Paul Schullery, Technical Writer, Research Division, Yellowstone Park, Wyoming 82190

Yellowstone Fires: A Preliminary Report

The fires of the Greater Yellowstone Area (GYA) were almost daily national news in July, August, and September of 1988. The fires were described in many ways: a national tragedy, a natural wonder, a unique research opportunity, the most significant ecological event in the history of the national parks, a policy disaster, and nature exercising its prehistoric right to make over landscapes.

Now that the fires are out, it appears that they might best be characterized more simply as a big surprise. Managers and their scientific advisors on U.S. Forest Service (USFS) and National Park Service (NPS) wilderness lands in the GYA were surprised by the magnitude of fires that exceeded all imagined scenarios built into their respective natural fire management plans. The nation's foremost professional firefighters were surprised to see fires exhibiting behavior and power that the best fire behavior models failed to predict. Most Americans, including the President of the United States, were surprised to discover that there even was such a thing as a natural fire policy. Certainly the media were caught by surprise; their coverage of the fires proved so uneven and confused that after-the-fact reporting on the fires, now appearing in many magazines, frequently devotes substantial ink to correcting misimpressions developed by daily media reports during the fires.

We seem now, at the end of 1988, to be past the stage of frequent surprises. As an assortment of independent panels, interagency commissions, and other government teams go about the analysis of the fires, fire policy, and fire fighting procedures, bureaucratic routine and process replace nature's whimsy. But lack of surprises should not lessen interest in Yellowstone's extraordinary fire season, especially among members of the scientific community. The fires, as several observers have noted, are only the first act of the play, and there promises to be a lot of drama yet to come.

Fire Management History

Since early in this century, plant ecologists have recognized the significant role of naturally caused fire in many forest communities. Prior to the arrival of Europeans, fire (set by lightning or by native Americans) was nearly as important as soils and climate in determining the condition and composition of many plant communities. Fires burned patches, sometimes small, sometimes large, of vegetation in irregular patterns, creating and maintaining habitat diversity for plants and animals. North American landscapes were in fundamental ways the products of fire.

Fire suppression was the order of the day on both public and private lands until relatively recent times, when several federal agencies began to experiment with prescribed (that is, intentionally allowed, whether human or lightning-caused) burns. The USFS began using human-set prescribed burns as a silvicultural tool in a few areas in the Southeast in the 1940s, for the purposes of removing low-value growth or generating new even-age growth. In 1970, the USFS began to permit lightning-caused fires to burn on some wildlands in order to preserve wilderness values, which were closely identified in the public mind with the natural processes of primitive wildlands.

The NPS, with its more wilderness-oriented legislative mandates, was more aggressive in attempting to reestablish the role of natural fire in its wilderness settings. Managers began actively experimenting with human-set prescribed burns in Everglades National Park in 1958 to

protect pine forests from incursions of hardwoods. In 1968, after several years of experimentation with small human-set prescribed burns, Sequoia National Park established a natural fire program, and by 1978, twelve areas in the National Park System had programs to allow at least some naturally caused fires to burn. The goal of these programs differed from that of early USFS programs in that a state of primitive wildness—and resulting species diversity and dynamic processes—was of primary importance rather than the production of lumber.

The GYA includes roughly 12 million acres in northwestern Wyoming, southcentral Montana, and east central Idaho. Yellowstone National Park, a 2.2 million acre reservation at the center of the GYA, initiated its Fire Management Plan in 1972, with 340,000 acres of backcountry designated for natural fire burns. By 1976, about 1.7 million acres within Yellowstone Park was included within natural fire zones. Yellowstone Park's Fire Management Plan required suppression of all fires that showed risk of threatening human life, property, historic and cultural sites, specific natural features, or threatened and endangered species. Human-caused fires were all subject to immediate suppression, and the Fire Management Plan gave park managers the option of starting fires for purposes of research or to speed up the natural process.

