Yellowstone's Fire Regime

by Paul Schullery

Most of us who aren't formally educated in ecology seem to drift toward it because of animals. We become interested in bird-watching, or hunting, or fishing, or some other form of wildlife appreciation, and from there we may or may not move on to a deeper appreciation of how nature works. Ask Sam Citizen for a definition of ecology, and he'll probably say something like, "the study of animals." If he's thought about it, he might say, "the study of animals and what they eat." But for those who look harder, coming into ecology from wildlife appreciation is revealed as the backdoor approach. One day it suddenly dawns on you that the study of animals is as much a study of plant communities. From plants it's a short hop to the realization that soil sets up the plants. At last you look below the soil and announce to your unconverted friends that "geology is everything." In fact, you've just made a start in recognizing all the processes and materials involved in an ecological setting (among other things, you're probably neglecting climate).

An understanding of Yellowstone's fire regime must begin at the bottom, underneath the plants, for the plants that burn are there because of what the geology has dictated can grow. Most of the Yellowstone plateau is composed of volcanic rocks that produce soils of low productivity, so vegetation is dominated by vast lodgepole pine forests, trees that can flourish on poor, thin, soils, with smaller areas of spruce and fir. On what is known as the northern range, along the Yellowstone River drainage, are richer, more productive soils, the result of glacial actions. The northern range is there about half grasslands with small stands of fir, pine, and spruce, and smaller areas of aspen and riparian vegetation.

Most of the famous fires of 1988 occurred in the continuous forests of the Greater Yellowstone Area. The rich vegetation of the northern range did not burn extensively until the late days of the fire season. But the ecological differences between the "big woods" and the more open northern range provide us with a helpful device for introducing the way fire works in Yellowstone.

Like many natural settings, Yellowstone's vegetative processes are in good part driven by fire. Fire history research done in the park reveals that repeated burning of the forests and grasslands has occurred naturally for many years, presumably thousands, and has given us the "mosaic" of cover and habitat types that are found in the park today. On portions of the northern range, a fire interval as short as 25 years has been documented. In the park's great forests, the interval is more typically 250 to 400 years.

Fire interval seen in terms of effects is the time between fires. Fire interval seen in terms of causes is the time it takes for enough fuel to accumulate to permit burning. Some grasslands in this country can burn again every year, while some forests may take decades or even centuries to accumulate adequate material to sustain and move a large fire.

This variation in fire intervals from one vegetation type to another caused some interesting and instructive confusion during Yellowstone's 1988 fires. Careless journalists (as well as numerous people in the Park Service) latched on to the fire interval of the northern range—a handy number appearing in many park publications—and presumed it applied to the entire park. They then reasoned, loudly, that Yellowstone's forests, where fire suppression had been in effect since the early days of the park (another mistake), had not been burned for three or four times the length of their natural fire interval, which meant that there were huge unnatural fuel buildups that made the fires much worse than they would have been. Of course the fire interval in the forests was in fact measures in centuries, not decades, and fire suppression had not been consistently successful in the park's interior forests until aerial fire fighting technology became available after World War II.

A more engaging and equally instructive complication that developed in dialogues over Yellowstone's fires was not based on such simple factual errors. Fire fighters and observers from around the country knew something about fire intervals back home, and Yellowstone's long history of fire suppression seemed to them assurance that unnatural fuel loads must have built up. Some ponderosa pine forests experience burning of some sort an average of every ten years, (usually fires that keep the understory clear without killing the trees), and some other forests have intervals just as short. In the summer of 1988, some visiting fire fighters complained that the Yellowstone staff acted as if they were the only people who had lodgepole pine forests, or knew anything about how they burned. As it turned out, Yellowstone lodgepole pine forests burn differently, not only from ponderosa pine or Douglas fir or many other trees, but also from lodgepole forests elsewhere in the west.

