FOREST FIRE PRIMEVAL

COURTESY OF JOHN DIETERICH

Fire is increasingly accepted as a worthy partner in the battle to preserve our wilderness and park lands.

THOMAS W. SWETNAM

On a warm June day in an Arizona pine forest, everything looks flammable. Even the pine-scented air smells like it could burn. On such a June day in the year 1900, a forester from Yale University rode horseback through the parklike stands of ponderosa pine along the Mogollon Rim of central Arizona. Gifford Pinchot, the chief of a new conservation agency—the Division of Forestry, later renamed the United States Forest Service—must have felt that he was as far from his accustomed realm of eastern hardwood forests as he could possibly be. Pinchot rode his horse to the edge of a bluff where he could look out over the spreading canopy of the largest continuous ponderosa pine forest in North America. Years later, in his book *Breaking New Ground,* he recalled that moment: "We looked down and across the forest to the plain. And as we looked there rose a line of smokes. An Apache was getting ready to hunt deer. And he was setting the woods on fire because a hunter has a better chance under cover of

Above: In some forested areas, "prescribed" fires are started by managers to reduce brush and deadwood accumulations that under other conditions may fuel a catastrophic fire that could destroy the entire forest.

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smoke. It was primeval but not according to the rules."

Pinchot was convinced that forest fires, whether started by people or lightning, were "not according to the rules" and must be extinguished with all the effort that could be mustered. That conviction became nothing short of a mission to the young agency that he built. While this mission has endured to the present, it has changed considerably in recent years. The direction of Forest Service fire policy, as well as that of other U.S. governmental organizations charged with public land management, has shifted toward greater acceptance of fire as a necessary natural component in wilderness and parklands, and even as a forestry tool to be used on other managed lands. This change has been forced by an accumulated weight of historical and ecological evidence regarding the role and pervasive influence of fire in the natural maintenance of forests. While policies have indeed changed, they have changed slowly, perhaps because of the momentum of bureaucracies and careers built upon different perspectives.

The long adherence of U.S. forestry organizations to a policy of all-out fire suppression was due to a combination of dedication to the protection of tremendously valuable forest resources and the self-preservation instincts of the agency that essentially had a blank check to draw upon for carrying out its fire-fighting mission. Fire fighting is also one of the most glamorous aspects of the forestry and park management professions. Fighting forest fires, at least in the mind of fire fighters, is the moral equivalent of war. Large numbers of men (and increasing numbers of women) combine efforts in an emergency struggle against a hostile force, and while there is significant danger, death is uncommon. On large "project fires," battle lines are drawn and forces are arrayed over the landscape with reinforcements on alert. Air support from aerial retardant bombers, helicopters, and smokejumpers (paratroopers) are called in, and legendary "last stands" are made by crack fire-fighting crews. It is no wonder that many professionals cling to this exciting lifestyle and have only slowly, if at all, accepted the proposition that not all fire is bad.

But fire fighters now understand that a new dimension and challenge has been added to their jobs. They must still fight forest fires, but only in certain situations, while in others they may even set the fires themselves. The reasons for this transformation are both historical and ecological.

More than 60 percent of all forest fires in the western United States are started by lightning. Forest and park managers now allow some of these fires to run their natural course.

Ancient Evidence

Gifford Pinchot was probably right in saying that setting the woods ablaze was an ancient Apache practice, although he must also have recognized that lightning was an even older and more prevalent source of ignition. In fact, Pinchot observed firsthand the evidence of ubiquitous historical fire in Arizona pine forests. On his horseback trip he saw many fire-scarred ponderosa pine, which remain to this day as witnesses to the waves of flame. One such tree, he noticed, had the characteristic rippled surface that indicates a record of repeated fires. The earliest recorded fire had originally burned through the thick, resistant bark, and subsequent fires reignited

on the pitchy wound. Each fire left its mark, but the tree survived. Pinchot cut into the edge of the burned area with a hatchet to count the tree rings formed during the interval between each fire-caused injury. In his notes he recorded the intervals in years from the most recent fire to the earliest. In all, Pinchot counted 14 fires, the most recent in 1898 and the earliest in approximately 1785.

Fire scars on old trees have been one of the most convincing forms of evidence that many forest types are not only resistant to fire, but that their structure and composition are also dependent on repeated burning. Fire histories have been compiled for many forests by taking cross-section samples from numerous fire-scarred trees. Annual tree rings in these samples can be dated, and positions of the scars in relation to the rings reveal not only the dates of past fires but sometimes even the season when the fires occurred. The combined fire-scar record from a collection of trees within a forest can provide a fairly complete history of fire occurrence in both time and space. From these histories, scientists can reconstruct the "fire regime," characterized by frequency, extent, and patterns of burning during the past two or more centuries.