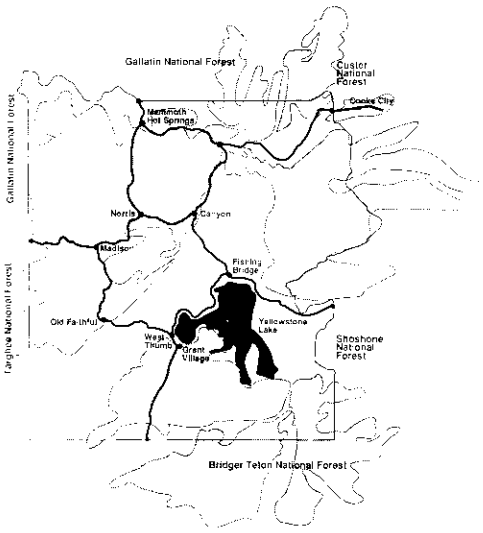
There has been considerable confusion in the media over the extent and effects of fire suppression in Yellowstone. The first known federal involvement in fire fighting occurred in the then fourteen-year-old park in 1886, when the U.S. Cavalry was assigned to its protection. One of their first duties was to fight a fire burning near Mammoth Hot Springs, park headquarters, in the northern part of the park. From that time on until the early 1970s, the goal of management was to suppress any fires, whether they were natural or human-caused. Fire suppression on the park's northern range, a mixed grassland/sageland region making up less than 20 percent of the park, has been largely successful for nearly a century. A fire cycle—that is, the rate at which natural fires recur—of 25 to 100 years has been documented on some portions of the northern range. Consequently, fire suppression there has been underway long enough to have noticeable effects on plant communities.

On the other hand, fire suppression in the rest of the park, which was largely covered by forests, was much more difficult. It was easier to reach and suppress fires on the northern range than in the vast forests that cover most of the park, and so firefighting in the forests was not consistently successful until after World War II, when aerial fire fighting technology became available, thus allowing easier movement of men and equipment to fires in hard-to-reach backcountry areas.

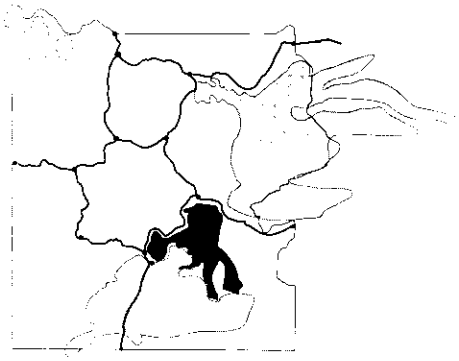
The fire cycle in the forests has been determined through tree-ring studies to be 250 to 400 years. This is of course a much longer fire cycle than that on the northern range, and is also a far shorter period of effective fire suppression. But the differences in fire cycles in different parts of the park have escaped the notice of many media, and the short fire cycle and long history of fire suppression on the northern range have often appeared in the media as applying to the entire park. This has led to unfortunate generalizations about "unnatural buildups" of forest fuels because of fire suppression in the park. In fact, fire suppression in the park forests over the years since World War II may not have made much difference in fuel levels. Older stands of lodgepole pines quite naturally contain substantial levels of dead and down trees, which have been described incorrectly as unnatural or abnormal by both agency personnel and reporters.

Fire Management in the GYA

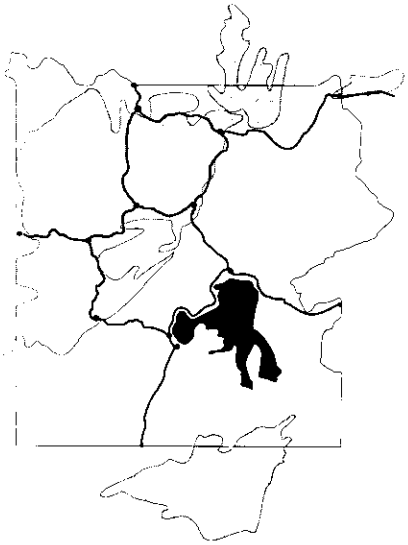
Within the GYA are portions of 6 national forests, 2 national parks, and 2 national wildlife refuges. In the past fifteen years, substantial progress has been made in coordinating ecological management across agency boundaries; part of the progress was development of agreements between the Park Service and some neighboring forests regarding the acceptance of each other's natural fires. In principle, this meant that a natural fire starting on one agency's land could be monitored jointly and could conceivably be welcome to cross the boundary. In fact, there were considerable differences in definitions between the agencies over what was an acceptable size fire and what was acceptable fire behavior. The Park Service's definition of acceptability was aimed at accommodating potentially much larger fires than the Forest Service's. Generally, the



A. Total burned areas.



B. Prescribed burn fires



C. Human caused.

D. Natural fires originating outside Yellowstone Park

Figure 1. Background to fires affecting the Greater Yellowstone Area. A. total burned areas of the Park (shaded). B. extent of natural fires originally managed as prescribed burns under the YNP Fire Management Plan. C. extent of human-caused fires originating outside of YNP, but spreading into the Park. D. extent of naturally caused fires originating outside of Yellowstone National Park, but spreading into the Park.

