the stand (Peterman 1978). Peterman suggests the ecological role of MPB could be to decrease the probability of lodgepole stands, with a high degree of serotiny, producing stagnant stands of offspring. By preventing the stand from getting too old, much less seed would be available. Such a mechanism could have evolutionary significance to lodgepole pine because stagnant stands do not reproduce well, and the stand following the stagnant stand could be outcompeted by climax tree species. Peterman further points out that prevention of stagnant stands would be advantageous to MPB because the beetle does not reproduce well in small, stagnant trees.

The contribution of dead fuel buildup, a result of the 391 000 ha infestation of MPB in Yellowstone National Park that was still active in 1982 (Gibson and Oakes 1987), to behavior of the 1988 fires was masked by the extreme fire conditions (Christensen and others 1989). Studies of small fires in portions of Yellowstone not involved in the 1988 tires probably would elucidate interactions of MPB infestations, dead fuel buildup, and tires. A relationship similar to MPB, lodgepole pine, and fire has been proposed for southern pine beetle (SPB) (D. frontalis Zimmermann) and pines in the Southern United States. There, pines are replaced by hardwood tree species in the absence of fire (Schowalter and others 1981). Therefore, survival of SPB and its host in natural stands is dependent upon frequent fires.

Bark beetles infesting climax tree species would not have the same need for a close relationship with forest fires as those infesting seral species. The spruce beetle (SB) (D. rufipennis [Kirby]) and the Douglas-fir beetle (DFB) (D. pseudotsugae) usually kill small groups of trees. However, occasionally they also cause heavy mortality, favoring large trees over vast areas, after building up in windthrown trees. For example, SB killed millions of Engelmann spruce in Colorado between 1939 and 1951 (Massey and Wygant 1954) and white spruce (P. glauca [Moench] Voss) in Alaska between 1960 and 1973 (Baker and Kemperman 1974). Schmid and Hinds (1974) describe the scenario in spruce-fir stands in the central Rocky Mountains following spruce beetle infestations. Following a spruce-beetle outbreak, the percentage of subalpine fir in the stand increases, with fir dominating the stand. As fir reach 125 to 175 years of age, they begin to die, with the bark beetle Dryocoetes confusus Swaine being one of the mortality factors. Young spruce and fir increase their growth as overstory fir die. The less shade-tolerant spruce is then favored over fir as the original canopy fir are killed. Spruce becomes dominant as it outlives fir and gains greater size. Eventually, the cycle is repeated. Spruce beetle generally live in moist forests where fires are less frequent and intense because of moist, sparse fuels (Amo 1976). Small fires in the spruce-fir type would expose mineral soil and probably favor establishment of spruce.

The Douglas-fir beetle seldom creates widespread destruction in the Rocky Mountains, generally killing groups of dense mature Douglas-fir (Furniss and Orr 1978). These groups are usually widely separated, and the space created by death of some overstory trees usually regenerates to Douglas-fir.

These observations suggest coadaptive or coevolutionary relationships between bark beetles and their host trees, and the importance of fire in maintaining these relationships for seral tree species.

BARK BEETLE/FIRE-INJURED TREE ASSOCIATIONS

Following the 1988 GYA fires, large numbers of trees girdled or partially girdled by heat remained at the bum perimeter and are providing infestation opportunity to bark beetles. Beetles may increase to large numbers and infest uninjured trees after most of the fire-injured trees are killed.

The bark beetle situation in the GYA at the time of the 1988 tires shows that the species were at low population levels, except the DFB. The massive infestations of MPB that covered over 391 000 ha in Yellowstone Park in 1982 had declined to only 135 ha by 1986 (Gibson and Oakes 1987) and to no infested trees in 1987 (Gibson and Oakes 1988). In 1988, insect detection flights over the park were not made because of fire fighting efforts and smoke (Gibson and Oakes 1989). However, on the nearby Bridger-Teton National Forest, MPB infestation had declined from 1,296 ha in 1987 to 364 ha in 1988 (Knapp and others 1988).

Although no survey estimates are available for other bark beetle species in Yellowstone Park, surveys of adjacent areas showed only the DFB was increasing, whereas spruce beetle infestation was light (Knapp and others 1988) and pine engraver (Ips pini Say) populations had declined (Gibson and Oakes 1989).

The small populations of bark beetles in the GYA at the time of the 1988 fires, coupled with timing of the fires in relation to life cycles of bark and wood infesting beetles, resulted in few fire-injured trees being infested in 1988. The SB, DFB, and pine engraver all emerge to infest new material in the spring, prior to occurrence of the fires. The MPB emerges in late July and early August, but few were in the GYA.

Studies were started in 1989 to determine bark beetle infestation of fire-injured trees and potential buildup of beetle populations. Observations were made in three areas: (1) near the Madison River, approximately halfway between Madison Junction and West Yellowstone (the North Fork tire); (2) along the John D. Rockefeller, Jr., Memorial Parkway, south of Yellowstone's South Gate (the Huck fire); and (3) in the Ditch Creek area of the Bridger-Teton National Forest (Hunter fire). In each area, variable plots (10 basal area factor) were established: area 1, three plots; area 2, nine plots; and area 3, seven plots. All trees in the plots were numbered so that survival of individual trees can be followed for several years. Survival of scorched trees can be predicted from volume of crown scorch (Ryan and others 1988). Peterson and Arbaugh (1986) found crown scorch and basal scorch were best predictors for lodgepole pine survival, and crown scorch and insect attack were most important as predictors of survival of Douglas-fir. However, the researchers did not identify the insects. I used the percentage of basal circumference in which the cambium was killed, rather than relating infestation to crown scorch, because of the high sensitivity of lodgepole and spruce to even light ground tire. Some bark was removed from trees infested by insects so that insects could be identified. Because our plots were mostly at low elevations (2 050 to 2 400 m), trees consisted mostly of lodgepole pine and Douglas-fir. The limited nature of our observations preclude their use for making predictions of bark beetle activity beyond our plots. Greater coverage of the burned area is planned in 1990.

Lodgepole Pine

Lodgepole pine is the most abundant tree in the samples. Overall, 28 percent of the trees were infested by the pine engraver (*Ips pini* Say) (table 1). Of the trees infested, only one had not been scorched by fire. All others had 50 percent or more basal girdling (phloem killed by fire). Most commonly, trees infested by the pine engraver had 100 percent basal girdling (table 2). Many of these trees showed little evidence of scorch and looked healthy except for boring frass made by the beetles. Upon closer inspection, however, the trees were completely girdled at the base by a light ground tire. Geiszler and others (1984) also found most lodgepole pine infested by pine engraver were moderately to heavily injured following a fire in Oregon.

