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Western Forests: Wildland Fire Ecology and History

PERSPECTIVES BASED ON A CAREER IN FIRE AND FORESTRY RESEARCH

Fire Management *today*

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Frequent low-intensity fire shaped and maintained this stand of old-growth ponderosa pine on the Deschutes National Forest in Oregon. USDA Forest Service photo.

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A Giant in the Fire Ecology of Western Forests

Steve Arno standing next to a ponderosa pine in Montana with a fire scar from wildland fires used by American Indians to maintain open pine woodlands. USDA Forest Service by Bob Keane.

By Jerry Williams

On June 4, 2022, we lost a humble giant in the field of fire ecology. Stephen Francis Arno was a loved family man, an enthusiastic outdoorsman, a tireless hiker, and a gifted teacher.

Long before he became a research ecologist, Steve was a practicing forester. He was a keen and curious observer of the natural workings around him. Building on the work of scientists that came before him and through his writings with colleagues Stephen Allison-Bunnell, Carl Fiedler, and others, he introduced many to the history and ecology of wildland fire in our western forests. Although Steve loved the forest, he was especially drawn to ponderosa pine and intrigued by fire's role in sustaining it in a healthy, resilient, and safe condition.

Steve was a respected scientist among his peers, but it was his dedication to the field that endeared him to a generation of fire managers. He was an applied fire researcher, teaching us that structure, composition, and function help define the health of the ponderosa forest. His work explained that the West's iconic ponderosa pine forests were adapted to and depended upon frequent, low-intensity surface burning in order to maintain their open, resilient condition. His lessons gave

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us the ecological basis for prescribed burning in ponderosa pine. He wisely explained that “understanding the character of yesterday’s ponderosa forests provides insights into how they might be restored today.”

Using the ponderosa pine forest he managed on his own property near the Bitterroot River in Montana, he showed by example that thinning and periodic low-intensity burning prevented the kind of severe wildfires that scarred the landscape all around his land.

When we were both much younger, Steve gave me a fire-scarred ponderosa pine cross-section that he had collected on one of his fire history projects. Some years later, I took it with me to my first Washington Office assignment. I can’t count the number of people that asked about it. Along with George Gruell’s Lick Creek photos, that well-handled ponderosa round, showing evidence of almost two dozen very old fires, told a story that congressional staffers and policymakers found fascinating: not all fires kill all trees, and some fires play important roles in protecting and sustaining some forests. That show-and-tell went a long way in getting support for the first Cohesive Strategy in 2000 and the funding that followed.[1] It helped “move” the fire use program. I know Steve liked that.

Steve was a prolific writer and, although maybe a bit uncomfortable standing in front of a crowd, a brave public speaker. I think Steve always believed—deep down—that one day we would all “get it,” that we would realize the futility of trying to keep fire out of the remarkable fire-formed ponderosa pine forests around us and instead align our laws, our policies, our land management plans, and our practices to use fire in ways consistent with the fire regime dynamics that give life to these forests, give resilience to these forests, and keep us safe. ■

1 Protecting People and Sustaining Resources in Fire-Adapted Ecosystems—A Cohesive Strategy, published by the Forest Service on November 9, 2000 (Federal Register 65(218): 67480–67511).

A sign on Montana's Lolo National Forest reflects insights from Steve Arno's pioneering work on the role of wildland fire in forests of the American West. USDA Forest Service photo.

Steve Arno: A Lifelong Career in Forestry and Fire Ecology

Hutch Brown

This issue of *Fire Management Today* is dedicated to Steve Arno, remembered by fellow scientists and forestry practitioners as a national leader in forestry and fire ecology research.

I first learned of Steve Arno in connection with a visit to Seeley Lake on Montana's Lolo National Forest. The Girard Grove on Seeley Lake is an open old-growth stand of western larch and other conifers, most of them 600 years old or more.

Wondering why the open stand was there amidst the dense surrounding forest, I found the answer in "Mimicking Nature's Fire" (Arno and Fiedler 2005). In brief, American Indians had used the site for centuries, and they had kept it open for various purposes through frequent cultural burning. Arno's work was a key part of my introduction to the historical role of fire in the forests of the American West.

So when I received Arno's valedictory manuscript on his life and work (Arno, n.d.), I was very interested. Arno offered me the opportunity to publish whatever parts I wanted as editor of *Fire Management Today*, so I read the manuscript and began breaking out parts of it into articles. Some of his articles appeared in previous issues of this journal, but I reserved most for this issue.

Before he passed away, Arno reviewed and approved the articles presented here. Based as they are on the entirety of his life and work, they include references that might appear to be dated. That's partly because so much of Arno's work was historical in nature.

Steve Arno was an American forestry professional and researcher of exceptional stature. It was a real pleasure and privilege to have had the opportunity to work with him as his editor.

Some of the articles from Arno's manuscript appeared in previous issues of this journal, but most are presented here. All articles in this issue of *Fire Management Today* were adapted, with the author's permission, from Arno, n.d.

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Fire-Adapted Western Forests: The Role of American Indians

Stephen F. Arno

American culture is imbued with the belief that fire in the forest is bad. However, because early colonists in New England observed what American Indians had done through the ages, they recognized the need to maintain forests and pastures with wildland fire (Cronon 1983). Some of the earliest settlers in the Appalachians, the South, and parts of the West also grasped the logic of maintaining ecosystems with fire (Pyne 1982), but most newcomers from Europe called Indigenous Americans savages and rejected their knowledge.

MAGNIFICENT FIRE-SHAPED FORESTS

Long before European-American explorers and settlers arrived, forests in the West were largely the product of fires ignited by lightning and Native Americans. Many forests were composed of magnificent fire-adapted trees, including coastal Douglas-firs 7 to 10 feet (2–3 m) in diameter and 300 feet (90 m) tall, with corky fire-resistant bark 6 inches (15 cm) thick; the forests also had equally large thin-barked Sitka spruce. Immense western redcedars survived surface fires

Open ponderosa pine forest on the Deschutes National Forest, circa 1900. Such landscapes, maintained by low-severity fires ignited by lightning or American Indians, were once common in the West. USDA Forest Service photo.

Steve Arno was a research forester for the Forest Service, Fire Sciences Laboratory, Rocky Mountain Research Station, Missoula, MT.

thanks to their wet habitat and fluted butts, where their principal roots reached out to anchor the trees to wet ground. The fluted butts prevented surface fires from girdling the trees.

Fire scars on old-growth ponderosa pines and old stumps tell a story of frequent fires from the late 1400s until heavy grazing removed grassy fuels in the 1800s and fire control began in about 1900. Giant sequoias in California's Sierra Nevada grew within a mixed-conifer forest of ponderosa and sugar pines, and fire-scarred sequoias extend the fire history record back for more than 2,500 years. The stumps of these mammoth trees logged in the late 1800s remain undamaged by decay. Using gigantic chainsaws, Tom Swetnam and his colleagues from the University of Arizona sliced sections of sequoia stumps from Big Stump Basin and other places. The team from the Laboratory of Tree Ring Research painstakingly examined the fire scars. They amassed a record of fires at average intervals of 2 to 5 years in each sequoia grove (or 20 to 50 fires per century!), a sure sign of burning by Native Americans (Swetnam 1993; Swetnam and others 2009).