Forest Service had much tighter restrictions on fire; the Forest Service's system required that fires be suppressed under climate and fuel conditions that the Park Service still found tolerable for allowing fires to burn, and the Forest Service set absolute maximum acreages (1,000 acres in Shoshone National Forest east of YNP, for example) on their fires. Any fire that showed a threat of growing beyond that size was suppressed immediately. Both the new strengths and remaining weaknesses of interagency cooperation would be highlighted by the fires.

In the first sixteen years of the Yellowstone plan's existence, 235 fires were permitted to burn

in the park under the terms of the plan (thousands of lightning strikes were observed to go out without burning any measurable acreage). A total of 34,157 acres was burned. The largest single fire burned 7,400 acres. Only 15 burned more than 100 acres, and most burned an acre or less.

The program was viewed as a success in many ways—restoration of fire as an ecological force, education of the public regarding natural systems, increased research opportunities—and the experiment was yielding significant information on fire ecology in Yellowstone vegetation types. In fact, only months before the fires of 1988, a preliminary research report by Dr. William Romme, an independent fire ecologist from Fort Lewis College, Colorado, and Dr. Don Despain, NPS plant ecologist, suggested that the Yellowstone area fire regime involved many small fires interspersed every 200-400 years by massive fires that swept across large portions of the park. Romme and Despain concluded that "Another major burning cycle may begin within the next century, as extensive areas are now developing flammable late successional forests." The fires of 1988 were not a big surprise to quite everybody.

Climate and Fire Conditions

The Rocky Mountains were in a drought through most of the 1980s. The driest previous year in the history of the Fire Management Plan was 1981, when prescribed fires burned 20,240 acres.

The GYA experienced a peculiar weather pattern during the drought. In the period 1982-1987, annual precipitation was well below average, but the shortfall (so to speak) occurred in winter. Summers during these years were unusually wet. Precipitation in July averaged about 200 percent of normal over 1982-1987. Summers are normally dry in the GYA, so 200 percent of very little is still very little. But it was more than enough to dampen natural fuels. From 1982 to 1987, while much of the West struggled with a famous and economically stressful drought, natural fires in Yellowstone Park only burned about 1,000 acres.

Part of the lesson being learned from the Fire Management Plan was that typically fires will burn a little bit here and there, but that there is an imaginary line or threshold, a combination of conditions produced only in extremely dry years. Once that threshold is crossed, fires will grow much more dramatically, and burn a lot more landscape. One of the biggest lessons of the 1988 fire season was that that threshold is difficult to identify and the experts disagree on where it is. Disagreements aside, one thing was clear: once the threshold is crossed, the fires will not be stopped by conventional fire fighting, and may burn a whole lot more landscape than managers anticipated or hoped for.

The 1988 Fire Season

Monitoring of fire conditions began in early April, when USFS and NPS fire specialists activated their regular system of fire indices. Well-established conventions in the firefighting community include measurement of a wide variety of conditions, including moisture content of various fuels, man- and lightning-caused fire risks, spread component (a measure of the speed with which a fire would travel if started), energy release component (a measure, in simplistic terms, of how hot a fire burns, which affects what sort of fire fighting equipment must be available), and others. By June 15, eighteen such indices were being computed daily at twelve locations in the park. By July 1, they were being computed at twenty-six locations. An unfortunate and misleading implication of the term, "Let-burn policy," used both within and without the agency, is that managers put their feet up in their office and do nothing. Quite the contrary; monitoring is a major, daily occupation during any fire season.

The fire season began normally. Long range drought indices suggested that the GYA was in at least a moderate drought by the end of April, but local conditions in the park revealed the complexity of interpreting such information. Rainfall was above average in April (155 percent of normal) and May (181 percent). During late May and June some twenty fires started, and 11 went out on their own. The others behaved more or less as fires had in earlier years. But June rainfall was only twenty percent of normal; sometime in early July, it appears, the theoretical threshold mentioned earlier was crossed.

The critical period of decisionmaking, as identified by post-fire review boards, managers, and other observers, was roughly July 1 until July 21. By July 15, when a total of 8,600 acres had

Figure 2. Satellite view of fires on 7 September 1988. Besides the fires in the Greater Yellowstone Area (upper corner of Wyoming), other fires are visible in Idaho (upper left), Utah (lower center), and smoke from a major Montana fire crosses the top of the image.

been burned in the park, NPS and USFS fire specialists and administrators were aware that weather conditions were extremely dangerous, but it remained unclear to many just what the danger meant. On July 21, NPS managers decided to suppress all existing and new fires as resources would allow. On that day, the total perimeter of all fires enclosed a little less than 17,000 acres.