It is not surprising that a large number of trees were infested by pine engraver because they are able to reproduce in wind-broken material (including large branches) and in decadent trees near death (Sartwell and others 1971). There always seems to be plenty of such material available. Consequently, the engraver is almost always present in substantial numbers, although not necessarily causing noticeable tree mortality.

Only one tree containing MPB was observed (Hunter fire on the Bridger-Teton National Forest) and it was not on a plot. Observations over the years suggest that MPB is not strongly attracted to fire-scorched trees, so few trees would be infested even if a large population had been present in the GYA. The MPB seldom breeds in trees injured or killed by tire in numbers sufficient to cause an increase in the population. Hopkins (1905) found no MPB in tire-injured ponderosa pine in the Manitou Park area of Colorado. However, he did observe several secondary species, including the red turpentine beetle (*D. valens* Lec.). In a subsequent publication concerning insect damage in the National Parks, Hopkins (1912) stated that forest fires contribute, to a limited extent, to the multiplication of certain species that breed in fire-scorched trees, but as a rule forest fires kill more beetles

Table 1.--Number of trees examined and the percentage infested by bark- and wood-boring beetles for plots located in three fires in the Greater Yellowstone Area, 1989

Tree species	Fire: North Fork		Huck		Hunter		All fires	
	No.	Pct	No.	Pct	No.	Pct	No.	Pct
Lodgepole pine	0	0	67	24	58	33	125	28
Douglas-fir	34	18	25	52	4	25	63	32
Engelmann spruce	0	0	2	50	15	67	17	65
Subalpine fir	0	0	9	33	8	38		35
All species	34	18	103	31	85	38	2::	32

Table 2.--Number and percentage of trees infested by bark- and wood-boring beetles in different fire-injury categories, Greater Yellowstone Area, 1989

Tree species	Percentage of basal circumference killed by fire: 0		1-25		26-50		51-75		76-100	
	No.	Pct	No.	Pct	No.	Pct	No.	Pct	No.	Pct
Lodgepole pine	21	5	4	0	15	0	12	25	73	41
Douglas-fir	17	28	3	0	10	30	11	36	22	41
Engelmann spruce	0	0	1	0	0	0	0	0	16	69
Subalpine fir	0	0	0	0	0	0	0	0	17	31
All species	38	16	8	0	25	12	23	30	128	43

than they protect (by protect, he probably meant provide breeding habitat). Swaine (1918), referring to Canadian conditions, wrote that ground tires that injure and kill large numbers of trees may provide material for rapid development of bark beetles. He thought this was particularly true if fires occur year after year in neighboring localities. Apparently the proximity of fires would allow beetles to continue to build up their populations for several consecutive years. Blackman (1931), working on the Kaibab National Forest in northern Arizona, found MPB did not prefer fire-scorched trees. He thought the scorched phlocm did not offer favorable conditions for beetle offspring. The MPB has fairly limited requirements of phloem thickness and moisture in order to reproduce (Amman and Cole 1983).

In agreement with most observations in the Rocky Mountains that MPB are not attracted to fire-scorched trees, Geiszler and others (1984) observed MPB mostly in trees uninjured or lightly injured by fire, in direct contrast to pine engraver in moderate to heavily injured trees. Rust (1933) reported fire-injured ponderosa pine were infested by MPB the first year following a tire in northern Idaho; however, the infestation declined the next year.

The wood borers, both Buprestidae and Ccrambycidae, were found occasionally in fire-injured lodgepole.

Douglas-fir

Douglas-fir was the second most common tree found on the plots. Of the trees examined, 32 percent were infested by insects, mostly DFB and a few wood borer larvae of Buprestidae and Cerambycidae (table 1). Most infested Douglas-Iir had 50 percent or more girdling by fire (table 2). Some Douglas-firs that had needles and limbs completely burned were infested by DFB in the base where the bark was thick enough to protect the phloem from complete incineration or from drying so excessively that beetles would not construct egg galleries in it. Phloem in such trees was completely brown, and larvae probably will not complete development in such trees.

Furniss (1965) studied the susceptibility of fire-injured Douglas-fir to bark beetle attack after a large fire in southern Idaho. He found 70 percent of the trees were infested by DFB 1 year after the fire. And even small or lightly burned trees attracted the beetles. He found incidence of attack increased with tree size and severity of crown and cambium injury by fire. However, infestation decreased sharply with outright tree killing by tire. Although beetles established brood in 88 percent of the trees, offspring numbers were small because of pitch invasion of the galleries and sour sap condition.

Fumiss (1965) did not report on DFB infestation in fire-scorched Douglas-fir beyond the first postfire year. However, following the Tillamook fire of 1933 in the coastal range of Oregon, DFB buildup in fire-injured Douglas-fir occurred. Beetles then killed large numbers of uninjured trees in 1935 and 1936, but the infestation soon subsided (Fumiss 1941). Fumiss thought beetles were able to increase because frequent tires in the Tillamook area provided large numbers of injured trees in which the beetles could reproduce.

Connaughton (1936) observed that delayed mortality of fire-injured Douglas-fir was mostly caused by insects (probably DFB) and fire damage to roots. He found Douglas-fir had a thick layer of duff around the trunk that burned slowly, heating the soil and badly injuring the roots. The evidence for root injury did not show up until a year or two after the fire in west-central Idaho.

Engelmann Spruce

Engelmann spruce constituted a small part of our tree sample, with only 17 trees examined. Spruce beetle infested 65 percent of the trees (table 1), and these were usually the larger diameter trees. Of the spruce, only those with 7.5 percent or greater basal girdling were infested (table 2). Some spruce burned similarly to Douglas-fir described by Connaughton (1936). Duff around the base resulted in a slow burning tire that often burned off the roots or so weakened them that the trees were easily blown over by wind. Windthrown trees with unscorched trunks created an ideal habitat for the SB, which shows a strong preference for windthrown trees (Massey and Wygant 1954; Schmid and Hinds 1974). Large numbers of spruce beetle larvae occurred in the spruce, as well as some larvae of Buprestidae and Cerambycidae.

Subalpine fir

Wood borers (Buprestidae and Cerambycidae) infested 35 percent of the 17 subalpine fir in the sample (table 1). All of the fir suffered 100 percent basal girdling. The bark was badly burned and not conducive to bark beetle infestation (table 2).