Studies of ancient sediments in ponds and lakes reveal a record of charcoal layers with tree pollen and macrofossils lined with fir needles, painting a picture of ancient forest composition and the associated fires going back to the end of the last Ice Age about 11,500 years ago (Mehringer 1996). Lewis and Clark observed and recorded several fires as they traveled through what is now Montana and Idaho, the majority attributed to American Indians (Gruell 1985a). On September 22, 1776, Spanish Jesuit missionary Father Silvestre Vélez de Escalante and his small party of explorers, hoping to spread Christianity to Indigenous people, were heading west over a pass in the Wasatch Range toward Utah Lake when they saw fires set by Native Americans (Roberts 2019):

> *Silvestre the [Native American] guide said they belonged to some of his people possibly out hunting. We returned the message with others [fires] to avoid being mistaken, should they have seen us, for hostile people and so have them run away or welcome us with arrows. Again, they began sending up bigger smoke clouds at the pass which we had to go through toward the lake—and this made us believe that they had already seen us, for this [fire] is the handiest and the regular signal used for anything worth knowing about by all the peoples in this part of America.*

Most newcomers from Europe called Indigenous Americans savages and rejected their knowledge.

In 1841, the Wilkes naval expedition observed and illustrated how American Indians burned much of Oregon's Willamette Valley on an annual basis (Wilkes 1845). Indigenous people had no means of and little interest in controlling the fires they set to favor food plants, to entice deer into unburned areas, to gather cooperating Tribes, or for countless other purposes. These are just a few examples of how we know that lightning- and human-caused fires once roamed the western landscapes unfettered, in many cases producing majestic forests that the early pioneers and lumbermen encountered. In recent years, many Tribes have recorded their traditional use of fire and described it as part of their deep spiritual relationship with a natural world that met their needs (Spence 2017). Their reverence for and interdependence with nature was—and still is—difficult to fathom within the framework of European-American culture.

MYTH OF THE VIRGIN LANDSCAPE

Two opposite views about the importance of fires set by Native Americans in western forests are entrenched even among ecologists. In the 1970s, American Indians were reluctant to disclose their knowledge of Tribes' historic use of fire, having long been forbidden by the Government to use wildland fire and chastised for using it.

However, several explorers, including the Corps of Discovery led by Captains Meriwether Lewis (1774–1809) and William Clark (1770–1838) and the 1830s trapper Warren Ferris (1810–73), left specific accounts of Indigenous people using wildland fire in the Northern Rockies. For example, Lewis and Clark described how their Native American escorts delighted in setting dead subalpine firs ablaze when they were camping together in Idaho, apparently as much fun as modern Fourth of July fireworks displays. In his journals, Ferris (1940) reported the following:

> *From the summit of Cota's Defile [a pass on the Continental Divide leading from Montana's Beaverhead Valley to Idaho's Lemhi Valley] we saw a dense cloud of smoke rising from the plains forty or fifty miles [64–80 km] leading to the southeastward, which we supposed to have been raised by the Flatheads, who accompanied Fontenelle to Cache Valley, and now were in quest of the village to which they belong.*

Ferris also witnessed fires used by the Blackfeet to gather warriors in order to massacre Flatheads, Nez Perce, other affiliated westside Tribes, and trappers when they gathered to hunt bison on the Great Plains.

Many ecologists and conservationists argue that wildland fires ignited by Indigenous people were localized and of little importance in long-term wildland fire history. This conveniently fits a view of the West as a virgin landscape prior to occupation by whites. Whites born in the United States often proudly proclaim themselves to be "natives," even though the true Native Americans are the Indigenous people displaced to reservations or allotted no land at all.

The mythical concept of western landscapes as primeval nature untouched by human hands was conveyed in Romantic-era paintings by Albert Bierstadt (1830–1902) and

A vertical scar made on a ponderosa pine by American Indians harvesting the sugar-rich inner bark for food on what is now the Bob Marshall Wilderness in Montana. American Indians used wildland fire to sustain the groves of old-growth pines. Note the heavy duff and litter buildup and the encroaching small trees—accumulating fuels that elevate wildfire risk. USDA Forest Service by Bob Keane.

Frederic Remington (1861–1909), followed by photographs in coffee table books by Ansel Adams (1902–84) and in 1970s issues of *National Geographic*. Similar portrayals of American landscapes as primeval nature appear in works by Henry Wadsworth Longfellow (1807–82), Henry David Thoreau (1817–62), and Ralph Waldo Emerson (1803–82), which have deeply influenced American culture. In sharp contrast are the paintings and behavior of artist Charles Marion Russell (1864–1926), who had deep respect for and many friends among the Indigenous Tribes.

Nostalgic romanticism is entrenched in American society. Untold millions of visitors queue up for half an hour or more to enter famous national parks and circle jam-packed parking areas to partake of "unspoiled nature." Modern romanticism is a big part of why millions move into fire-prone western forests, building homes in the wildland-urban interface. As philosophy professor Alston Chase, author of "Playing God in Yellowstone," pointed out in a 1990 interview (Petersen 2020): "As people move to cities, they become infatuated with fantasies of land untouched by humans." Surely, that fantasy is even more pervasive now, decades later, and it impedes efforts to restore a more wildfire-resistant forest.

Other ecologists—along with historians, anthropologists, archeologists who study the contents of 30,000-year-old packrat middens, and palynologists who study layers of pollen, needles, and charcoal in cores from the bottom of ponds extending back 12,000 years—have amassed evidence that fires ignited by American Indians, as well as lightning, spread unchecked over vast western landscapes. This seems obvious in view of the fact that Native Americans had no means of extinguishing large fires ignited for signaling, for clearing out areas around Tribal campgrounds, or for other purposes.

In the 1950s, the historian Omer Stewart tried to publish a revolutionary book based on extensive research, including interviews with Indigenous American elders. Perhaps because the book challenged the orthodox opinion of anthropologists regarding Indigenous landscape management, the manuscript was rejected. As opinions changed, Henry Lewis and M. Kat Anderson published Stewart's book after he died. "Forgotten Fires: Native Americans and the Transient Wilderness" documents the use of wildland fire by Indigenous people in Eastern, Midwestern, and Western States (Stewart 2002).

In the 1980s, the wildlife biologist George Gruell published papers documenting evidence of wildland fire use by Indigenous people in the West (Gruell 1985a, 1985b). Since Stewart's book first appeared, many authors have produced more evidence for the importance of burning by American Indians in western forests. In 2001, Gruell published a book of old photos and retakes called "Fire in Sierra Nevada Forests" (Gruell 2001).