It is unlikely that the extreme dryness alone would have been enough to create the situation that next developed. In July, August, and September, a series of six dry cold fronts passed through the Yellowstone area, with winds of 40 to 60 miles per hour that fanned the fires and moved them great distances very quickly. It was during these episodes of high wind that the fires performed most spectacularly, and ate up the most fuel.

Extreme fire behavior became nearly the order of the day, as fires ran as much as 10 miles in a day, sending embers as much as a mile and a half ahead of the main fire to create dozens of "spot fires." The presence of so many spot fires, along with the rapid and wide advance of the main fires, made it impossible to fight the fires head-on without risking many lives. Hundreds of miles of fire lines were constructed, but with the spotting behavior fires routinely jumped usual barriers such as rivers and roads. Standard

hand- or bulldozer-built lines were no barrier at all. Among the examples of black humor (an appropriate term, if ever there was one) with firefighters was, "What's black on both sides and brown in the middle?" The answer: a bulldozer line in Yellowstone.

Fire experts found themselves using terms like "slopover" to describe a huge 15,000-acre burn that appeared on the edge of the North Fork Fire. The scale of the fire events regularly exceeded projections, until to many the entire summer had an unreal quality.

By September 26, the perimeter of burns in the GYA was 1.38 million acres. Fifty fires had been ignited by lightning, of which eight were still considered alive, though after that date they made no more of the dramatic runs that had been seen during the summer, when thousands of acres of forest were eaten up in hours. At the peak of fire fighting efforts, 9,500 firefighters (civilian and military), dozens of helicopters, and more than 100 fire trucks from many states were involved in a massive interagency struggle with the fires. The cost is now estimated at about $120 million.

Media attention, and to a great extent fire suppression efforts, concentrated on the protection of various developments in the park and communities nearby. The resultant media coverage was perhaps inevitably confused, as so many stories and issues were under attention at once that any brief report was almost certain to muddle them. A brief chronology of the major fires may help set the stage.

Major Fires

The huge North Fork fire, whose perimeter eventually exceeded 500,000 acres, was a human-caused fire started on June 22 in Targhee National Forest just west of Yellowstone National Park (none of the human-caused fires in the GYA in 1988 originated as prescribed management-set fires; they were all accidental fires, fought from the outset). It quickly burned into the park and eventually threatened developments at Old Faithful, Madison Junction, Norris, Canyon Village, Mammoth Hot Springs (NPS headquarters), and Tower-Roosevelt, and the communities of West Yellowstone, and Gardiner, Montana.

The Shoshone Fire, a naturally caused fire, started in southern Yellowstone Park on June 23 where it was managed as a natural fire. It grew to a perimeter of more than 24,000 acres before being administratively redefined as part of the Snake River Complex of fires, whose total perimeter acreage was more than 172,000. By then it had threatened Grant Village, a park development on the shore of Yellowstone Lake.

The Storm Creek Fire, a lightning fire started on July 3 on the Custer National Forest north of Yellowstone Park, was at first managed as a prescribed natural fire under the terms of the national forest's fire management plan, but after two weeks was redefined as a "wildfire," that is a fire no longer within management prescriptions. It was then fought, but grew to a perimeter of 95,000 acres and threatened the communities of Silver Gate and Cooke City, Montana.

The Clover/Mist Fire, started by lightning on July 9 in eastern Yellowstone Park, was originally managed as a prescribed natural fire under the terms of the park's fire management plan, then was fought. It grew to a perimeter of more than 319,000 acres in the park and in Shoshone National Forest east of the park, and showed signs of threatening Silver Gate and Cooke City, then ran east and burned several structures in the Crandall/Squaw Creek area of Wyoming.

The Hellroaring Fire, a human-caused fire started on August 15 on the Gallatin National Forest north of Yellowstone Park, eventually burned a perimeter acreage of 66,000 acres.

The Huck Fire, a human-caused fire originating on August 20 on the John D. Rockefeller Memorial Parkway between Yellowstone and Grand Teton National Parks, eventually grew to a perimeter of more than 106,000 acres before it was administratively redefined as part of the Huck/Mink Complex, whose total acreage was more than 228,000. It required the evacuation of Flagg Ranch, a development just south of Yellowstone Park.

Several smaller fires added to the total acreage. Merely that the Fan Fire, for example, which burned a perimeter of 21,000 acres in Yellowstone Park, can be referred to as a "smaller" fire suggests the tremendous scale of this event.

Even the most casual reading of this summary of the major fires will reveal the extent to which

this was an interagency emergency, as well as the extent to which the fires were managed under a variety of policies. Public perception, created largely by the media, was simpler.