Fire scars from pine forests, like those noted by Pinchot, are generally good records of "surface fires" that burned over the forest floor and around the trunks of mature trees. A common theme observed from the study of western pine forest fires is a repeated but irregular pattern of surface fires before approximately 1900, followed by a nearly total cessation of the episodic burning.

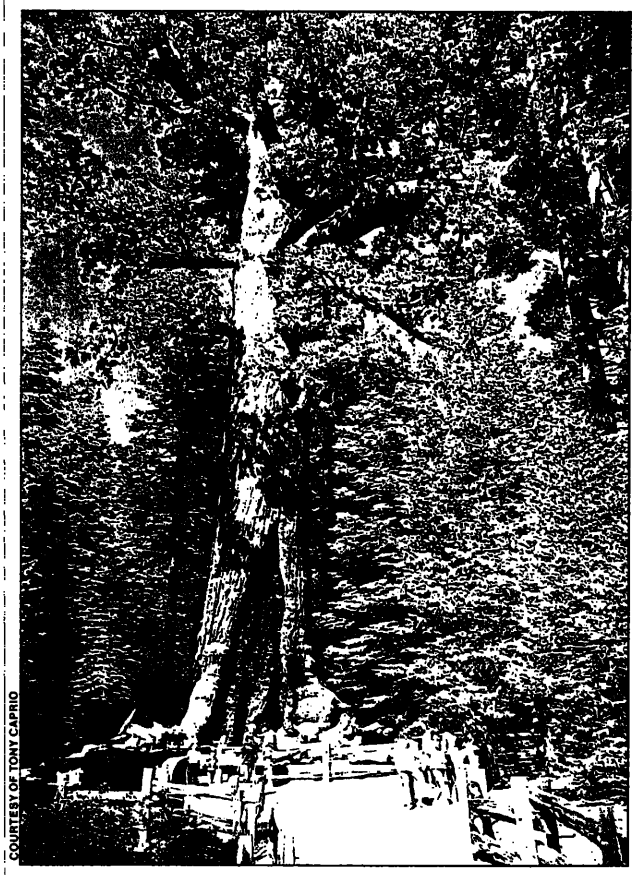
The end of the "natural" fire regime around the turn of the century has been dubbed the "Smokey Bear Effect" by fire historians. This is because fire suppression efforts by the Forest Service and other land managers began in the western United States just after the turn of the century. However, the effectiveness of fire-fighting efforts, especially in the early days, may be overrated as the reason for the observed end of episodic surface fires in most pine forests. It is quite likely that sheep and cattle grazing played an important role as well. The late nineteenth century and the early decades of this century saw tremendous herds of sheep and cattle entering mountain areas of the West. Feeding by these animals on grasses—an important carrier of fire in the open pine forests—was the beginning of the end of a centuries-long pattern of fire. The importance of grazing animals in reducing fire occurrence is revealed by a recent study of the Chuska Mountain region of northeastern Arizona. This area was used as early as the 1830s by the Navajo Indians for sheep herding, and the fire-scar records show a precipitous drop in fire occurrence at this time.

Ecologists and land managers have thus learned that fire has always been present in forests and that fire is not in all cases a strictly destructive force. For example, most virgin ponderosa pine forests of the western United States are dominated by 300- to 400-year-old trees that germinated and grew throughout most of their lives in a fire regime characterized by low-intensity surface fires that swept through the understory. Ring analysis indicates that these fires occurred about every five to ten years, and some areas burned as often as every other year. These surface fires consumed dead branches, stems, and needles on the ground, while fire also thinned young stands of seedlings in openings left by dead trees. Thus, fire kept the forest open and "parklike," as described by early travelers through the area.

Although Pinchot knew about these fires, his concept was that fire had no place in a "managed forest." The conventional wisdom at the time was that surface fires kept pine forests "understocked," and without fire more trees could be harvested. In addition, surviving trees were often scarred like the one he observed in Arizona; this kind of injury allowed decay fungus to enter the stem, thus reducing the quantity and quality of harvestable wood. Perhaps Pinchot also underestimated the frequency of lightning-ignited fires in western forests and ascribed most evidence of past fires, and the presumed understocking of forests, to burning by Indians. However, records for the western United States show that more than 60 percent of all fires are started by lightning. In some national forests, particularly in the southwestern United States, more than 90 percent of all fires are started by lightning. For other regions, however, the figures are very different. For example, less than 5 percent of fires are started by lightning in the southeastern United States, while the remaining 95 percent are started by careless or malicious humans.