Whitebark Fine

Whitebark pine (P. albacaulis Engelm.), which is generally found at high elevations in GYA, did not occur in any of our plots. MPB infestations during the past 20 years caused considerable whitebark mortality (Bartos and Gibson 1990), but the number of infested trees was low at the time of the 1988 fires. Although MPB is not strongly attracted to fire-scorched lodgepole and pondcrosa pines in the Rocky Mountains, Craighead and others (1931) state that it prefers weakened and fire-scorched western white pine (P. monticola Dougl.), one of the five-needle pines. Therefore, MPB may be more attracted to fire-injured five-needle pines, whitebark and limber (P. flexilis James), than to lodgepole pine.

CONCLUSIONS

Of the bark beetles in the GYA, MPB plays a significant role in converting live fuels to dead fuels in a relatively short period. This behavior probably promotes hot stand replacement tires that assure survival of lodgepole pine and, hence, survival of MPB. Fire is not as important in the ecology of bark beetles infesting climax tree species.

Although a limited number of fire-injured trees were sampled in the GYA, almost one-third were infested by bark beetles. Therefore, numbers of infested trees in the sampled areas likely will increase because of the remaining large numbers of tire-injured trees.

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YELLOWSTONE MEDIA MYTHS: PRINT AND TELEVISION COVERAGE OF THE 1988 FIRES

Conrad Smith[1]

Abstract-This paper draws on comments from 89 reporters who covered the fires, on comments from 146 of their news sources, and on evaluations of network television coverage by four groups of wildfire experts. The research also incorporates a content analysis of stories about the fires that appeared in Yellowstone-area and elite newspapers. The results suggest that repotters sometimes made serious factual errors, and often did a poor job of reporting on ecological issues and fire management policy. There were substantial differences in how the fires were covered by different news organizations.

INTRODUCTION

Molotch and Lester (1974, 1975), who examined hundreds of newspaper stories about the 1969 Santa Barbara oil spill, concluded that the contents of the news accounts were not determined by objective characteristics of the spill, but rather by a power struggle among various news sources who had vested interests in differing interpretations of the event. Only the local newspaper framed the story in the way it was perceived by Santa Barbara residents.

In the present paper, coverage of the Yellowstone fires by six newspapers and the three television networks is interpreted as a power struggle among sources offering two competing interpretations of the event: 1) Enlightened public land managers attempted to maintain the ecological integrity of a pristine national park by following a scientifically-based fire suppression regime which treated wildfire as a natural and necessary part of the biological process that shaped the ecosystem, and 2) Inept government bureaucrats allowed a national treasure to be destroyed because of their insensitivity to the beauty of Yellowstone forests and a cavalier attitude towards the fears of local residents and the right of local merchants to realize a fair return from investments in tourist-related business ventures.

BACKGROUND

On its surface, news can be viewed as an objective account of reality, as an impartial reflection of what happened. This is the newsgathering model offered by many journalists, and the goal described by various professional codes of journalistic ethics, which identify the search for truth as the most basic goal of all journalistic endeavors. In the real world of newsgathering, however, reporters must make many value-driven choices that shape the ensuing stories. Who to interview? What questions to ask? Which facts to include at the expense of others that are left out? What angles should be emphasized? What kinds of stories are being written by competing reporters? What instructions have been received from an editor or producer? How much time is there before deadline? What kind of story will advance my career?

The impression made by news accounts is also shaped by editorial decisions that determine when the story is important enough for a newspaper or network to assign a reporter rather than relying on wire service accounts, the decision about who to assign to the story, and the decision about where to place the story and how much time or space to give it.

The Yellowstone fires were difficult to cover to the extent that they occurred outside the normal news routine. National reporters had to find their bearings in an unfamiliar place, and to seek information and identify new sources from scratch. Most of journalism has to do with routine stories covered from fixed locations through repeated contact with established sources. On the other hand, the urban fire is one of the most basic stories in the journalist's repertoire, and that made coverage easier because the urban fire model could be used as a model for covering wildfires. When reporters have little expertise about an event, they are more likely to rely on their personal values to interpret it (Gans 1979), and more likely to borrow information and story angles from other reporters (Gitlin 1980). Research by Patterson (1989) and Wilkins (1987) indicates that disaster coverage tends to focus on immediate events rather than the context in which they occur, and suggests that these stories are often told in terms of cultural stereotypes and not as objective accounts of what happened. A study of news stories about environmental issues related to construction of the Tellico Dam (Glynn and Timms 1982) indicated that the snail darter fish itself, rather than the issues, dominated coverage.

Media scholar Gaye Tuchman (1978) says that journalists create news stories by transforming real events into a socially constructed "reality" that meets the organizational needs of news work. Some sources and facts are discarded, she observes, because of shared notions among journalists about what constitutes news. This process, according to sociologist David Altheide (1976), often distorts events by removing them from the context in which they occurred. "Journalists,"

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writes Altheide, "look for angles, interest, and entertainment value." Some of the ways in which reporters frame news, according to Gitlin (1980), "can be attributed to traditional assumptions in news treatment: news concerns the event, not the underlying condition; the person, not the group; conflict, not consensus; the fact that advances the story, not the one that explains it."

Many of the reporters who covered the Yellowstone fires were general assignment reporters rather than specialists in regional or environmental subjects. Herbert Gans (1979) observes that general assignment reporters "are like tourists, albeit in their own culture; they seek out what is memorable and perceive what clashes with the things they take for granted." Because of this, national news accounts of local stories are almost always inaccurate and exaggerated.

METHOD

This study is based on examination of 814 news accounts about the Yellowstone fires that appeared in 1988 in three elite American newspapers (the New York Times, Washington Post and Los Angeles Times), three Yellowstone-area newspapers (the Billings, MT Gazette, the Bozeman, MT Daily Chronicle and the Casper, WY Star Tribune), and in the evening newscasts of the three commercial television networks. The three elite newspapers are widely considered America's best and most prominent, while the three area newspapers circulate in Yellowstone and adjacent communities.

Yellowstone-area newspaper stories were obtained from the newspapers themselves, and newspaper employees judged whether individual stories should be categorized as being about the Yellowstone fires. Stories from the elite newspapers were obtained from the VuText and Nexis electronic databases, which allowed computer retrieval of all stories that contained the words "Yellowstone" and "tire" or "wildfire" (except for wire service stories in the Washington Post, which are not included in either database). Television stories were obtained from the Vanderbilt Television News Archive in Nashville.

The New York Times, which is published in the nation's media capital, received special scrutiny. It is widely read by journalists, and is often used by the networks and by journalists not only as a source of news, but also as a guide to the importance of stories and as a guide to how to cover stories (Gitlin 1980).

