LESSONS FROM THE FLAMES

First in a two-part series

By RICHARD MONASTERSKY

Scientists ponder how 1988 burned a hole in their theories about forest fires in Yellowstone

Peaco/National Park Service

Driven by strong gusts of wind, a fiery wave flows across the night sky, engulfing sagebrush and grass on the Blacktail Plateau. Park Service photographer James Peaco says this late September ground fire was so fluid it seemed like a lava flow and was one of the most spectacular sights he saw this summer in the park.

Through August and into September, casualty reports from Yellowstone National Park covered front pages and television screens, resembling accounts of some particularly gruesome overseas war. Each day the line of flames marched forward, propelled at times by 70-mile-an-hour winds and always by the uncompromising drought. The United States watched in horror as its oldest and arguably most beloved national park burned.

Conflagrations erupted all across the rain-starved West last summer, but Yellowstone's flames burned brightest in the media, in part because of the monumental war waged against the uncontrollable infernos. In total, the federal government spent more than $115 million attempting to combat fire in the Yellowstone area this summer — making this by far the most expensive fire-fighting effort in history.

Statistics for forest fires in the park strain our sense of scale. More than 72,000 forest fires have broken out in the entire United States so far in 1988, their perimeters enclosing a total of more than 5 million acres, according to estimates by the Boise Interagency Fire Center. The greater Yellowstone ecosystem, which includes the park and seven surrounding national forests, accounts for over a quarter of that countrywide acreage.

Scientists have known for decades that large fires are natural to Yellowstone; this great plateau in northwest Wyoming has a history of burning hundred-thousand-acre chunks of forest at intervals measured in centuries. But while experts knew such massive fires could sweep the area, they didn't expect extensive flames this year or anytime soon. Theories based on past fire behavior told park managers that large portions of the forest would not support a ravaging fire for years to come.

Obviously, something went wrong.

Critics of the Park Service blame park managers and particularly Yellowstone's 16-year-old fire management plan. Misleadingly dubbed the "let burn" policy, it allows natural fires to burn so long as managers remain confident the flames will not threaten people, property, special sites or endangered wildlife.

Facing off against their critics, Park Service scientists contend that human policy is not to blame for the size of Yellowstone's burns. They argue that a wild card popped up this year that made large fires practically inevitable.

"We had a type of weather that we hadn't seen before," says Donald G. Despain, a research biologist at Yellowstone. "I know that weather has an extremely important role to play and I've always known that. It's just that we had a weather situation so rare that we didn't expect it."

Although the fires dwindled in late September, small hotspots continued to act up sporadically though mid-October, clouding the air and confounding the efforts of those trying to assess the full scale of the burns. As November rains and snow dampen the last embers, fire researchers are discussing what they learned about Yellowstone's amazing ability to burn.

In September, news reports stated that fire had destroyed 1.6 million acres in the Yellowstone area, more than 1.1 million acres inside the park alone. According to the most exaggerated accounts, flames had left half of Yellowstone a smoldering field of embers. Park officials have labored to deflate the hyperbole, and by now many people realize these numbers represent the maximum area enclosed within fire perimeters. Much of the land inside this area did not burn or burned only lightly.

From aerial photographs, park officials estimate about 440,000 acres or 20 percent of the park land actually burned in some degree. Approximately half this area suffered canopy fires that sweep through the top of the forest, killing almost all the trees in a stand.

Viewed from a helicopter, the forest takes on a peculiar pattern, called a mosaic by ecologists. Charred stands and living ones are woven together in alternating patches of black and green that reveal how flames often charged through an area, leaving much forest untouched. "It's sort of like a blanket with holes burned in it," Despain says.

Fires from past centuries have also left a mosaic legacy, and this hopscotch pattern of vegetation lends diversity to the forest. Most of the greater Yellowstone ecosystem, including some three-quarters of the park itself, sits on a plateau with elevations ranging from about 7,000 to 9,000 feet.