In many media reports, especially on television, all fires were usually referred to as the "Yellowstone fires." Of course they all did occur in the GYA, and thus were more or less Yellowstone fires. But to the public, "Yellowstone" means Yellowstone Park, and the distinction between fires on NPS land and those on USFS land was easily lost. As a result, all the fires, including those caused accidentally by humans and those caused by lightning in national forests near the park (these two categories include five of the seven largest fires in the GYA), were frequently attributed to the NPS Fire Management Plan. There was a common public misconception that all of these fires were, in other words, the result of the park service's policy of letting fires burn.

There was also confusion over the Fire Management Plan. The NPS "let-burn policy" was blamed (in interviews with local citizens, in the statements of politicians, in editorials, and in some hilarious political cartoons) for the continued growth of the fires throughout the summer and fall, with the implication that the NPS continued to allow the fires to burn, though full suppression was the order of the day after July 21. Television coverage of evacuations of developments and nearby communities was regularly linked to discussions of NPS fire policy, when only one park development, Grant Village, was evacuated because of a fire originating as a natural fire under the NPS Fire Management Plan. All other evacuations in or near the park resulted from human-caused fires. Thus it was that NPS fire policies appeared solely responsible for what was reported as a giant management fiasco and ecological tragedy.

One of the many fascinating consequences of the fires does involve media handling of the story. The Yellowstone fires have few equals among natural resource issues for the amount of media attention they generated. Among the investigators studying the enormous amount of material generated in the press and electronic media is Dr. Conrad Smith of the Ohio State School of Journalism, who is conducting quantitative studies of emphasis and accuracy in both agency information handling and media reporting during the fires. His preliminary work suggests to him a gradual improvement over the course of the summer in the quality and accuracy of reporting; perhaps both agencies and media can benefit from this sort of analysis.

Effects and Aftereffects

Public interest in the GYA, especially in Yellowstone Park, following the fires has amounted to a heartwarming outpouring of sympathy and offers of support. It has been estimated that as many as 30 percent of all Americans visit Yellowstone during their lives, so the park is familiar to many million people. Numerous corporations, institutions, organizations, and individuals have offered help of one kind or another. Much of the help offered is inappropriate, such as pledges of non-native seedlings from other parts of the country, but the agencies involved recognize the most important fact in this public reaction: Yellowstone is a remarkably well known and loved place. NPS and USFS officials have established offices to deal with offers of assistance, and to channel them in meaningful directions.

This array of public interest, some informed and some not, points up the challenges faced by agencies in what is awkwardly called the "recovery" process. For the USFS lands where timber harvests or other commercial uses may prevail, there is indeed something to recover from. Active reseeding and revegetation may be useful in some places. For NPS lands where visitor facilities such as trails, picnic areas, or buildings were damaged, recovery also seems an

Figure 3. In the foreground is a thirteen-year regrowth of lodgepole pine following a 1954 fire in YNP. This picture was taken in 1967. NPS photo by J. R. Douglass.

appropriate word. But for the large areas of wilderness burned by natural fires, recovery is by definition the job of nature. Rhetoricians even argue that it is inappropriate to describe a naturally burned forest as one in need of recovery at all; it is merely a forest in a different stage of its life, a stage through which it passed many times prehistorically, during previous fire cycles.

But the language of recovery is not easily dismissed. Both managers and commercial interests hoping to persuade potential visitors that Yellowstone is still worth seeing are relying heavily on a "rebirth rhetoric," emphasizing the esthetic excitement of seeing the GYA "come back to life," when at least the Yellowstone Park portion of the GYA has just experienced an especially active stage in its primitive life, of which fire was a major element.

Recovery needs, that is actual physical work to be done, are indeed extensive in both Yellowstone Park and in surrounding national forests. In the GYA some 850 miles of hand-dug firelines had to be restored, to avoid erosion and incursions of exotic plants on exposed soils. About 137 miles of bulldozer lines (32 in Yellowstone Park) needed similar treatment. Dozens of "spike camps," helicopter landing sites, and hundreds of smaller disturbances also needed to be repaired. In many instances, the efforts of fighting the fires created more enduring disruptions of settings than did the fires. Much of the work of restoring fire lines and rehabilitating campsites was accomplished before winter snows came.

Figure 4. Bulldozer damage. It is a common expression among fire ecologists that fire suppression activities can do longer-term damage than the fire itself. In 1943, this bulldozer line was dug near Lewis Lake in southern YNP. Thirty years later, when this photo was taken, native vegetation had made little progress in recolonizing the cut; non-native grasses planted on the cut in 1943 remain the only significant cover. NPS photo by Don Despain.