This paper also draws on two earlier studies by the author. One was about the Yellowstone tires as seen by 68 print journalists who covered them and by 146 news sources for newspapers and news magazine stories (Smith 1989a). The other was based on evaluations of all 1988 evening network television stories about the fires by incident commanders, forest ecologists, wildfire behavior experts, and fire management policy experts (Smith 1989b).

RESULTS

Each of the six newspapers published its first account of the Yellowstone fires between July 1 and July 8. ABC and NBC television broadcast their first stories on July 25, after the evacuation of Grant Village. The first CBS story was broadcast on August 22, when soldiers joined the firefighting effort.

The Yellowstone tires were more newsworthy in the west than in the east. They made the front page of the Los Angeles Times 39 times, starting on July 18 with a news brief about wildfires in the west; the front page of the Washington Post three times, starting on September 8 after the fire's visit to the Old Faithful Geyser Complex; and the front page of the New York Times three times, starting on September 11 when the secretaries of Interior and Agriculture arrived in Yellowstone for an inspection. Stories about the fires appeared in the first five pages of the Washington Post 17 times, but only three times (the front page stories) in the New York Times.

The first Los Angeles Times story written by a full-time staff reporter for the paper (Tamara Jones) was published on August 24. The Los Angeles Times did not use freelance stringers to cover the fires. The Washington Post and New York Times, however, relied partly on outsiders. Freelancer Geoffrey O'Gara wrote seven stories for the Post. The first of these appeared on July 17. The New York Times also made use of material provided by stringers, starting with an August 10 article by Jim Robbins.

Although fire visited the Old Faithful geyser complex only on September 7, the geyser was a recurrent theme in news stories as a symbol of the park. Old Faithful is mentioned in 13 of 47 stories about the fires in the New York Times, in 13 of 41 stories about the tires in the Washington Post, and in 24 of 75 stories in the Los Angeles Times. The first stories on ABC and NBC also mentioned Old Faithful, and pictures of the geyser appeared in 18 network stories about the fires.

All of the Yellowstone tires were classified as wildfires on July 21, and were subjected to full suppression (Christensen 1989). However, I was unable to find any mention of this fact in any news report published or broadcast during July or August. Several news organizations did quote Interior Secretary Donald Hodel as saying on July 27 that all new tires would be suppressed (emphasis added), but many reporters retained the impression some fires were being allowed to burn unchallenged, and perhaps unmonitored, through all of August and into September.

Coverage in the New York Times

A free-lance story by Jim Robbins (1988a), published in the New York Times on August 10, said the abandoned natural-bum policy was still in effect, and was "the talk of the campgrounds and restaurants" in the Yellowstone area. Four days later, another story (Robbins 1988b) said that some fires were being fought, but that a dozen were being allowed to burn. On September 1, yet another New York Times story (Wilson 1988), said "Some of the fires arc allowed to bum unchallenged as part of a philosophy that holds they arc a natural process." A September 10 article (Shabecoff 1988) described criticism of Yellowstone's natural-burn policy by Wyoming senators Alan Simpson and Malcolm Wallop without explaining that suppression of all fires began in July.

Seven weeks after all fires were in suppression mode, the Nation's most influential and prestigious newspaper thus continued to support the myth that some of the fires were being allowed to burn. A search through the Nexis computer database for all 1988 New York Times stories containing the words "correction" and "Yellowstone" indicates that no corrections of this mistake were ever published.

The language used to frame New York Times stories about the tires sometimes encouraged the idea that they were being managed ineptly and insensitively. On August 14: "It may seem strange to a generation that grew up with stern admonitions from Smokey Bear, but the Park Service refuses to use words like 'damage' or 'destruction,' and instead describes how the tires will rejuvenate aging park forests and benefit wildlife" (Robbins 1988b, emphasis added). This clearly implies deviant behavior ("strangeness" and the "refusal" to use "reasonable" language). On September 11, in the Times' first front-page story about the fires: "(O)fficials could not keep up with reports of areas threatened by the blazes." "Evacuations were so numerous it was hard for park officials to keep track of them." (Robbins 1988d). The language here implies a park administration in disarray. On that same day, the major local paper, the Billings Gazette, had no trouble keeping track of the same evacuations. September 22: "(E)ven at the height of the fires, bulldozers were allowed into the park only on a case by case basis" (Egan 1988, emphasis added). The qualifying phrase tends to cast doubt on the management policy.

When Democratic Presidential candidate Michael Dukakis visited Yellowstone on September 15, the Times was the only elite newspaper to include an observation alluding to the Bambi myth that animals cope poorly with wildfire. The account describes Dukakis reading a letter from a firefighter received from a little girl who wrote, "I wish you could help the animals" (Toner 1988).

The kinds of factual errors described above continued in the second New York Times front-page story, published on September 22 (Egan 1988). This story said that the government had a policy of allowing all naturally-caused fires in parks and wilderness areas to bum themselves out, and also that the Forest Service has a policy of fighting all fires in National Forests. The story said, incorrectly, that Interior Secretary Hodel had ordered on July 21 that all fires be fought.

A September 14 New York Times editorial supported the National Park Service by stating that the fires were not a disaster, as Interior Secretary Hodel had said they were, but helped perpetuate the myth that natural ecosystems arc static rather than dynamic, and supported the notion that it might have been possible to preserve Yellowstone forever as it was before the tires. "Yetlowstonc may take years," the editorial said, "to grow back exactly as it was" (emphasis added).

The first New York Times story about scientific aspects of the 1988 wildfires (Malcolm 1988) was thoughtful and thorough, although it was not published until the end of September when the fires were largely under control. It contained interviews with Yellowstone research biologist Don Despain, with Cornell soil biologist Susan Riha, with fire-behavior expert Richard Rothermel, and with wildfire historian Stephen Pyne.

Coverage in the Washington Post

Stories in the Washington Post tended to be less judgmental than those in the New York Times, and tended to contain fewer factual errors. The first non-wire story (O'Gara 1988a) described fire as a positive influence on the forest, although it also helped establish the myth that Old Faithful was threatened by a "natural bum" fire when it attributed the human-ignited North Fork fire (the only one that ever threatened the Old Faithful tourist complex) to lightning. The second non-wire story (O'Gara 1988b) contained a reasonably good description of the natural-bum philosophy that later became controversial. The Post interviewed fire experts Don Despain and Richard Rothermel two months earlier than the New York Times (O'Gara 1988c). Unlike the New York Times and the three television networks, the Post specifically pointed out that the North Fork fire, which made the September 7 run on Old Faithful, and which caused all but one of the major evacuations in the park, was never subject to the natural-bum policy (Reid and Peterson 1988).