Given the height and the semiarid climate, the plateau supports several kinds of subalpine forests, including white pine, Englemann spruce, firs and, more than any other, the lodgepole pine. Owing its name to a ramrod posture that makes it ideal for tepees and telephone poles, the lodgepole accounts for 77 percent of the forests in the park.

Visitors to Yellowstone, especially those who have climbed peaks in other parts of the Rockies, quickly notice the gentle terrain of the plateau. Rolling hills spread across the park's central and southern reaches with few craggy peaks or steep valleys to break the flow. Lacking dramatic changes in topography, the plateau has relatively uniform moisture and temperature conditions. For this reason, forests across most of the plateau would develop into a nearly homogeneous spread of old lodgepole pines or spruce-fir forests if left untouched for several hundred years.

Wildfires arrest the growth toward uniformity and add texture to the plateau by opening areas in the forest to be filled with grasses and then with young trees. The jigsaw-puzzle pattern of young, middle-aged and old forests creates a wide range of habitats side-by-side that can support many different communities of wildlife. In fact, fire actually increases biological diversity on the plateau, says William H. Romme, a biologist at Fort Lewis College in Durango, Colo.

Aside from adding habitat diversity to the forests, the vegetation mosaic plays a substantial role in controlling fire in Yellowstone—at least in theory.

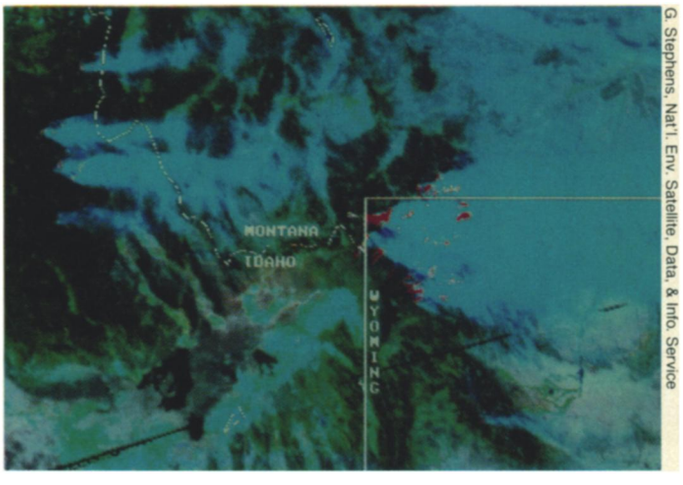
Over the past few years Romme and Despain analyzed the fire history of a large study area that forms 15 percent of the park. By measuring the modern mosaic and analyzing tree rings, they have been able to chart the spread of fires in the area since the late 1500s. Romme and Despain found that most patches of forest tend to go 200 to 400 years between large fires, an interval that seems to depend on the way a forest grows back after burning.

The growth cycle goes roughly like this: After an intense fire burns through an area, killing most of the trees, light-loving lodgepole pines spring up. In a few decades, the upper branches of these saplings intertwine to create a closed canopy that shades the ground and hinders the growth of grasses, shrubs and other trees that need light. When the canopy closes, lodgepoles prune themselves of their lower limbs, forming clean-shaven trunks that rise from the ground straight to the needle-laden branches in the canopy.

As the forest matures, shade-tolerant spruces and firs start to grow, and an understory sprouts beneath the lodgepole canopy. This canopy does not start to open until some 150 to 200 years after the last fire, when the original lodgepoles begin to die and drop to the floor as dead wood. In many forests, spruce and fir replace the lodgepole and form a new canopy; in others, a second generation of lodgepole renews the pine forest.

According to theory, only after the forest develops a solid understory layer—or ladder fuel—can it support the dangerous and uncontrollable crown fires, which sweep through the canopy, killing all trees. In the young forests, says Romme, "there is very little dead wood on the ground and there is a big gap between the secondary fuel and the fuel up in the canopy. The heat from a little, light fire on the ground cannot get up to ignite the canopy."