Structural losses were light, limited to about 55 small buildings, cabins, trailers, and outbuildings. Other losses included some small bridges, 8 miles of main power lines, numerous picnic areas, and related service areas in the park. There is a widespread if informal feeling that the massive firefighting efforts probably did not significantly reduce the acreage burned, but there is also consensus that firefighter's efforts to protect property and human life were remarkably successful. Firefighting activities resulted in many minor injuries to personnel and one fatality was reported: a firefighter was killed by a falling snag in Wyoming.

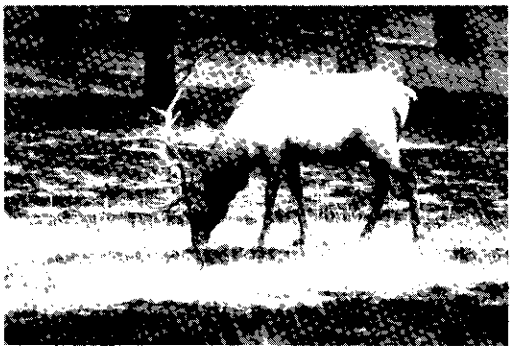


Figure 5. Bull elk feeding on unburned grasses in burn area, YNP; wildlife frequently fed and bedded down within sight of fire. NPS photo by Jim Peaco.

Wildlife losses were also light: the large herds of grazing animals that are a major attraction of the GYA displayed behavior not at all like that in traditional portrayals of forest fires, such as the movie "Bambi." Animals were only caught by fires when the fires made fast, wide runs. Most of the time, animals more or less stepped aside. Many photographs and films have already been published of bison and elk grazing calmly in a meadow while the forest behind them burns. Surveys of carcasses in Yellowstone Park revealed 257 dead elk (less than 1 percent of the park's summering population of about 32,000), 9 bison (park population—2,700), 2 moose, and 4 mule deer. Most apparently died of smoke inhalation. Similarly light losses, including at least 6 black bears, were reported on surrounding national forests. No threatened or endangered animals have been reported lost.

Of greater concern has been loss of winter range for ungulates. About 11 percent of the winter range (160,000 acres) in the GYA was burned. Of that 11 percent, 8 was canopy or surface burn in forest, and 3 was either meadow or sage/grassland. On some of the smaller ranges, percentage burned is as high as 50 percent.

By early winter of 1988, some public interest emerged in the possibility of supplemental feeding of ungulates, but the USFS, NPS, and the Montana Department of Fish, Wildlife & Parks (MDFWP) all have expressed opposition to feeding for a variety of ecological and scientific reasons. Their position was supported by an independent panel of ecologists assembled in November to assess the GYA ecological situation.

Supplemental feeding of park wildlife is an engaging issue, part of the complex suite of issues surrounding modern parks and their determined tendency toward nonconsumptive uses of park resoures. In most wildlife management situations, winter feeding of animals is recognized as a political and sociological issue rather than as an ecological one. That is, feeding can be used to prevent malnutrition mortality or to manipulate animal movements, but the need to do so is based on human needs—humanitarian concerns to prevent death of animals, or sporting needs to maintain high huntable populations—rather than on any intrinsic need of the animal population. Winter mortality is a reality of virtually all northern grazing herds. In YNP, where the goal is to maintain natural processes, feeding would short-circuit the processes of population control and natural selection that occurred in this setting prehistorically, and thus betray the park's greater goal. Herd numbers fluctuate with environmental conditions, which included primitive fire events on the same scale as the fires of 1988. For this principle alone, feeding was deemed inappropriate.

Other supporting reasons included the existence of many research projects involving park animals, projects whose data bases and results would be seriously compromised by such artificial manipulation; the heightened risk of disease transmission among animals at feeding sites; and the high price tag on such a program, conservatively estimated for the largest herd, the northern one, at about two million dollars.

Political and public pressure in favor of feeding still exists as of 1/89, but it is still too early in the winter for much attention to be focussed on the subject. The heaviest mortality among park animals occurs in late winter. The series of mild winters prior to 1988 have allowed park animal populations to grow, so even a normal winter will result in mortality, especially among elk and bison, that may seem alarming to the uniformed (the elk herd routinely experiences 10 percent mortality during winter). Now that the cameras are focussed, so to speak, on Yellowstone, it can be assumed that any mortality will be of greater public interest than in past years. Park service pundits already are speaking gloomily about the possibility of simplistic media reporting on the agency's "Let-die" policy.