As always, it starts with geology. Yellowstone's plateau has young, thin soils. Dr. James Brown of the U.S. Forest Service, in a recent paper on the practicality of prescribed burning in Yellowstone, followed this fundamental element of the Yellowstone fire regime up from the ground to the crowns of the trees:

> Fuels and potential fire behavior change dramatically over the life span of lodgepole pine depending upon establishment, growth, mortality and site characteristics. The major fuel components are needle litter and duff; downed woody material; and understory herbs, shrubs, and small conifers. Following stand replacement fire, grasses and forbs are the primary ground cover until a new stand of trees is established and crowns begin to close. Herbaceous vegetation then declines. Shrubs appear slowly and are never abundant. Understory herb and shrub biomass in Yellowstone lodgepole pine stands is several times less than found in other lodgepole pine stands of the Northern Rocky Mountains. A sparcity of herbaceous and shrub fuels is characteristic of most lodgepole pine in Yellowstone. In mature to over mature lodgepole pine, spruce and subalpine fir often develop in the understory and contribute to torching, crowning, and spotting.

The point is that it takes a long time for enough fuel to build up to permit fire in Yellowstone forests. Park plant ecologist Dr. Don Despain, working with Dr. William Romme of Fort Lewis College, Colorado, has determined that 80 percent of all Yellowstone forest fires occur in stands more than 250 years old. Only in those oldest forests do sufficient understory fuels (in the form of spruce, fir, and small pine, as well as in downed old trees) exist for fires. As Don has observed, "large fires in years past have burned up to lodgepole pine forests that lacked a spruce and fir understory and gone out, skipped over, or gone around them. Very little of these younger lodgepole pine forests have burned. Fire brands have fallen into them from neighboring fires and small patches have burned and some of the rotten logs have been consumed, but crown fires have had a difficult time developing in them. The small shrubs and herbaceous plants on the forest floor are usually too green to carry the fires to the clumps of drier dead fuels."

If fire is the driver of vegetative succession in Yellowstone, climate is the driver of fire. The popular impression of how fire "renews" a landscape is that it is a piecemeal process: a thousand acres here, a hundred acres there, until over the course of centuries old forests are replaced with new ones. Again, Yellowstone offers surprises.

In the sixteen years of the park's natural fire program prior to the big fires of 1988, we learned that in a year of average rainfall, very little burns in Yellowstone. In the years 1982 to 1987, when the west was in a drought, lightning strikes in Yellowstone were only able to burn about 1,000 acres. What occurs here is not a steady progression of small fires, but a less tidy process, in which long periods of small fires are interrupted by occasional years of extreme climate conditions that allow huge areas to burn. One such fire event occurred in the early 1700's, and another in the mid-1800's.

Between the big fires—that is, fires on the scale of those that occurred in 1988—there are many small ones. Altogether, the fires make over the setting, but do not do so with much regard for human notions of even pace and balance. We might prefer, were we gardening Yellowstone, to see to it that every age class and habitat type is equally represented in terms of acreage. This isn't how it happens.

The dates of those earlier large fire events are revealing. In 1988, Yellowstone was approaching a stage of high volatility again. An estimated 1.4 million acres of lodgepole pine in the park was 80 years old or older, and 32 percent of that was 250 years old or older. There may not have been an unnatural buildup of fuels, but there was without question a substantial natural buildup. When 1988, with its extraordinarily dry conditions and its unusual series of high winds, arrived, the park's forests were ripe for burning.

This is the barest summary of how fires have affected the Yellowstone setting. It leaves out several things, especially human influences. There are parts of the park where fire suppression activities since the establishment of Yellowstone in 1872 have probably changed what nature was doing quite a lot. There are heated debates these days over just how fire suppression has affected vegetation, especially on the northern range. There are also unanswered questions about how Native Americans set fires here as frequently as they did in other parts of the country, though there is little direct historical or anthropological evidence to prove or disprove these assumptions. New fires and new research bring new questions. As much as we already know about fire in Yellowstone, the summer of 1988 showed us that we still have a lot to learn.