Coverage in the Los Angeles Times

The east-coast newspapers framed the fires as being more controversial than the Los Angeles Times. Although the New York Times mentioned controversy about Yellowstone's natural-bum policy on August 10, and the Washington Post first ran a story describing the controversy on August 9, the Los Angeles Times did not allude to any controversy about Yellowstone's natural-burn policy until September 1, and then only in an editorial endorsing the wisdom of that policy.

"Most of the complaints," the editorial said, "have come from a handful of landowners who have felt threatened by the raging fires and from business owners on the periphery of Yellowstone who have suffered economic losses because of the fall-off of tourism." This frames the fires quite differently from the September 22 New York Times story that said the fires had led to unspecified but "widespread" criticism of the government's natural-burn policy (Egan 1988).

The Los Angeles Times carried a second editorial on September 13 that said the "unwarranted criticism of the Park Service, the U.S. Forest Service and environmental experts has reached a level of misinformed hysteria that is racing out of control, as the fires have done." This was followed by two op-ed columns supporting the scientific validity of the natural-burn policy, published on September 17 and September 26. On September 22, the Times carried an article that suggested officials were overreacting when they canceled a planned prescribed burn in the Santa Monica Mountains because of negative publicity about the Yellowstone fires (Fuentes 1988).

Stories in the Los Angeles Times were presented in a way that interpreted the Yellowstone fires as more natural and less alarming than stories in the eastern elite newspapers. Yellowstone-area residents described in the New York Times and Washington Post tended to be critics of Yellowstone's tire management efforts. One of the very few local residents described in the Los Angeles Times, a merchant whose business was given a 25-percent chance of surviving one of the fires, was framed more positively. Ralph Glidden was quoted as saying "I'm trusting the professionals involved in this will do what they can do" (Los Angeles Times 1988).

The Television Networks

Like the New York Times, and perhaps following the example set by the Times, the three television networks continued to suggest that tires were being allowed to bum in Yellowstone long after that policy had been abandoned. The last such story on ABC was broadcast on August 25. NBC implied on September 6 that fires were still being allowed to burn, and CBS did so on September 7. The biggest difference in how the three networks framed the story was the differing ways in which they selected interviews with local residents and tourists. CBS and NBC focused on tourists and residents who were critics of Yellowstone's fire management policy, but ABC did not carry a single critical comment on park policy by a local resident or tourist.

NBC and CBS lent credibility to the Bambi myth of animals fleeing from the fires; ABC did not. CBS, for example, implied large-scale fire-induced migration in a September 7 story that said some Yellowstone animals had been spotted 50 miles from their normal range. NBC twice focused on pictures of animals that appeared either to bc fleeing the flames (September 8) or to be confused by the thick smoke (August 25). ABC specifically said that moose didn't seem to notice the tires (August 25), and showed elk calmly grazing at Mammoth Hot Springs on September 9 as evacuation loomed.

The Yellow&one-Area Newspapers

Of the three daily newspapers in the Yellowstone area, one (the Casper, WY Star Tribune) circulates primarily outside the direct economic influence of Yellowstone Park. The other two (the Billings, MT Gazette and the Bozeman, MT Daily Chronicle), circulate heavily within the area directly affected by the Yellowstone tourist trade. Perhaps for that reason, the Casper Star Tribune carried virtually no stories about the effects of the Yellowstone fires on area businesses, while the Gazette and Chronicle carried many such articles.

The Star Tribune framed the tires as more natural and less disruptive than either of the Montana newspapers, and carried several stories and a column about the ecological benefits of the fires. The Bozeman Daily Chronicle adopted a relatively calm tone in describing the fires, but virtually ignored the scientific perspective about fire's biological role. The Billings Gazette carried far more stories about the fires than either of the other papers, and published many thoughtful and well-reported articles, especially those reported by Robert Ekey. But the Gazette also published many letters containing sharp attacks against the National Park Service and against specific officials of Yellowstone National Park, and published an editorial cartoon that ridiculed Yellowstone superintendent Robert Barbee. An August 29 Gazette editorial said "This fiasco is riddled with questions, and it's not too late for Congress to demand to know why Barbee blindly rode a dead policy into hell." A September 11 editorial called for the tiring not only of Superintendent Barbee, but also of the Director of the National Park Service and the Secretary of the Interior.

Coverage of the Natural Burn Policy

Because virtually all of the controversy that made the Yellowstone fires newsworthy centered around the policy that initially allowed many lightning-ignited fires to bum monitored but unsuppressed, it would have been reasonable to expect detailed articles about that policy's origins. Although most news organizations paid lip service to explaining the policy by explaining the role of fire in "cleansing" or "renewing" the forest, I was unable to locate a single article on the news pages of any of the newspapers published in 1988, or a single story in any of the evening network newscasts broadcast in 1988, that specifically mentioned the Leopold Report (Leopold 1963) that formed the philosophical foundation for the prescribed natural-fire policy. The Leopold Report was mentioned only once in all of the stories, in a December 11 New York Times Magazine article by Peter Matthiessen.

DISCUSSION

The New York Times and two of the three television networks lent considerable credence to the interpretation of the Yellowstone fires favored by local merchants and their elected representatives (including senators Wallop and Simpson of Wyoming and Baucus of Montana). This interpretation suggested that the National Park Service handled the fires ineptly. This reinforces findings by Molotch and Lester (1974, 1975), who predicted that business interests and federal officials would have more power to define the context in which the news media interpreted the tires than would environmentalists, scientists, or Yellowstone officials. However, the Washington Post and ABC television news framed the fires more neutrally, and the Los Angeles Times interpreted them as natural and as a somewhat positive event.

Myths About the Fires

For the purposes of this paper, there are two kinds of myths that help us define and explain features of the external world about which we have insufficient or incorrect knowledge. The first sort of myth is usually based on inadequate or inaccurate information, such as the idea inspired by the Disney film Bambi that animals flee in terror from forest fires. The second form of myth rises out of our effort to understand events that contradict cultural assumptions. For example, often assumed is that modem technology can extinguish forest fires. If the fires in Yellowstone are still burning, the reasoning goes, there must be some kind of conspiracy to mislead the public about tire suppression efforts. This myth probably gained credibility because of the initial policy not to suppress some of the naturally ignited fires.