Preliminary mapping suggests that a maximum of 15 percent of the whitebark pine in the GYA was burned; whitebark pine nuts are an important food for grizzly bears, and more study is necessary to determine the effects of the loss on the threatened bear.

There has been general agreement among park scientists and advisors that only for purposes of landscaping around developments (such as to screen service facilities from roadways) should any reseeding be undertaken in Yellowstone Park. Extensive soil testing, done as part of the first reconnaissance mapping in September, showed that less than .1 percent of the soils in burned areas received heats extreme enough to kill seeds, roots, rhizomes, and other regenerative plant parts more than an inch under the surface. By late September, newly-cast lodgepole pine seeds in burned forests were covering the forest floor at densities ranging from 50,000 to 1 million seeds per acre. Yellowstone's long history of regrowing its vegetation following fires seemed sufficient proof for most observers that the park's vegetation would regrow at its own pace.

Other short-term ecological concerns include increased erosion or sedimentation in many streams. Levels of erosion and sedimentation will depend upon the rate and amount of spring snowmelt and precipitation, and ecologists generally agree that the long-term benefits of increased nutrients released by the fires will enrich many aquatic systems. Another concern is the risk of non-native vegetation invading burns,

especially in wilderness areas. This is especially a concern in the hundreds of miles of fireline built during the fires, where native vegetation has been removed or destroyed and soil is easily colonized by new vegetation. Sedimentation, erosion, and invasion by non-native plants will, like the other ecological issues discussed earlier, require long-term monitoring.

Social and Political Consequences

Formal review of the fires, of fire fighting logistics and decisionmaking, and of fire policy, will be underway throughout the winter of 1989. There may be Congressional oversight hearings in late winter.

The fires that involved interagency efforts—that includes all of the large ones—have already been subject to technical review by interagency teams. The findings of these teams are difficult to summarize because each fire was so large, with so many decisions and logistical complications, that each team addressed a unique set of issues. For example, the team evaluating the fighting of the Clover-Fire gave the fire fighting agencies high marks for protecting structures, coordinating military participation, training new fire fighters, safety ("1/3 the normal injury rate"), public relations (coordinating fire activities with local communities), and grizzly bear safety (an unaccustomed hazard for most firefighters not used to having to protect their food at night). On the other hand, the team observed that NPS fire management guidelines did not include "circuit breakers" to tell the agency at what set of conditions it was no longer safe to allow fires to burn, that in several ways communications between the NPS and the USFS were inadequate, and that though the personnel on the fires were qualified, there were never enough of them. One interesting sidelight of these fires is that there were so many of them at once that fire fighting resources were often inadequate, or were shifted from one fire to another as priorities changed.

The fundamental necessity for some kind of natural fire policy seems recognized by most participants in the scientific and political debates now underway. The extent to which fires should be allowed to exercise their primitive prerogatives is hotly debated, and though there appears already to be nearly a consensus among participants in the political and scientific dialogues that some sort of natural fire policy is necessary, there is great difference of opinion over what it should be. The Yellowstone fires of 1988 revealed the extent to which a policy that seems perfectly workable for many years suddenly can become the center of giant controversy. Critics of the NPS policy say it should have been better designed to anticipate the unusual fire conditions of 1988; defenders of the policy say that building fire policy around the extreme conditions of 1988 would be like a farmer managing his best bottomland in constant anticipation of a 100-year flood.

A common thread in the current dialogues is the fear that while natural fire may be respected in principle, it will be eliminated in fact. It is easy to imagine that the political process may create a policy that in all respects is a model of approval—that expresses all the affirmative sentiments about the importance of allowing fire to play its natural role in the dynamic processes of the national parks--but that is so restrictive in its "circuit breakers" that in fact no fire of any useful size could ever occur. The sorting out of these details and priorities promises to be one of the most interesting processes the conservation movement has witnessed in recent years.

Even the scientific process of analyzing the fires promises to be stirring, newsworthy, and controversial. For example, during the fires, daily reports gave rough estimates of the perimeters of the burns, emphasizing that as much as half of the area within the perimeter was not burned (media reports typically quoted only the larger number). By late September, these rough estimates said that 1.6 million acres had been included within fire perimeters, 1.1 million of which was within the park. First estimates of actual burned acreage within fire perimeters in the park were arrived at by seat-of-the-pants guesstimates by skilled observers in helicopters. The figure they gave was 440,000. Then in late October the first round of infrared aerial reconnaissance mapping was completed, and it estimated a total burned acreage in the GYA of 1.38 million acres, and within the park of 995,000 acres. Then in early December an EROS satellite image analysis of the burns estimated a burn acreage of 706,000 acres in the park. These numbers, all derived by respected means, differ so widely that further confusion is sure to result.