In 2005, M. Kat Anderson published "Tending the Wild: Native American Knowledge and the Management of California's Natural Resources." The book contains detailed information, including documents and interviews with American Indian elders from the early 1900s, on the many uses of wildland fire in grasslands, chaparral, oak woodlands, coastal prairies, and forests.

Robert Boyd sought out several authors in the greater Pacific Northwest and edited their articles in "Indians, Fire, and the Land in the Pacific Northwest" (Boyd 1999). The bestseller "1491: New Revelations of the Americas Before Columbus" revealed recently unearthed knowledge about Native peoples' major impact on much of North America (Mann 2005). William Cronon, an environmental historian, has produced or inspired several publications on this subject (Cronon 1983, 1995; Dowie 2019).

In 1976, Jeff Hart wrote "Montana Native Plants and Early Peoples," published by the Montana Historical Society and reprinted due to high demand (Hart 1996). Hart obtained much of his information from American Indian elders. To gain credibility with Tribal people—who had been exploited by whites for more than a century—he had to arrive at their homes, hope they were there, and then show friendship and disregard time. Often, he had to visit multiple times; eventually, most would trust him and divulge their knowledge.

In the late 1970s, Steve Barrett, a graduate student at the University of Montana who was interested in historical fires, contacted me for advice on what to choose for a graduate project. He readily agreed to learn all he could about wildland fire use by American Indians for his master's thesis. In addition to searching the historical literature and talking with knowledgeable historians, I suggested that he should follow Jeff Hart's methods of interviewing Tribal elders. Barrett obtained extensive knowledge about burning practices by American Indians; his 1980 thesis compared fire history in places where Native peoples concentrated with comparable sites that were more remote, revealing that the remote areas had about half as many fires recorded in their tree-scar chronologies. We published a joint article in *Journal of Forestry* (Barrett and Arno 1982). Barrett went on to publish more articles and carve out a niche as a fire history and fire ecology consultant (see, for example, Barrett 1999a, 1999b, 2000a, 2000b).

Modern romanticism is a big part of why millions move into fire-prone western forests.

THE UPSHOT

The belief that fire in the forest is bad began with a misreading of the environment centuries before the science of ecology developed. As White Americans severed the ties between Indigenous people and their lands and attempted to remove fire as well, they ignored the fundamental ecology of fire-adapted ecosystems across the West. Disregarding fire's effects on western forests produced a massive increase in forest canopy density, with the number of trees per acre often increasing a hundredfold since the late 1800s.

As small and midsize trees proliferated in many western forests, they created fuel ladders that virtually ensure that any ignition will blow up into the forest canopy. Under dry conditions, running crown fires plague much of the West and even reach Eastern States, like the Great Smoky Mountains wildfires that destroyed much of Gatlinburg and other communities in eastern Tennessee in November 2016.

When I give presentations on why western forests are fire dependent and what we might do to restore a few of them, people often ask how we got into this vicious cycle in the first place. Our predicament originated in forestry curriculums in Europe dating to the late 1700s, brought to the United States in 1898 by Carl Schenck at his Biltmore Forest School in Ashville, NC; by Bernhard Fernow at Cornell University; and by Gifford Pinchot and Henry Graves at Yale University.

To its credit, the Forest Service, which led early efforts to eliminate fire from America's forests, has become increasingly committed since the 1970s to returning a reasonable semblance of the beneficial effects of historical wildland fires. As fire ecology emerged within environmental science in the 1970s, Forest Service leaders and related personnel came to support management of fire and fuels as a means of restoring forests. Huge barriers prevent using prescribed fire, fuel removal, thinning, and carefully crafted timber harvesting at the scale needed, but small-scale progress is possible if the public supports it.

Prescribed fire in 2019 in ponderosa pine on the Ochoco National Forest in Oregon. The fire reduced surface fuels, including litter, grasses, and small trees without damaging most mature trees. Fire managers are replicating the historical effects of wide-ranging surface fires ignited by Indigenous Americans or lightning. USDA Forest Service photo.

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The "Light Burning" Controversy

Stephen F. Arno

Early colonists in New England, observing what American Indians had done through the ages, recognized the need to maintain forests and pastures with wildland fire (Cronon 1983). Some of the earliest settlers in the Appalachians, the South, and parts of the West also grasped the logic of maintaining ecosystems with fire (Pyne 1982). Until the 20th century, fire use traditions remained in many parts of the United States, including among forest landowners in California who managed their lands for timber.

REASONS FOR ELIMINATING FIRE

On his early visits to western forests, Gifford Pinchot—who helped found the Forest Service in 1905 and served as its first Chief—recognized the role that occasional fires played in perpetuating the giant Douglas-firs in northwestern coastal areas. In 1899, he published an article in *National Geographic* describing the role of fire in these forests, observing that without fires, valuable Douglas-firs would gradually be

Forest land cutover, burned over, and left to degrade near Leadville, CO, in 1915. The early Forest Service used such scenes of destruction to argue that wildland fire had no place in the woods. USDA Forest Service photo by S.T. Dana.

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replaced by smaller and less profitable western hemlocks (Pinchot 1899). In "Breaking New Ground," his autobiographical account of the early Forest Service, Pinchot wrote that he had seen Douglas-fir reproduction only in places that had burned, yet he remained careful not to encourage use of fire in forests (Pinchot 1947).

John Leiberg, who inspected the Bitterroot Forest Reserve in Idaho and Montana in the 1890s, was blunt about wildland fire: "The aftereffects of fires in this region are various, but are always evil, without a single redeeming feature" (Leiberg 1900). It was a surprising statement from an otherwise perceptive naturalist (Nisbet 2018); for example, Leiberg reported—correctly, as it turned out—that a huge glacial lake must have filled the valleys of western Montana and drained rapidly downstream, creating gigantic floods multiple times. Leiberg based his inference on the grass-covered mountain slopes with multiple shoreline terraces. The presence of Glacial Lake Missoula and its catastrophic flooding of eastern Washington, known as the Channeled Scablands, wasn't confirmed by geologists until the 1950s!

Leiberg shared Pinchot's view that fire should be kept out of western forests, which was understandable in

Gifford Pinchot in 1910 at his desk in Washington, DC, near the end of his tenure as Forest Service Chief. Though aware of the ecological role of fire in American forests, Pinchot advocated a policy of fire exclusion for the Forest Service. USDA Forest Service photo.

A crusade to save the forest reserves from wildfire seemed necessary to fulfill the Forest Service mission.

the early 1900s. During Pinchot's time with the Forest Service, destructive wildfires often resulted from fires left burning or deliberately ignited by campers, loggers, homesteaders, and ranchers. Prospectors set fire to whole mountainsides to expose mineral deposits. Forest clearing for railroads produced great accumulations of tinder-dry branches along rights-of-way, and trains spewed sparks that lit adjacent forests on fire.