For the last 16 years, the period when managers have allowed some lightning ignitions to burn, fires have followed this theoretical code of behavior. In most cases, young forests served as natural fire breaks. If flames moved into one of these areas from a nearby old forest, the fire often slowed its advance and died among the young trees. When lightning struck inside young stands, it usually failed to spark a lasting blaze, Romme says. Past experience in Yellowstone's forests has also shown that fire generally travels great distances only if it reaches the crowns of trees—an unlikely possibility in a young stand.



In a Sept. 7 false-color image from the NOAA-9 satellite, the fires of Yellowstone show up clearly as red spots at the border between Montana, Wyoming and Idaho. Smaller fires are also visible in Idaho and southwest Wyoming. Air currents carry the blue and white plumes of smoke eastward.

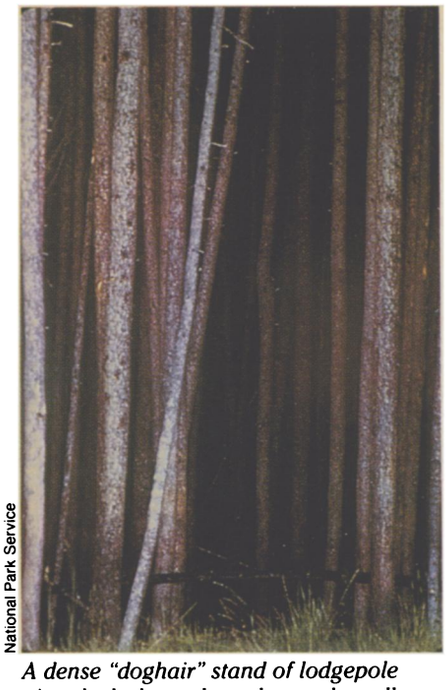
This summer, however, the fires of Yellowstone illuminated a major flaw in these theories. Scientists learned they had overestimated the power of the mosaic and underestimated the power of weather.

"In the paper I wrote in 1982 in Ecological Monographs," says Romme, "I emphasized the mosaic much more than weather in controlling the fire cycle. And I still think the vegetation mosaic does have a large influence. But after watching what happened this year, I think I have to back off a little on giving the mosaic the major role."

In late spring, park scientists actually expected a cool, moist summer. Weather predictions and abnormally abundant rainfall in April and May pointed to the continuation of a six-year trend of wet Julys, says John Varley, head of research at Yellowstone. Yet from the beginning of June until late August, Yellowstone saw essentially no rain, making this the driest summer in the park's 112-year-long weather records. Throughout the summer, relative humidity figures often dropped into the single digits.

Such exceptionally dry conditions

Bird's-eye view of Yellowstone reveals the mosaic created by the summer's fires. Untouched peninsulas of green reach into black seas of charred pines, showing that the fire did not burn everything in sight. About 20 percent of the park saw flames this summer; half that area suffered the devastating effects of canopy burns.



National Park Service

A dense "doghair" stand of lodgepole pines lacks lower branches and small trees that help fires climb to the canopy.

changed many of the ground rules in fire behavior. While young forests usually do not support crown fires, they burned better than anyone ever expected this year. Floor flames, which are not supposed to travel far, also surprised experts.

As an example of the fire's relentless march, Despain mentions two areas that burned in 1946 and were filled by young stands. "In years past, the fires have burned up to those areas and have gone out," he says. "But this year they took a week and a half or more and worked their way across those areas. There weren't any rainstorms at all during that period. If there had been, it would have put them out. Even a light sprinkle would have put them out."

Unusually strong winds combined with the drought to create an almost indomitable force pushing the fire through the park. Often blowing steady at 40 mph, they could gust as high as 80 mph.

The wind carried burning brands as much as 1½ mile ahead of the flame front. On certain days, the needles and wood on the forest floor were so dry that 90 percent of the flying embers ignited a new blaze—a much greater percentage than in a normal year. Swaths of land cleared by people, bulldozers or explosives often limit a forest fire's spread, but conditions this year made these well-used techniques "damn near useless," Varley says.

The unexpected weather conditions confounded computer models designed to predict fire behavior. On the basis of simulations, scientists predicted that under the worst conditions, the fire perimeter in the greater Yellowstone area would spread to enclose little more than 400,000 acres – an area one-quarter the actual size, says Varley.