The news media helped foster several myths about the Yellowstone fires. The most widely disseminated myth was that many of the fires were allowed to bum unsuppressed throughout August and into September. The New York Times and the three television networks also helped spread the myth that the most newsworthy of the tires, which was apparently started by a woodcutter's cigarette, spread because of the park's natural-bum policy. The North Fork fire was fought with available resources from the day it started.

By quoting park critics and tourists who lamented the fire-induced changes in Yellowstone ('*it won't be the same for a hundred years"), many media accounts supported the idea that Yellowstone is a static rather than dynamic ecosystem, and that it could be managed like a city park in which burned trees can be replaced by planting new ones, and in which elk can escape mortality if only they are provided with enough supplemental food. To a large degree, reporters failed to understand (or at least to communicate) the dynamic forces that shaped the way Yellowstone looked before the 1988 tires.

Another myth, which has deep roots in the technological orientation of our culture, persisted despite minimal support from the media. This myth, that humans have the technology to control all wildfires, was regularly debunked by news accounts quoting firefighters and other officials who said only a change in the weather would put the fires out. This myth flourished in spite of the media.

The mythological way the media interpreted the fires is apparent in the fact that Old Faithful geyser was featured in about a quarter of all the stories in the elite press and on national television newscasts, despite the fact that only a small fraction of those stories dealt with the single day on which a fire actually made a run on the geyser. Other prominent Yellowstone features, such as Mammoth Hot Springs, Yellowstone Lake, and Yellowstone Falls, were seldom mentioned. A person not familiar with the park could easily have gotten the impression that Old Faithful Geyser was the only real attraction in the park, and that virtually all of the Yetlowstone firefighting efforts in 1988 were part of a massive effort to save the geyser from destruction.

News as a Curriculum

Media scholar James W. Carey (1986) believes it is "unforgivably self-righteous" to criticize daily news accounts because they often fail to put news events into a perspective that explains how they happened and what they mean. He says news is a curriculum, and that it is unfair to expect the initial reports of any event to provide complete information about what happened. Considering the short deadlines under which daily journalists must operate, this perspective has some merit. But it does not explain why some interpretations of events are more likely than others, and does not explain why a major newspaper like the New York Times consistently failed to report that all Yellowstone fire were being fought.

All of the media organizations studied here published or broadcast thoughtful reports and analyses of the Yellowstone fires after they were brought under control in 1988, and all of the organizations continued to follow the story in 1989. Although these analyses were less prominently displayed than the initial dramatic stories about the tire's various runs, the persistent media consumer was eventually able to get a balanced picture of the fires, especially if she or he supplemented ordinary news sources with specialized magazines such as Audubon and Smithsonian. Media consumers without that kind of dedication, however, were likely to be misled by the high visibility of the stories that characterized the initial coverage. The panels of experts who evaluated all of the 1988 evening television stories about the Yellowstone fires rated the stories during the peak coverage period, when the fires got top-of-the-show coverage, as significantly less accurate than the stories that appeared earlier or later (two-tail t-test, $p<0.001$).

The lesson here is that the initial news coverage of any unanticipated natural event, such as the 1988 Yellowstone fires, is likely to contain many flaws. It may be unrealistic and even uncharitable to expect journalists to do a better job, but as long as the public has confidence in the news media, these shortcomings will continue to mislead newspaper readers and television viewers. These misinformed media consumers may support land-management decisions that are based on interpretations of events provided by special interests rather than on scientific research or long-term management goals.

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THE EVOLUTION OF NATIONAL PARK SERVICE FIRE POLICY

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Abstract—National Park Service policies concerning fire have changed over the years from no policy at all in the early years, through years of absolute fire suppression, to a period of experimentation and refinement with a full spectrum of integrated fire management strategies. During much of this time, the Service was influenced by other agencies and organizations but is now emerging as a leader in the fire community.

Fire policies in the National Parks have evolved from no management at all, through the full suppression of all fires, to the sophisticated application of scientifically based fire management strategies. When Yosemite was set aside as a State reserve in 1864 and Yellowstone as a national Park in 1872, there were no efforts to control fires. An era of full fire suppression began when management of Yellowstone passed to the U.S. Army in 1886 and to the National Park Service in 19 16. Experimental prescribed burning was first conducted in Everglades National Park in 19.51. The Leopold Report (1963) influenced the Park Service to reevaluate its fire policies. Revisions to the policies completed in 1968 permitted the use of fire as a management tool and led to the creation of the first wilderness fire management Program, in Sequoia and Kings Canyon National Parks. To data, more than 2,000 lightning fires have been allowed to burn under carefully monitored conditions in 46 Parks, and more than 1,000 prescribed burns have been set in 58 parks to meet management objectives. The Yellowstone fires in 1988 led to an examination of Service fire policy which affirmed current policy but recommended refinements in implementation.

THE ERA OF FIRE SUPPRESSION

In 1863, President Lincoln set aside Yosemite Valley and the Mariposa Grove of sequoias as a State reserve. This was the first federal government action specifically designating an area for preservation and is considered by many to mark the beginning of the national Park idea. Although the native Americans who occupied the Yosemite region had at least 4,000 years (Riley 1987) used fire for many cultural purposes, it is doubtful that they practiced any fire suppression. Early Euro-American settlers in the Yosemite region used fire to clear land and to improve grazing for sheep and cattle. Their only fire suppression efforts were directed toward protecting structures. The State reserve employed only one guardian, who had little time to fight fires.

Yellowstone and Yosemite were designated as national Parks in 1872 and 1890.However, no agency was assigned responsibility for their administration and their new status did not result in the implementation of fire management. Although there no fire management policies or activities during these early years, the stage was set for the beginnings of fire suppression.

The Army Years

The United States Army was assigned the responsibility for managing Yellowstone in 1886 and Yosemite and Sequoia in 1891. The Policy of suppressing all fires began in Yellowstone in 1886 (Agee 1974) and was soon followed by similar policies in the other two parks. The Army built extensive trail systems to facilitate patrolling the new parks for sheep and timber trespass and for wildfires. As new parks were established, the Army assumed control and dispatched the troops to extinguish all fires. Although there are few records of the Army's efforts, fire scars were formed less frequently during this period (Kilgore and Taylor 1979). This could be interpreted to mean either that there were very few fires or that the Army was very successful in extinguishing those that did occur.