An infamous forest fire that started the same day in 1871 as the Great Chicago Fire overran the frontier town of Peshtigo, WI, killing about 1,500 people and burning more than a million acres (400,000 ha). In 1894, the Hinkley Fires in Minnesota claimed 418 lives. In the Pacific Northwest, a series of blazes on September 12–13, 1902, was fueled by logging slash and settler fires as well as driven by high winds. These Yacolt Fires burned about a million acres (400,000 ha) in southwestern Washington and nearby Oregon, killing 38 people. Loggers, settlers, and wild animals plunged into Trout Lake in Washington to save themselves from the deadly conflagration ([No author] 2017).

In 1898, when Pinchot was appointed head of the Bureau of Forestry in USDA, he had a staff of 60. By 1905, when Congress created the Forest Service, he had 500 full-time employees. The fledgling Forest Service needed to gain visibility and funding from a Congress ruled by parsimonious "Uncle Joe" Cannon (R–IL), also called "The Czar." The Organic Administration Act of 1897 specified that Forest Service had to protect the forest reserves, sustain forested watersheds, and manage forests to produce a continuous supply of timber for the citizens of the United States. This brief act and its subsequent amendments governed the Forest Service until Congress passed the Multiple Use–Sustained Yield Act in 1960.

A crusade to save the forest reserves from wildfire seemed necessary to fulfill the mission (Egan 2009), and it allowed Forest Service Chief Pinchot and Assistant Chief Henry Graves to hire and train a large cadre of foresters, many of whom attended Yale's School of Forestry, founded by Pinchot and Graves in 1900. Both men came from wealthy northeastern families. In Pennsylvania, Pinchot's father, troubled by the ravages of abusive logging, had encouraged young Gifford to take up the field of forestry, virtually unknown in the United States at the time. Pinchot traveled to Europe and studied with professional foresters in France and Germany, bringing their ideas back to the United States and adapting them to American conditions.

COUNTERING THE "LIGHT BURNERS"

In his groundbreaking book "Fire in America: A Cultural History of Wildland and Rural Fire," Stephen Pyne devotes an entire chapter to the "light burning" controversy at the turn of the 20th century (Pyne 1982). He concludes that there was no good reason for Pinchot and other early foresters to reject intentional low-intensity burning of forests to control fuel buildups or for other beneficial purposes, called "light burning" by its practitioners. Beneficial burning had long been practiced in England and British-controlled India and was advocated by some prominent scientists, including Franklin Hough (who had headed the USDA Division of Forestry a decade before Pinchot). Many American foresters came to recognize the value of broadcast burning under certain conditions, but the Forest Service fought the practice in the early 1900s just as it was gaining traction.

The primary spokesmen for light burning were settlers and timberland owners in northeastern California, who used the practice to control fuel buildups and prevent conflagrations. Romantic-era poet Joaquin Miller described light burning as a return to Indigenous American's way of managing the forest. Even John Wesley Powell, the intrepid Grand Canyon explorer and Director of the U.S. Geological Survey, advocated light burning. Powell's allusion to Paiute burning practices offered the Forest Service a chance to belittle the practice as "Paiute forestry" at a time when whites generally regarded American Indians as ignorant savages (Greeley 1920; Pyne 1982). In a sense, light burning advocates and American Indians who used wildland fire discerned the importance of fire ecology long before it gained a place in the ecosystem sciences of the late 20th century.

After the 1902 Yacolt wildfire catastrophe in Washington and Oregon, Pinchot's Bureau of Forestry accelerated efforts to control fires. In 1905, the year when the Forest Service was established, Dr. Urling Coe moved to the frontier town of Bend, OR, surrounded by a vast ponderosa pine forest. Coe's memoir "Frontier Doctor" provides a vivid account of the role of fire in sustaining open ponderosa pine forests and the light burning practices of local timberland owners (Coe 1939):

> *When I came to eastern Oregon in 1905, all of the beautiful pine timber was an open parklike forest. … Each summer there were many forest fires, the vast majority of which were caused by lightning. As there was no underbrush, these fires consumed nothing but the dead pine needles, cones, and twigs that had been blown to the ground by the winds. The little blaze, only a few inches high, crept slowly over the ground and cleaned the forest of all debris. … It was these annual fires which had existed for centuries that had produced the beautiful open forests.*
>
> *No one tried to put these annual fires out, as they were known to be a benefit to the timber. When the big lumber companies began to buy the timber, their representatives in the field saw to it that their holdings were burned over every year. If the lightning did not start enough fires, the timber men started more of them.*
>
> *[Then the Government foresters arrived.] These new rangers were fine young fellows, mostly college men, who had acquired their knowledge of forestry from books and knew nothing about local conditions. They all had the same conviction and that was that fire should be kept out of the timber at all times at all costs. … The experienced timber men on the ground tried to convince them that fire was necessary and beneficial to Oregon pine, but it was useless.*

Forest Service Special Agent J.T. Jardine fighting a surface fire on Oregon's Wallowa National Forest near the Billy Meadow Ranger Station in 1908. Such low-severity wildland fires sustained open ponderosa pine woodlands like this for thousands of years; their suppression led to fuel buildups and high-severity crown fires. USDA Forest Service by W.J. Lubken.

T.B. Walker's Red River Lumber Company owned 900,000 acres (360,000 ha) of ponderosa pine and mixed-conifer timberland in northeastern California, and the company practiced light burning. Walker even donated $100,000 (about $2 million in 2018) of his own funds to get the Yale Forestry School and the Forest Service to test the practice (Pyne 1982). The recipients apparently used the money for other purposes.

Other timberland owners advocated light burning in print. One of them, George Hoxie, published an article in Sunset magazine in 1910 arguing that "[w]e must count on fire to help in practical forestry … as a servant … [otherwise] it will surely be master in a short time" (Hoxie 1910). Light burning was also practiced by ponderosa pine timberland owners in central Oregon, northwestern Montana, and South Dakota's Black Hills.

In ponderosa pine forests, the oldest needles, typically 4 to 5 years old, turn brown and drop off in late summer and autumn, accumulating in prodigious quantity. This is an adaptation that virtually ensures frequent fire, which historically sustained open-grown pine forests.

Unfortunately, Hoxie's article coincided with the Big Blowup of 1910 (Arno 2021). Moreover, one of Walker's light burns blew up and burned 33,000 acres (12,000 ha) before it was stopped at the edge of a national forest. Then, as now, few people discerned the difference between burning a layer of dead pine needles and other litter beneath an open-grown forest and a wildfire burning dense forest augmented by heavy slash. Fire exclusion became the order of the day by the late 1930s. The Forest Service

Light burning advocates discerned the importance of fire ecology long before it gained a place in ecosystem science.

was pursuing a policy of extinguishing all wildfires by 10 A.M. on the morning after they were first reported.