Differences in methods explain much of the discrepancies. For example, the resolution of the

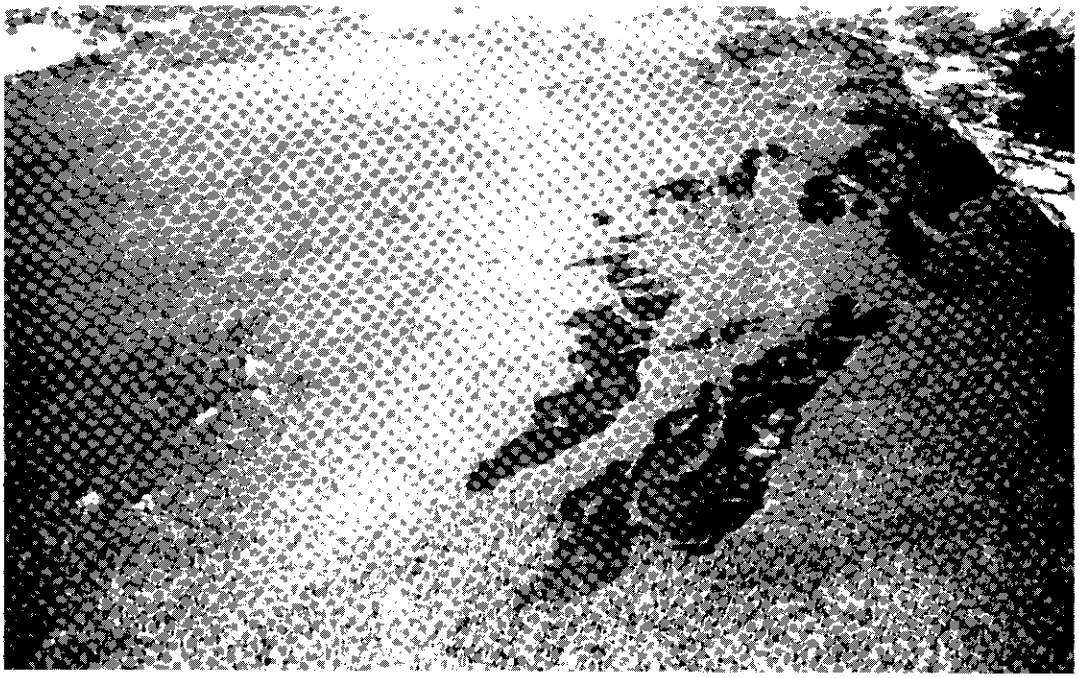


Figure 6. Aerial view of fire patches. "Mosaic" of burns became the object of fascination for fire fighters and visitors alike by the end of the summer, as winds and vegetation dictated the movements of fires leaving mixed patchworks of black and green across Yellowstone. NPS photo by Jim Peaco.

aerial mapping of October is only 200 acre units. Fires frequently burn in a "mosaic" pattern that creates a variety of shapes and sizes of new wildlife and plant habitats, and quite often the "jigsaw puzzle" is composed of very small pieces, each only a few acres in size. The EROS imagery, on the other hand, is measuring units of burnt or non-burnt land as small as 30 meters on a side.

Also, the helicopter guesstimates, flown in smoky conditions, were rough counts only of burnt forests, while the aerial reconnaissance also measured ground fires under green forest canopies; of the 995,000 acres reported by the IR aerial survey, 367,000 was ground fire under forest canopy, and another 55,000 was meadow or sage/grassland. No doubt upcoming surveys will also differ, and no doubt further public confusion will result.

Opportunities

Promoters of travel to the Yellowstone region are emphasizing the singular opportunity the fires present; only once in several generations can visitors view such a huge ecological unit "starting over" this way. Other opportunities are also presented here; scientific research will certainly burgeon. The park currently hosts some 200 government and independent researchers from many disciplines each year. Yellowstone Park Chief of Research John D. Varley estimates that number may increase by 50 percent.

Opportunities for political haymaking and axegrinding also abound. The fires have already generated a wild assortment of commentary and polemic, as resource-oriented groups and individuals work to affect public opinion and policy. The very volume and diversity of this flow of talk probably is the best tempering influence on it, and the best guarantee that no one viewpoint will dominate.

But for those who enjoy ecological consequences more than political and social ones, the finest opportunity is the resource's. The biotic communities of the GYA have just received a dynamic jolt of prehistoric dimensions, and all the members of those communities will be doing all that evolution will allow to take advantage of the new order. For nature, opportunity rarely has knocked so loudly in Yellowstone.