Another important reason that forest fires in any form could not be accepted was the harsh reality of massively destructive fires, called crown fires, that consume mature trees entirely. Hundreds of thou-

sands of acres of trees—as well as a number of towns —went up in smoke in a series of deadly forest fires during the three decades around the turn of the century. Indeed, catastrophic fires still occur almost yearly somewhere in North America, as well as in other temperate forest areas of the world. But ecologists now understand that different forest types have historically had different fire regimes. In the absence of human interference, stand-replacing fires are necessarily very infrequent events in most forests, occurring only once per several centuries. In cases where they have occurred, forests may have grown and developed for centuries and never have had episodic surface fires. Examples are spruce-fir forests that occur at higher elevations in most of the United States and throughout much of Canada. It should also be noted that many of the conflagrations that occurred around the turn of the century in lower elevation forests were started by settlers clearing land or by sparks from railroads that cut through recently logged areas with tons of accumulated woody slash.



COURTESY OF TONY CAPRIO

Grizzly Giant in Mariposa Grove, Yosemite National Park, California. Nearly all mature giant sequoia have ancient fire scars on their trunks, attesting to their many encounters with fire.

Why Burn?

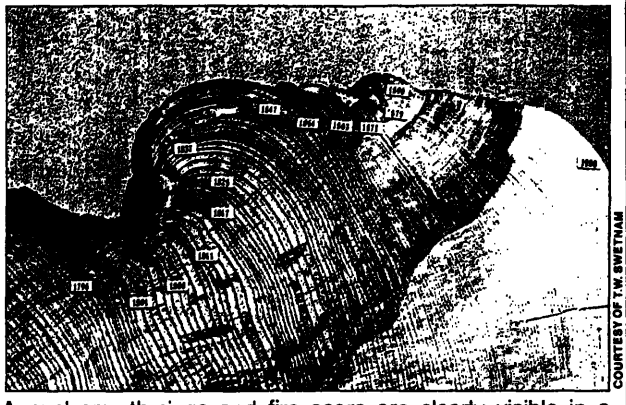
In addition to an increasing body of historic evidence of the long-term presence of fire in forests, ecologists continue to identify special adaptations, and even physiological and ecological requirements, of plants for fire. For example, pine trees often have a thick bark that insulates the stem from the intense heat of fire. During heating, moreover, small resin bubbles within the bark heat up and "pop" small pieces of smoldering bark away from the trunk. This is an effective mechanism for reducing heat buildup. Forest scientists also generally accept that fire plays a major role in the recycling of nutrients back into the soil. Without the fire process, many important nutrients would be locked up in the biomass of large, woody tree stems, which decay relatively slowly in many temperate forests.

Perhaps the evidence of benign and beneficial fire would never have been enough to convince foresters and park managers that some fires should be allowed to burn (much less be set by managers). Two major concerns, however, have pushed land management agencies in this direction. The first was the public movement toward the legal protection and preservation of wilderness, leading to passage of the Wilderness Act in 1964. The act went beyond the establishment of boundary lines on maps; it also encompassed the ideal of preserving both living and nonliving forces that produce the essential character of wilderness. Scientists and forest managers began to recognize that suppression of one of the most prevalent natural forces—fire—has resulted in significant changes in forest structure and composition in many areas. Generally, during the last 80 to 100 years there has been an increase in the number of trees, an increase in the amount of woody fuels on the forest floor, a decrease in the extent of aspen stands (which often regenerate after fire), and an increase in tree species that are more tolerant of shaded conditions in closed-canopy forests. The essential question for wilderness and park managers became: Are these changes acceptable in areas that

are supposed to be kept in a condition of "primeval character" and "untrammeled by man" as mandated by the Wilderness Act?

Another concern, which is still generally underappreciated by both the public and many forest managers, is the increasing hazard of catastrophic fire. Intensive historical study has failed to document any cases where stand-replacing crown fires occurred in the ponderosa pine forests of the southwestern United States before 1900. In contrast, there have been numerous fires exceeding 5,000 acres in size since the early 1950s that have totally razed forests down to mineral soil. The unusual intensity of these fires is attributed to woody fuel accumulations on the forest floor and dense stands of trees that have become established since 1900, which provide a ladder for fire to enter the crowns of larger trees.

Fire records kept by the U.S. Forest Service also suggest an increasing fire hazard, with forest fires reported in the southwestern United States generally on the rise. But this is largely explained by improvements in fire detection and surveillance capabilities. As more lookout towers were built and aerial reconnaissance of forest lands during the fire season became commonplace, more fires were reported. Most fires were very small; quite often only a single tree was burning. However, for at least one national forest—the Gila in southwestern New Mexico—there has also been an increase in the number of large fires (over 10 acres). This increase cannot be explained by improved detection, because fires of this size would surely have been noticed by the early forest rangers. While it is possible that climatic change could also be an explanation for the increased numbers of large fires, forest changes brought about by more than 70 years of fire suppression are, ironically, the most likely cause of an increasing incidence of large conflagrations.


COURTESY OF T.W. SWETNAM

Annual growth rings and fire scars are clearly visible in a cross-sectional view of a fire-scarred tree trunk. The dates of fires are determined by analyzing the rings and observing the position of lesions within rings caused by heating and killing of tissue during the fires.