AFTERMATH

The 10 A.M. Policy notwithstanding, many foresters continued using wildland fire for silvicultural purposes, including some in the Forest Service. Broadcast burning was a tradition in pinelands of the Southeast and is still applied extensively on both private and public lands. In several Southeastern States, "Right to Burn" legislation limits claims to actual damage if a properly executed fire escapes, shielding burners from claims for punitive damage. The State of Washington, encouraged by a large collaborative organization in the State's northeastern corner, enacted comparable legislation. Fire science students from the University of Montana are routinely transported to a large tract in Georgia, managed by The Nature Conservancy, to learn how to apply prescribed fire on the ground, a measure of the South's ongoing leadership.

There were also other inklings that controlled burning might be useful in managing forests. In a 1910 Forest Service publication, pioneering ecologist Frederic Clements advocated using fire for managing high-elevation lodgepole pine forests in Colorado (Clements 1910). However, Clements and other ecologists developed models of "natural" forest succession, suggesting that the conceptual endpoint of forest development—the "climax" forest—is the ideal condition (Clements 1936). Under this theory, a coastal Douglas-fir forest would be exemplary if the giant trees were replaced by a thick forest of western hemlock, likely scourged by root rot and other diseases. Many ecologists and students still believe that the "climax" represents perfection and that fire-maintained forests are less desirable, no matter what history tells us.

The Forest Service rejected pleas by Walker, the lumber company owner, to cooperate in developing a systematic approach to burning the understory of northeastern California's forests, dominated by ponderosa pine and sugar pine. Based on forestry models imported from Europe, the Forest Service believed that mixed-conifer stands needed far more trees and that light burning would kill saplings. These seemed to be plausible judgments, based on a concept that most of the West's inland forests could be converted to fast-growing plantations like those in Europe.

However, the European model applied to relatively humid habitats that can support more trees in plantations, where they are harvested when only about 50 years old—much younger and smaller than the long-lived trees in the American West. Walker and other timberland owners were harvesting groups of much bigger trees, and vigorous pine saplings survived light burns in openings to successfully grow, a paradigm that has now been repeatedly validated. The Forest Service was also concerned that burning would cause basal scars on tree trunks, lowering their value for lumber; but deliberate burning at predetermined intervals greatly limits this kind of damage. Despite a few proponents of burning and an almost under-the-table policy of allowing burns only in the American South, it would take the Forest Service decades before it began to embrace the benefits and necessity of using fire to manage forests.

Prescribed burning in 1954 in an open longleaf pine woodland on a national forest in Florida. USDA Forest Service photo by Daniel O. Todd.

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The Emergence of Fire Control in the United States

Stephen F. Arno

The light burning controversy of the early 1900s, together with the debacle of the Big Blowup of 1910 (Arno 2021; Egan 2009), induced the Forest Service to adopt a policy of systematic fire protection (Greeley 1920). Under the Clarke–McNary Act of 1924, the agency oversaw generous Federal funding for cooperating fire control entities, including State and other Federal agencies, provided that they followed specific fire control guidelines (Pyne 1982). Rising Forest Service hegemony over national fire policy quashed open advocacy of light burning in Sequoia National Park, for example, by Superintendent Colonel John White. Unable to compete with the Forest Service juggernaut, light burning advocates faded away by 1930.

SYSTEMATIC FIRE PROTECTION

Federal patronage expanded greatly in 1933 under President Franklin Roosevelt's New Deal work programs, especially the Civilian Conservation Corps (CCC). Stephen Pyne's exhaustive research revealed that the CCC constructed 1,629 lookout towers and dwellings and nearly 40,000 miles

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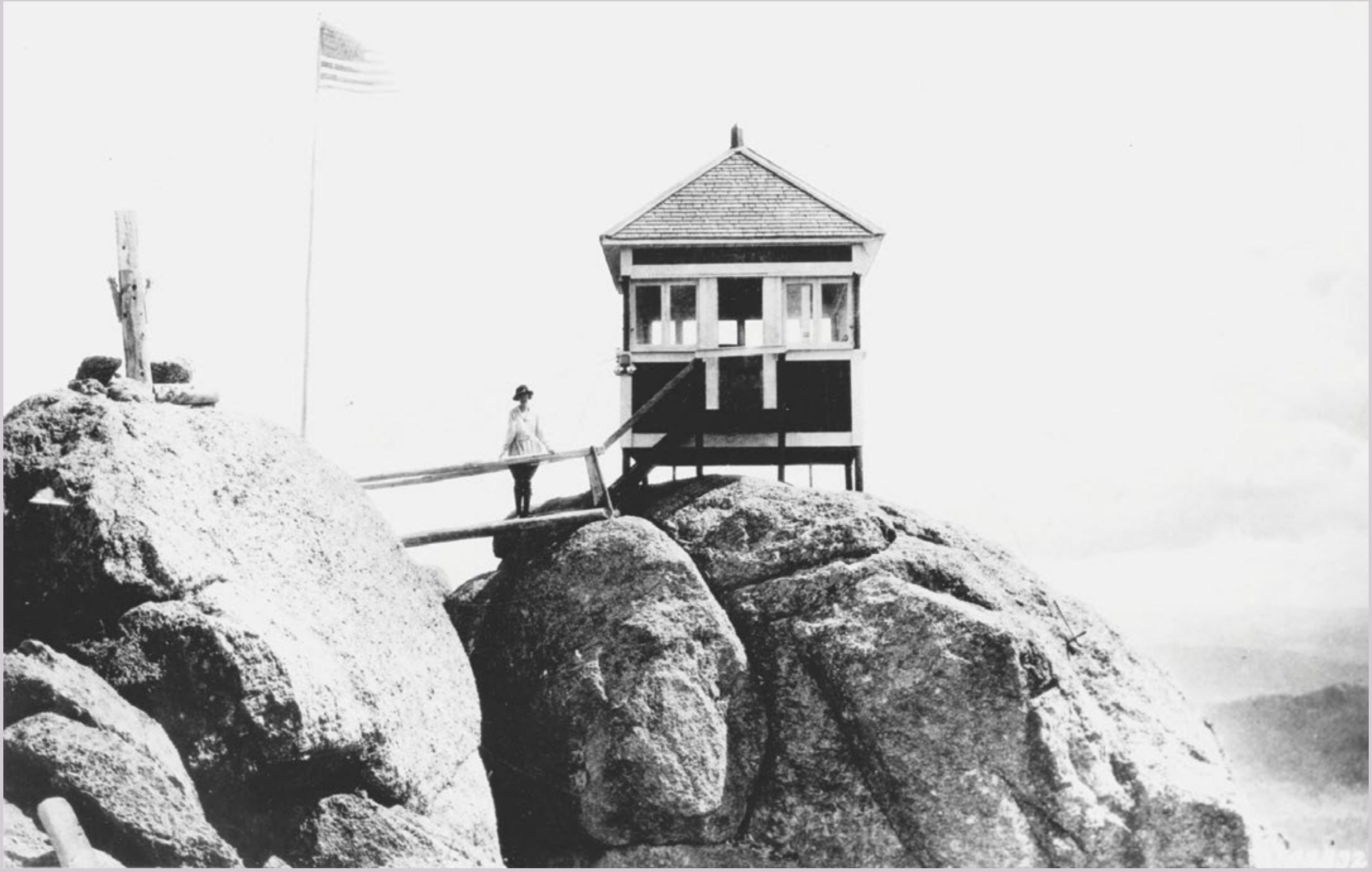
Jackknife Lookout Tower, Kaniksu National Forest, Idaho, in 1932. USDA Forest Service photo by K.D. Swan.