The Years of Forest Service Influence

When the National Park Service was established in the U. S. Department of the Interior in 1916, administration of the Parks passed into civilian hands. Many of the personnel who had previously served in the Army switched uniforms and became the first park rangers. Although they carried with them the lessons and experience of fire suppression, they had little formal training. Professional guidance of the fire program came from the Forest Service in the U. S. Department of Agriculture (Pyne 1982). Established as a separate agency in 1901, the Forest Service had developed both a theoretical basis for systematic fire protection and considerable expertise in executing that theory. The suppression of all fires became the official policy of the new National Park Service.

Since many of the Parks established during this period were originally parts of national forests, the Park Service inherited an infrastructure of fire control facilities and equipment. Fire stations, lookouts, and trails were already in place. In addition, many of the new Park rangers came from the Forest Service and had forestry and fire backgrounds (Pyne 1982). The Forest Service and the Park Service joined together to form the Forest Protection Board, which advised agencies on fire policy and standards.

Although the Park Service developed a separate fire control organization, it relied heavily on the Forest Service for expertise, personnel, and equipment. Mutual-aid agreements allowed the two agencies to respond to fires across boundaries

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and to share training and dispatching facilities. In most cases, however, the exchange was in the direction of the fledgling Park Service.

The CCC Yea-s

Professional fire protection began in the Park Service with the establishment of the Civilian Conservation Corps in 1933. A massive influx of personnel made it possible to expand firefighting facilities and deploy suppression forces throughout the parks. During the first 10 years, the program went from a single national fire officer, a special crew at Glacier National Park, and a fire guard at Sequoia to an organization of some 6.50 camps with over 7,000 employees (Pyne 1982).

The Park Service's fire policy was still identical with that of the Forest Service, which in 1935 adopted a policy of extinguishing any fire during the first burning period or, if that were not possible, by 10:00 a. m. the following day. Strict adherence to this policy required quick response time and numerous crews. Efforts were also directed toward developing better access to further reduce response times.

During this period, the Park Service greatly professionalized its approach to fire protection. Vegetation and fuel hazard maps were prepared from field surveys and response zones were delineated. Complete fire records were kept; each tire's cause and behavior were described, and the measures necessary to control each fire were detailed. These records did describe occasional large fires that might have exceeded the capabilities of the suppression forces.

The War and Postwar Years

World War II caused a decline in fire protection throughout the nation. Skeleton crews were kept on **to** protect resources necessary for the war effort. Park Service: crews were practically nonexistent, although the fire records show that fires were still being suppressed successfully.

Demobilization after the war brought a new and different kind of influx to the fire lighting agencies. Although the Forest Service had used bulldozers and smokejumpers before the war, airplanes, helicopters, tanks, and parachutes were products that the war had refined that were now available to fight the war against fire. Retardant drops, heliattack crews, bulldozers, and smokejumpers became the new tools of choice (USDA Forest Service 1960). The Park Service relied heavily on the Forest Service for this new technology, and shared support of aircraft and a smokejumper base at Yellowstone (Pyne 1982). The resulting fire-fighting force was very effective in continuing the policy of full fire suppression.

THE ERA OF FIRB MANAGEMENT

The effectiveness of fire protection was partly responsible for the beginnings of a shift in policy from fire control to lire management. As had long been recognized in the South, the absence of fire from an ecosystem that has evolved with fire can lead to unexpected, and often undesirable, results. Specifically, researchers found that periodic fires reduced accumulations of woody and brushy fuels and thinned thick understories of shade-tolerant species. Without tire, species composition shifted and fuel accumulations increased.

The Years of Revelation

Although the National Park Service's first experiments with the use of fire occurred in Everglades National Park in 1951 (Robertson 1962), impetus for a change in policy came later from outside researchers in California. As early as 1959, Dr. Harold H. Biswell, of the University of California at Berkeley, advocated the use of prescribed fires to reduce the accumulation of debris underneath ponderosa pine stands in the Sierra Nevada of California (Biswell 1959). His work was expanded upon by Dr. Richard Hartesvelt, from San Jose State University, who concluded that the greatest threat to the giant sequoia groves was not trampling by humans, but was catastrophic fire burning through understory thickets and unnaturally high accumulations of (Hartesvelt 1962).

In 1962, the Secretary of the Interior asked a committee to look into wildlife management concerns in the national parks. This committee, named after its chair, Dr. A. Starker Leopold, did not **confine** its report to wildlife, but took a broader ecological view that parks should be managed as ecosystems (Leopold and others 1963). They recommended that the biotic associations within a park be maintained or recreated as nearly as possible in the condition that prevailed when first visited by Euro-Americans. The report stated in an often quoted passage:

> When the forty-niners poured over the Sierra Nevada into California, those that kept diaries spoke almost to a man of the wide-spaced columns of mature trees that grew on the lower western slope in gigantic magnificence. The ground was a grass parkland, in springtime carpeted with wildflowers. Deer and bears were abundant. Today much of the west slope is a dog-hair thicket of **young** pines, white fir, incense cedar, and mature brush a direct function of overprotection from natural ground fires. Within the four national parks - Lassen, Yosemite, Sequoia, and Kings Canyon the thickets are even more impenetrable than elsewhere. Not only is this accumulation of fuel dangerous to the giant sequoias and other mature trees but the animal life is meager, wildflowers are sparse, and to some at least the vegetation tangle is depressing, not uplifting. Is it possible that the primitive open forest could be restored, at least on **3** local **scale'? And if so, how?** (Leopold and others 1963)

It was not a coincidence that Dr. Leopold's office was just across the street from Dr. Biswell's office. In **fact, these** gentlemen often discussed the ecological ramifications of fire exclusion over lunch and during seminars. Nor is it surprising that their graduate students would pursue fire-related Ph.D. dissertation topics and become Park Service scientists (Kilgore 1968; van Wagtendonk 1972; Agee 1973; Graber 1981). The intellectual atmosphere at Berkeley invited students to challenge conventional approaches and practices.

The Turning Point

Only in 1968, after several false starts was the Leopold Committee report incorporated into policy. First the Secretary of the Interior had to find out whether or not the report's findings were acceptable to the public. A department underling was sent to the meeting where the report was being presented and found it to be overwhelmingly supported. The Park Service was then directed to incorporate the report into its management policies. The entire report was included as an appendix and the section on fire management revised to reflect the new thinking (USDI National Park Service 1968). For the first time since 1916, the Park Service viewed fire as a natural process rather than as a menace:

> The presence or absence of natural fire within a given habitat is recognized as one of the ecological factors contributing to the perpetuation of plants and animals to that habitat.
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> Fires in vegetation resulting from natural causes are recognized as natural phenomena and may be allowed to run their course when such burning can be contained within predetermined fire management units and when such burning will contribute to the accomplishment of approved vegetation and/or wildland management objectives.
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> Prescribed burning to achieve approved vegetation and/or wildland objectives may be employed as a substitute for natural fire (USDI National Park Service 1968).