Critics have blamed much of the burned forest on the Park Service's natural fire policy, saying the agency waited too long before attempting to suppress the fires.

Fire-effects researcher Stephen Arno comments that many other areas in the West have experienced summer drought in recent years and were probably better prepared for these severe conditions than were Yellowstone managers. "Yellowstone has escaped the recent drought

Taking the heat: A policy under fire

Yellowstone will recover from the fires of 1988. Far less certain is the fate of forest fire policy around the nation. When Congress reconvenes next year, so will debate on forest fire management. The myriad agencies controlling forests in the West have complex policies dealing with fire, yet this summer brought Yellowstone's program into the forefront of controversy.

In 1972, the park initiated an experimental program giving managers the power to allow lightning-caused fires to burn, provided the fires and weather fit certain criteria – namely that the flames did not threaten people, property or endangered species. Since then, several other parks and forests have adopted variations of this program.

Until this year, the Yellowstone policy was "very successful," says John Varley, head of the park's research department. "There were literally tens of thousands of lightning strikes during that period, and most went out without burning any more than the tree snag they hit." All the fires from those 16 years combined burned 34,000 acres – less than one-tenth what burned this year.

When asked whether the 1988 fires will alter the natural-burn policy, Varley says, "Of course we're going to revise our policy. We just took a giant step forward in understanding fire behavior. That policy has evolved. It's not some kind of dogma we adopted in 1972."

Critics from all sides have attacked the Park Service for what happened this summer. Some of the most vocal are people in communities bordering the park, who faced the danger of losing their homes to fires that managers allowed to burn early in the summer until they flamed out of control.

Varley will not rule out the possibility that park officials will start suppressing all fires as they did before implementing the natural fire program – a tactic he and many other scientists would like to avoid. "Biological-diversity people would come unglued because the more of this park you get into old growth, the less diverse it is for plant and animal species," he says. Fire suppression also allows fuel to build up and practically ensures that fires similar to this year's blazes will again ravage the park.

Some critics suggest that the natural-burn policy is really an artificial one that ignores the role native Americans played over the past few thousands of years in the park. They say Indians regularly burned the forests both accidentally and intentionally, to control vegetation and to drive game into specific regions. One of the most vocal proponents of this theory, Alston Chase, author of *Playing God in Yellowstone* (Harcourt Brace Jovanovich, 1987), says lightning does not start enough fires to mimic the effect of the Indians. He suggests the Park Service periodically burn sections of forest under carefully controlled conditions – a technique being tested at other parks.

Many fire experts reject the idea. "Indians may have been setting fires, but their influence in these lodgepole pines and fir zones may have been minimal," says Thomas W. Swetnam of the University of Arizona's Laboratory of Tree-Ring Research in Tucson. Fire ecologists say weather and the condition of the forest determine whether a forest can burn. With lightning striking the forest so often, ignition is not the most important factor, says Swetnam.

Yellowstone's Varley maintains it would be almost impossible to establish a policy of controlled burns in the backcountry. The ubiquitous lodgepole pines will normally carry a fire only if the flames spread through the tree crowns, "which by definition is uncontrollable," he says. Managers say it would be hard to manage intentional fires on Yellowstone's plateau, which lacks many deep valleys or steep ridges that form natural fire breaks.

Varley adds that to implement this policy, the park would have to burn almost 70,000 acres per year, sending a pall of smoke over the park and hundreds of miles downwind—an effect the public would not accept, he contends. "By far the thing people hated most this summer was the smoke," he says.

Fire historian Stephen Pyne says this year does not necessarily signal a failure of Yellowstone's policy. "I think that questions have to be asked about the execution of it, and I don't think they are trivial questions."

He adds, "I think a natural fire policy is the right thing for Yellowstone. But you can't just leave it with a statement of philosophy." – *R. Monastersky*

until this year, and I think that if they had a longer-term perspective on weather and how fire burns, they would find that you can expect things like this to happen," says Arno, who works at the Forest Service Intermountain Fire Sciences Laboratory in Missoula, Mont.