Devil's Head Fire Lookout on the Pike National Forest in Colorado in 1919, with Helen Dowe as seasonal fire lookout. USDA Forest Service photo by F.E. Colburn.

(64,000 km) of telephone "ground lines" to connect lookouts to fire crew dispatchers (Pyne 1982). Some of the prefabricated lookout buildings were small cupolas, as little as 12 feet by 12 feet (3.7 × 3.7 m) in size, perched atop sharp boulder-clad peaks. Despite their picturesque locations and status as national historic buildings, they are hard for hikers to climb up to today.

In large wild areas (such as the huge area of Montana backcountry now designated as the Bob Marshall Wilderness complex), hand-crank telephones were mounted on trees and at remote Forest Service log cabins for lookouts to relay information about wildfires, order supplies, request evacuation when sick, or report on injured hikers. Some backcountry phones are still in use, although compact battery-operated radios are now mainly used and carried by all fire crew members.

Today, only a small percentage of the lookouts are used by seasonal Forest Service personnel because aerial surveillance, especially after lightning storms, became the norm in the late 20th century, augmented in the 21st century by satellite tracking of lightning strikes and the fires they started. Of course, watching for human-caused wildfires is also important, even in wilderness areas. Many lookouts are manned by volunteers; like the seasonal lookout tenders of days gone by, they often come back summer after summer. When lookout houses are occupied, visitors are welcomed. Some lookouts are also available as rental cabins.

The CCC built 43,000 miles (69,000 km) of narrow one-lane truck roads and more than 8,000 miles (12,900 km) of foot trails to improve access to fires and high-mountain lookouts. Starting in 1930, the CCC built specialized corrals, and they ordered big trucks to quickly haul mules that packed supplies and equipment for fighting fires in the backcountry. Three hundred mules were pastured at just one of these stations—the Ninemile Remount Depot and Ranger Station (Pyne 1982). Similar trucks with hard wooden seats and tall sideboards hauled fire crews up the same rough roads to the nearest trailhead or access point for attacking the fires. Riding in one of these trucks must have been akin to riding on the wooden benches of a Conestoga wagon on the Oregon Trail.

In 1934, coincident with the massive upsurge in firefighting capacity for the Forest Service through the CCC, a deluge of wildfires struck northern Idaho's biggest wild area in the rugged mountains of the upper Clearwater River drainage. This embarrassed the Forest Service's Northern Region, which had just established the Ninemile mule operation together with roads to rush mules and firefighters into that very drainage.

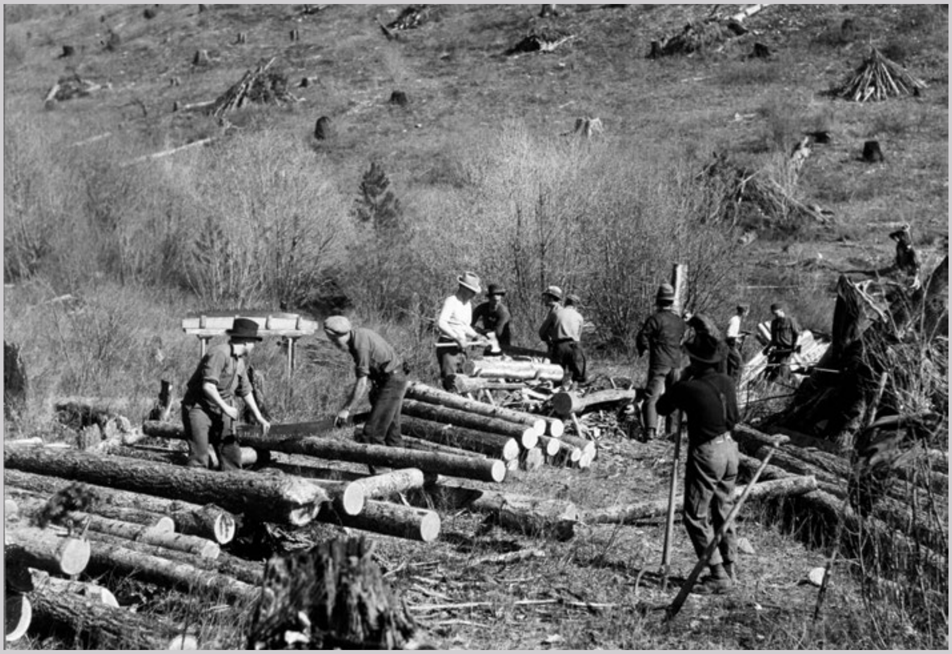
RAMPING UP FIRE CONTROL

In 1935, the Forest Service established the 10 A.M. Policy of controlling every wildfire by 10 A.M. on the day after it was first detected (Pyne 1982). Forest Service leaders attributed conflagrations to lack of aggressive fire control, necessitating the 10 A.M. rule. Mindful of funding limits, however, they allowed line officers to give inaccessible fires low priority, which could be confusing for district rangers. Nevertheless, the 10 A.M. Policy remained in effect until the 1970s, when increasing numbers of Forest Service personnel began questioning its usefulness.

At about the same time, aerial delivery of "water bombs" and smokejumpers was proposed (Pyne 1982). The Soviet Union started using smokejumpers in 1936, followed by the United States in 1939, when daring men dropped experimentally into forests in Washington's Methow Valley. The first deployment of smokejumpers on a fire was in 1940 on Idaho's Nez Perce National Forest; from then on, the program expanded, with smokejumper bases now located across the West.

America's entry into World War II (1941–45) gave public support for eliminating wildland fire additional impetus. Japan launched hundreds of incendiary balloons intended to start wildfires in western forests. Although they achieved little success, the Forest Service used the balloons in posters as an effective scare tactic (Pyne 1982).

In 1919, the U.S. Army Air Corps (forerunner of today's U.S. Air Force) joined fire control efforts with surveillance flights to spot fires in the backcountry. After World War II, the military worked with the Forest Service and its cooperators to adapt military planes for use in fighting fires (Pyne 1982). Military planes were modified and retrofitted to drop smokejumpers, fire equipment, and supplies; by the 1950s, aircraft were dropping water and chemical fire retardant on wildfires. Aerial accomplishments enhanced public enthusiasm for the "war against wildfire."



Civilian Conservation Corps crew making a fence in 1934 for the Forest Service's Ninemile Remount Depot pasture on the Lolo National Forest in Montana. USDA Forest Service photo by K.D. Swan.

Staged photo showing various kinds of aerial and ground equipment involved in wildland fire suppression by the 1950s, Shasta–Trinity National Forest, California. USDA Forest Service photo by Donald J. Lewis.