The Years of Experimentation

As is often the case with the National Park Service, a policy change led to experimentation. A prescribed natural fire program was initiated in Sequoia and Kings Canyon National Parks in 1968 (Kilgore and Briggs 1972), as were concurrent research studies of prescribed burns (Kilgore 1971; Parsons 1976). At Yosemite National Park a similar prescribed natural fire program was started in 1972 (van Wagtendonk 1978), and research concentrated on refining techniyues for prescribed burning (van Wagtendonk 1974; van Wagtendonk and Botti 1983). Experimental burns were ignited in several parks, and Yellowstone and a few other parks established prescribed natural fire zones (Romme and Despain 1989).

The Years of Policy Refinement

As experience with both prescribed burning and prescribed natural fire programs increased, interim guidelines were issued. Research also continued to contribute to the growing body of knowledge on both fire ecology and fire use.

Contrary to Pyne's (1982) assertion, the National Park Service was a leader in the development of prescribed natural fire techniques. Although National Park Service personnel cooperated with Forest Service managers and researchers in the same field, they did not need to look to the Forest Service for leadership.

The first revision of the 1968 fire policy came out in 1978 when all management policies for the National Park Service were rewritten (USDI National Park Service 1978). The policy stated:

> Fire is a powerful phenomenon with the potential to drastically alter the vegetative cover of any park.
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> The presence or absence of natural fires within a given ecosystem is recognized as a potent factor stimulating, retarding or eliminating various components of the ecosystem. Most natural fires are lightning-caused and are recognized as natural phenomena which must be permitted to continue to influence the ecosystem if truly natural systems are to be perpetuated.
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> Management fires, including both prescribed natural fires and prescribed burns, are those which contribute to the attainment of the management objectives of the park through execution of predetermined prescriptions defined in detail in the Fire Management Plan, a portion of the approved Natural Resources Management Plan.
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> All fires not classed as management fires are "wildfires" and will be suppressed. (USDI National Park Service 1978)

The policy further described the conditions under which fire could be used and specified that any management fire would be suppressed if it posed a threat to human life, cultural resources, physical facilities, or threatened or endangered species or if it threatened to escape from predetermined zones, or to exceed the prescription.

The Forest Service was also revising its fire policy to embrace fire management rather than fire control (DeBruin 1974). In 1978 it abandoned the 10:00 a. m. policy in favor of a new one that encouraged the use of fire by prescription. The Forest Service's policy was also preceded by experimentation and research.

Thus, after a period of 10 years, policies of both the National Park Service and the Forest Service recognized the ecological role of fire and provided for its use. Pyne (1982) states, "Guided by the dazzling philosophy of the Leopold Report, the Park Service had advanced a policy too far ahead of its knowledge and technical skills; the Forest Service, with expertise and information in abundance, lagged in policy." While not entirely correct, his statement does point out the distinctive and synergistic roles the two agencies play.

In 1986, the Wildland Fire Management Guideline (NPS-18) was issued. It outlined in detail the procedures and standards to be used to manage wildfires, prescribed natural fires, and prescribed burns (USDI National Park Service 1986). With regard to prescribed natural fires, the new guideline specified that the condition limits under which naturally ignited fires would be permitted to burn must be clearly stated. In addition, the ultimate size and boundaries of the fires must be preplanned and stated. Parks were also required to monitor each fire and to assess each burning day whether or not the fire should be allowed to continue to burn unimpeded.

Although there were no apparent problems with the Park Service's fire policies, they were revised again in March of 1988 as part of a 10-year comprehensive review of the management policies (USDI National Park Service 1988). The new policy emphasizes management objectives and plans:

> Fire is a powerful phenomenon with the potential to drastically alter the vegetative cover of any park. Fire may contribute to or hinder the achievement of park objectives. Park fire management programs will be designed around resource management objectives and the various management zones of the park. Fire-related management objectives will be clearly stated in a fire management plan, which is prepared for each park with vegetation capable of burning, to guide a fire management program that is responsive to park needs.
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> All fires in parks are classified as either prescribed fires or wildfires. Prescribed fires include fires deliberately set by managers (prescribed burns) or fires of natural origins permitted to burn under prescribed conditions (prescribed natural fires) to achieve predetermined resource management objectives. To ensure that these objectives are met, each prescribed fire will be conducted according to a written prescription. All fires that do not meet the criteria for prescribed fires are wildfires and will be suppressed. (USDI National Park Service 1988)

THE POST-YELLOWSTONE ERA

The fires of the Greater Yellowstone Area during the summer of 1988 brought fire policies of the National Park Service and the Forest Service under close scrutiny. The Secretary of Agriculture and the Secretary of the Interior appointed an interagency fire management policy review team to investigate the adequacy of national policies and their application for fire management actions in national parks and wilderness and to recommend actions to address the problems experienced during the 1988 fire season. With regard to policy, the review team recommended that:

> Prescribed fire policies be reaffirmed and strengthened.
>
> Fire management plans be reviewed to assure that current policy requirements are met and expanded to include interagency planning, stronger prescriptions, and additional decision criteria. (USDA and USDI 1989)

A moratorium was placed on all prescribed natural fire programs until the agencies had complied with the recommendations of the review team. Although the National Park Service policies were determined to be adequate, implementation guidelines and fire management plans were found to be in need of revision.

A task force was convened to rewrite NPS-18, the fire management guideline. The guideline was completely rewritten and addressed all of the operational recommendations of the review team report (USDI National Park Service 1990). Specifically, it requires approved fire management plans, established contingency plans, quantified prescriptions, monitoring procedures, fire situation analyses, and daily certification by the line manager that resources are available to manage the fire within the prescription. In addition, the prescription must include at least one indicator of drought and at least one definition of the maximum prescribed extent of the fire.

All the existing fire management plans were reviewed by teams of fire specialists from throughout the Park Service for compliance with the review team report and for adequacy of environmental documentation and public participation. Plans were sent back to the parks for revision. To date, three fire management plans have been approved. Prescribed natural fire programs will be in effect in 1990 for Yosemite, Voyagers, and Sequoia and Kings Canyon National Parks.

National Park Service fire policies have evolved in a pattern of leaps forward followed by experimentation and refinement. The decentralized nature of the agency allows it to take advantage of new philosophical ideas and translate them into policy. The experience and expertise within the Service assures that it will continue to play that role.

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