COURTESY OF TONY CAPRIO

These giant sequoia seedlings germinated on a forest floor that had recently been burned by a surface fire set by park managers. Sequoia seed-bearing cones may remain in the treetops for more than a decade after maturity, but the heat from fire typically opens many of them at once, showering a recently burned area with seeds.

Fire as a Process

From the great fires of the late nineteenth century to the burning of Bambi's forest in the classic Walt Disney film, the indelible image of forest fire as catastrophe has been imprinted on the public mind. It is therefore not surprising that the initial reaction of many visitors to national forests and parks is shocked indignation when told that the column of smoke rising in the distance is from a fire set by government fire fighters! But when a brief explanation is provided—"This is a 'prescribed fire' of low-intensity that is burning on the surface through the understory of the forest; it is removing dangerous fuels that have built up over the years; most trees are not harmed; wildlife habitat is being restored and improved; fire is a natural component of the forest that maintains its wilderness characteristics . . ."—then acceptance and support of this new policy is usually rapid.

Although many land managers are dedicated to reintroducing fire as a forestry tool for objectives such as reducing fire hazard and improving wildlife habitat, there are, unfortunately, many practical limitations to this endeavor. These include the annoyance of smoke interfering with scenic enjoyment of parks, the pollution of nearby urban centers, and the always present hazard that a fire will "escape" and rage out of control.

A major task faced by managers and scientists is reeducation of the public. Smokey the Bear (not to mention Bambi) has done a terrific job convincing people that any forest fire is a terrible thing. The new message is that fires set by careless humans are still very destructive, but fires can be beneficial when set or allowed to burn by fire ecologists and fire managers who have made it their business to know where, when, and how they should burn. There is still very much for ecologists, managers, and the public to learn about fire and forests.

Fire in the Big Trees

The problems faced by managers in reintroducing fire to highly valued ecosystems is illustrated by the situation in Yosemite, Sequoia, and Kings Canyon National Parks on the western slopes of the Sierra Nevadas in California. These parks contain the largest remaining groves of the magnificent giant sequoia. Many ecological studies have demonstrated that fire is an integral part of the sequoia life cycle. For example, giant sequoia seedlings tend to germinate most successfully in areas that have had relatively intense surface fires. However, one public group strongly objected to prescribed burning by park managers because of a perceived decrease in the aesthetic appeal of recently burned groves. Prescribed burning within the groves sometimes eliminates the young firs and pines that have grown up beneath sequoia trees since fire suppression began 80 to 100 years ago. Of even greater concern to visitors is the charring that is visible on the trunks of some mature giant sequoias following prescribed burning. On close examination this charring is observed to be less than one inch thick on a total bark thickness that often exceeds one foot! Giant sequoias are obviously well adapted to withstanding surface fires.

In response to this public concern, the Park Service suspended prescribed burning activities and convened an independent review panel of leading fire and forest ecologists from throughout the United States. The panel considered available scientific evidence of fire's role in sequoia ecosystems, as well as the philosophy and actual implementation of fire management programs within the parks. They recommended that prescribed burning be continued. They emphasized that reintroduction of fire in sequoia groves should be based on the guiding principle that managers should allow natural processes to operate, and should reintroduce these processes where necessary. Moreover, the panel pointed out that, from a long-term perspective, change itself is the only constant feature of plant communities. Forest ecosystems change in response to environmental variations (such as climate) that humans have no control over. Furthermore, we cannot practically hope to arrest natural changes or the processes that cause them without upsetting the natural balance that has produced the very ecosystems we want to protect.

Park managers are now allowing lightning-ignited fires to burn in some areas of the parks, and in other areas they may set fires where greater control is needed to remove heavy fuel accumulations or to ensure visitor safety. Restoration of natural processes is not a simple matter, however, and much remains to be learned. Continued research on the history and effects of fire in giant sequoia forests will help to refine fire management programs.

Recent tree-ring studies of fire-scarred specimens from giant sequoia stumps and logs reveal that fire was no stranger to these groves. Some trees have recorded more than 50 fires over their 1,500-year lives. The earliest dated fire scar observed so far was caused by a surface fire in the year 931 B.C. It seems very likely that the oldest living sequoia grove, with many trees exceeding 2,000 years in age, has experienced more than 100 surface fires.

Obviously, the effort to totally eliminate fire from many forest ecosystems is a "rule" made by humans. The challenge for ecologists and park managers who wish to preserve the giant sequoia as a species is to discover and follow the rules that sequoias have lived by for millennia. On observing a prescribed fire today, the forest-management heirs of Gifford Pinchot can confidently state: "It is primeval *and* according to the rules."■

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A "prescribed" fire started by forest managers burns in Oregon. Burning accumulated underbrush reduces the chance for a major fire that would destroy the whole forest (p. 236).