In 1935, the Forest Service established the 10 A.M. Policy of swiftly controlling every wildfire.

BAMBI AND SMOKEY'S DEBUT

Walt Disney's dramatic animated movie "Bambi" was very effective in aiding the Forest Service's campaign against wildland fire. First released in 1942 and re-released multiple times, this enormously popular movie has a frightening scene showing a heroic deer trying to escape a devastating wildfire caused by a "hunter" who is actually a diabolical poacher.

R.H. Lutts published a fascinating analysis of the movie under the title, "The Trouble with Bambi: Walt Disney's Bambi and the American Vision of Nature" (Lutts 1992). He argued that the movie presented "a distorted image of woodland ecology" and created adverse effects. When "Bambi" appeared, a chronically overpopulated deer herd in Wisconsin was denuding forage plants and preventing ecologically important broadleaved shrubs and trees from regenerating. Conservationist Aldo Leopold, who had waged a hard-won campaign to reduce the herd by allowing does to be harvested, found it suddenly derailed by the popularity of "Bambi."

In 1982, this Smokey Bear fire prevention poster drew on the Bambi legacy from 1942. USDA National Agricultural Library, Special Collections image.

During World War II, timber resources were needed for the war effort. The Ad Council, created in 1942 to mobilize the advertising industry in support of the war, began working with the Forest Service to promote fire prevention. Soon after "Bambi" appeared, the Ad Council purchased the right to use the animated deer to highlight its fire prevention posters.

In 1944, the Ad Council replaced Bambi with Smokey Bear, who began appearing on posters with his trademark slogan, "Only You Can Prevent Forest Fires." Like Bambi, Smokey conveyed the idea that forest fires are inherently destructive and unnatural, even though many fires are ignited by lightning. To this day, the Ad Council controls the tremendously successful Smokey Bear campaign; when the Forest Service abandoned its 10 A.M. Policy in the 1970s in favor of a more nuanced approach to wildland fire management, Smokey's message remained the same.

At first, Smokey was no more than an illustrated drawing. In 1950, however, a bear cub with burnt paws was rescued from a fire in New Mexico (Pyne 1982). Turned into "the living symbol of Smokey Bear," the cub drew much media fanfare. Soon Smokey educational materials and mementos were distributed to grade schools, a tradition that continues to this day.

FIRE CONTROL DOMINANCE

With origins in 19th-century forestry concepts and practices adopted from northern Europe, fire control came to dominate professional forestry and wildland fire management in the United States throughout most of the 20th century. Nevertheless, light burning persisted in parts of the South, where even the Forest Service continued using prescribed fire. Moreover, the effects of fuel buildups led to rising concerns, and discoveries in the nascent field of fire ecology raised growing doubts about fire exclusion, leading to eventual reforms.

Walt Disney's "Bambi" was very effective in aiding the Forest Service's campaign against wildland fire.

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The Emergence of Alternatives to Fire

Stephen F. Arno

Under Forest Service leadership, a policy of fire exclusion took hold in the United States in the early 1900s and prevailed throughout most of the century. The adverse results are apparent today. In open-grown ponderosa pine forests, for example, fallen pine needles, other leaf litter, and pitchy pine cones piled up on the forest floor for decades, as did dead shrubs and branches and tangles of fallen trees. In most western forests, conditions are so dry that such surface fuels don't readily decompose; historically, they were recycled by wildland fires. As a result, the accumulating surface fuels heightened the intensity of running crown fires.

Today, many wildfires erupt so suddenly in California and other Western States that firefighters can't attack them in time—or directly at all. In November 2018, for example, the Camp Fire destroyed Paradise, CA, in a flash, taking 85 lives within the first 24 hours (Brown 2020). In terms of lives lost and structures destroyed, it was the most devastating in California's long history of severe wildfires.

Aftermath of the Camp Fire on November 8, 2018, which ravaged the community of Paradise in the Sierra Nevada of California within a matter of hours. A Forest Service law enforcement officer surveys the damage to homes and property. USDA Forest Service photo by Tanner Hembree.

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Conditions for the Camp Fire's "perfect storm" took time to develop, and they stand in stark contrast with what firefighters experienced in the mid-20th century. Many long-retired firefighters don't understand today's conditions, and they get angry when big fires near where they live aren't attacked directly like they used to be.

DISSENT FROM WITHIN

Some foresters had early misgivings about the policy of fire control. They included Elers Koch, part of the first generation of foresters and wildland firefighters in the Forest Service.

Koch was one of the few early Forest Service recruits who was born and raised in the West. He lamented the impotence of the greatly expanded firefighting force and regretted the roads being built into rugged mountains where timber harvesting was impractical and the terrain highly erosive (Koch 1935). He pled his case in a detailed letter to the Forest Service Chief; then, in 1935, he published his fervent beliefs in a *Journal of Forestry* article titled "The Passing of the Lolo Trail," referring to the route that the Corps of Discovery, led by Captains Meriwether Lewis and William Clark, had taken across the Bitterroot Mountains in 1805 and 1806.

One wonders what Gifford Pinchot, founder of both the Forest Service and the *Journal of Forestry*, thought about the radical view argued by his erstwhile protege, Elers Koch. However, Koch's views were not new within the Forest Service. High-ranking officials in the agency had repeatedly questioned the need to promptly suppress wildfires in remote areas, but these views were expressed in private think-tank sessions and not eloquently presented in publication, as Koch had done.

In any case, Aldo Leopold and Bob Marshall, both instrumental in establishing today's National Wilderness Preservation System, were the only prominent Forest Service employees to endorse Koch's view. The Forest Service's national office in Washington, DC, arranged for a rebuttal, to be paired in the *Journal* with Koch's article.

Forest ranger on fire patrol in 1909 on what is now the Lolo National Forest in Montana. Some early line officers for the Forest Service questioned the need for fire control and the related roadbuilding in the backcountry. USDA Forest Service photo by W.J. Lubken.

SOUTHERN BURNING WON'T DIE

Meanwhile, controlled burning continued in the Southern States. The long tradition of laissez-faire burning in the hills of the rural South, captured in the phrase, "My pappy burned the woods," lasted well into the 20th century (Pyne 1982).

On the broad Coastal Plain from eastern Texas to southern Virginia, the dominant forest type was originally fire-dependent longleaf pine, which covered an estimated 60 million acres (24 million ha). After an 1840 trip, Mississippi Congressman John Claiborne described the Coastal Plain as nearly pure longleaf pine "rolling like the waves in the middle of the great ocean. The grass grows three feet [1 m] high and hill and valley are studded all over with flowers of every hue" (Claiborne 1906).

By 1910, when Federal foresters started focusing on the South, its forests were being destructively logged and overgrazed by cattle and hogs. Longleaf pine wasn't regenerating, and biologists speculated that wildland fire might be necessary for restoring the pinelands. A professor at Yale's School of Forestry named H.H. Chapman began long-term studies of controlled burning and fire exclusion.