Despain acknowledges that some of the lightning-caused fires might have been extinguished early in the summer when they were small. Yet that policy is not the real reason behind the summer of '88, he argues. "Most of it had to do with the way Yellowstone burns under these conditions."

On July 21, when Yellowstone officials began full suppression, the area inside the fire perimeter in the park measured under 17,000 acres—less than 2 percent of the total area eventually burned. Humans ignited half the fires in the park this summer, and managers fought these blazes immediately upon their discovery.

One human-lit blaze, the infamous North Fork fire that threatened the buildings around Old Faithful, "was probably started by some woodcutter's cigarette in the Targhee National Forest" adjacent to the park, says a Park Service report issued last month from Yellowstone. In spite of attempted early suppression, this conflagration marched eastward into the park and grew to cover almost 500,000 acres, making it the largest fire in Yellowstone's recorded history.

"We had fires managed under all kinds of management systems this year," says Despain, "and they all went ahead and did what they wanted."

Many fire researchers agree. "Regardless of whether the fires were suppressed from the start, there would have been a severe fire season this year," Arno adds. "I think the news media have failed in general to recognize that it has been a real severe fire season and man's attempts to suppress fires are puny. We just don't have the capability to suppress fires burning under severe conditions."

When Varley speaks about the past summer, the word "unprecedented" often makes its way into his sentences. Both the summer's drought and the fire's extent surpassed all previous historical records in the park. From an ecological standpoint, the fires scorched habitats such as certain young forests and high-precipitation areas that researchers had never seen burn before.

On his list of unprecedented events, Varley also mentions Aug. 20, a hot day with extremely strong winds, known around Yellowstone as Black Saturday. "That was a really bad day when I think that every professional fireperson saw things that none of them had seen before in their lives. People who had been fighting fires for 30 years were just in awe."

Yet in an historical sense, the 1988 fires in Yellowstone were far from unique. Areas outside Yellowstone have suffered more extensive blazes during recent history, the most famous being the 1910 fires of Idaho and Montana that burned more than 3 million acres, says fire historian Stephen Pyne from Arizona State University in Phoenix. In a coincidence of history, Aug. 20 of that year also earned an infamous epithet — the Big Blowup — commemorating the day when fierce winds created uncontrollable infernos.

Even the park itself has seen fires larger and more severe than the flames of 1988, say scientists. Wildfires have been a part of the Yellowstone ecosystem at least since the glaciers retreated some 12,000 years ago at the end of the last ice age, and most forms of vegetation have evolved special techniques for dealing with the inevitable flames. Scars on trees testify that fires comparable to the ones this summer swept through large portions of the park sometime in the early 1700s.

However, Despain says, "until this year, we haven't seen the conditions that caused that. We haven't seen a fire that can put those scars on trees over such a large area."

Scientists contend this year's extraordinary events don't really invalidate theories about fire in Yellowstone. The mosaic still played an important role, as it has in the past, Romme says. Almost all the big blazes started in an older area of the forest, where they could develop into particularly hot conflagrations that were able to burn through young stands. Although the younger trees supported fires much better than expected, few fires made their start in these stands, Romme says. Moreover, some young areas simply refused, as they have in the past, repeated challenges to ignite.

According to Romme and Despain, the 1988 Yellowstone fires have added a new dimension to their ideas rather than disproved any theories. Varley likens the theories to a recipe that receives constant revision. Before 1988, researchers thought the vegetation mosaic was the most important ingredient in the recipe, the one that really controls how fires spread. Now, most agree weather should head the list. This makes it difficult to predict when an extraordinarily rare drought will bring similar fires to the park. Despain asks, "When would you expect a 200-year flood? It could come next year or in 400 years."

Those who study fire are only beginning to comprehend the magnitude and the effects of the flames in Yellowstone this summer. Varley often quotes a comment by one of the fire chiefs in the park this year: "There's going to be a new chapter in the fire behavior books as a result of what happened here. And it's going to be a long chapter." □

Next: Yellowstone's regeneration