Excluding fire while also preventing destructive livestock grazing allowed dense brush and palmetto plants to rapidly grow. This highly combustible and nearly impenetrable type of vegetation is often called "southern rough." Chapman found that the rough could be controlled with fire and that burning at intervals of a few years allowed longleaf pine seedlings to attain a larger, fire-resistant size (Early 2004). This form of burning also controlled the brown spot needle disease that kills pine seedlings.

Today, southern rough is a prime breeding ground for the estimated 6 million feral hogs that, according to USDA, cause about $2.5 billion in damage to crops and recreation areas each year. Despite year-round hunting, feral hogs are extremely hard to kill or trap in their dense hideouts. The hogs have now spread to several Western and Northern States as well as to southern Canada. Wildlife biologists are watchful and trying to control this invasive species.

Chapman's publicized findings were bolstered by other studies showing that burning the pinelands enhanced their forage value for livestock. In 1931, the U.S. Biological Survey published studies showing that fire is essential for maintaining habitat for the South's premiere game bird, bobwhite quail, a prime attraction at hunting resorts. The rapid buildup of southern rough and the wildfire hazards it posed caused field foresters to urge Forest Service administrators to allow controlled burning. By 1934, the agency's Southern Research Station recommended to administrators that skilled technicians be allowed to use controlled fire (Pyne 1982).

The Forest Service's national office feared that allowing controlled burning in the South would revive advocacy for light burning in the West. The Forest Service therefore suppressed research findings that supported fire use in the South while covertly allowing the practice to proceed. In December 1943, the wartime shortage of firefighters and compelling evidence in favor of controlled burning prompted Forest Service Chief Lyle Watts to formally sanction the use of fire, but only in the South (Pyne 1982).

WEAVER: A BOMBSHELL IN THE WEST

Interest in light burning in the West had already revived. In January 1943, the *Journal of Forestry* published a revolutionary article by Harold Weaver, a forester with the Indian Service (now the Bureau of Indian Affairs). Weaver made the case for controlled burning in the West's extensive ponderosa pine forests for both practical and ecological reasons. Eight years after Elers Koch's critique of backcountry fire policy, this new article provided strong evidence for burning in commercial forests, in effect legitimizing the case for light burning.

Weaver (1943) recounted fire's historical role and its contribution to timber management based on his long experience. This was a bombshell out of the blue for most members of the Society of American Foresters. They probably wondered how a Federal forester could publish such heresy, but it quickly became clear as they started reading. For one thing, the article was accompanied by the unique disclaimer that it "represents the author's views only and is not to be regarded in any way as an expression of the attitude of the Indian Service." Some foresters probably hadn't heard of the Indian Service, let alone that it conducted forestry on Indian reservations. (Tribes conduct their own forestry and fire operations today.)

Fire is essential for maintaining habitat for the South's premiere game bird, bobwhite quail.

The disclaimer was doubtless an attempt to shield the Indian Service from Forest Service wrath. The article had been heavily scrutinized and was followed in the same issue of the journal by a rebuttal crafted by high officials in the Forest Service. Nevertheless, Weaver's article lived up to its title—"Fire as an Ecological Factor in the Ponderosa Pine Region of the Pacific Slope"—starting a movement for burning in the West that wouldn't die.

Weaver had a low-key demeanor but was earnest and persistent in working with others to test different approaches to thinning and selective harvesting combined with controlled fire, also known as broadcast burning because it was ignited in a way that would allow low-intensity fire to spread throughout a parcel of forest. By 1943, he had considerable experience using these techniques on different Indian reservations, and his article presented clear photographic evidence to support his claims.

In a later article, Weaver explained his conversion to acceptance of testing for broadcast burning (Weaver 1968). He grew up in the mining and logging country of central Oregon's Blue Mountains; as a young man, he graduated with a degree in forestry from Oregon State College (now University) in 1928. As he put it, he was "thoroughly imbued at the time with the incompatibility of [ponderosa] pine forestry and fire."

Controlled burn in a longleaf pine stand in Georgia in 1927. The caption to this Forest Service photo was terse and without comment, reflecting general agency disapproval, despite a practical willingness to tolerate fire use in the South. USDA Forest Service photo by E.S. Shipp.

Soon, he was working in central Oregon's ponderosa pine forest and was shocked when experienced woodsmen—and even a renowned entomologist who was an expert on tree-killing bark beetles—told him that keeping fire out of the forest was a serious mistake. Young Weaver countered with the conventional forestry argument that pines couldn't regenerate if fires were used, but the entomologist showed him stands containing pine saplings, many of which had fire scars and survived to continue growing.

This revelation induced Weaver to inspect fire scars on stumps of previously logged trees, and he noticed from the obvious scars from multiple fires that the trees had survived with little damage. He dated the scars and periods between fires by counting growth rings on many stumps, and he found that low-intensity fires occurred at intervals of 5 to 25 years dating back to the 17th and 18th centuries.

Historically, surface fires thinned young trees, killing more small Douglas-firs, grand firs, and white firs than ponderosa pines, which have sparse foliage near the ground and large buds shielded by tufts of needles. Inspecting a broad range of forests originally dominated by big pines, Weaver found that most had experienced a long period without fire and contained dense thickets of small pines and firs that were often malformed and stagnating.

Disputing standard theory, Weaver reported that the young trees were seriously overstocked and incapable of growing into commercial size without thinning by hand or with fire. Fire would be more economical and have the advantage of reducing pine needle litter and other surface fuels as well.

Although most foresters probably doubted or dismissed Weaver's findings, one national forest supervisor congratulated him: "It takes a lot of courage, even in this free country of ours, to advance and support ideas that are contrary to the trend of popular, professional thought" (Carle 2002). In the years after his groundbreaking article appeared in 1943, other foresters who were curious about the possibility of using fire contacted and visited Weaver or took a course from him, initiating a lasting legacy (see the sidebar).

Weaver conducted burning experiments in the ponderosa forests of Washington, Oregon, and Arizona, and he wrote more articles. In the early 1950s, University of California Professor Emanuel Fritz congratulated Weaver for continuing to study fire as part of forest management. "In the early days of forestry," Fritz admitted, "we were altogether too dogmatic about fire and never inquired into the influence of fire on shaping the kind of virgin forests we inherited. Now we have to 'eat crow'" (Carle 2002).

Area on the Coconino National Forest in Arizona used by the military and abandoned in about 1923. Fire exclusion resulted in heavy ingrowth of young ponderosa pine, forming dense "doghair" thickets with ladder fuels that endanger the few remaining old-growth pines. USDA Forest Service photo by E.W. Kelley.

Prescribed burn at Kootenai National Forest. USDA Forest Service photo.

George Curtis, Forest Service Pioneer

George Curtis, a Forest Service fire manager on Montana's Kootenai National Forest, attended one of Harold Weaver's workshops and put it into action. In the 1950s, he started using fire in the Kootenai River Canyon's prime wildlife winter range. I had the good fortune of working with George when I was employed at the Forest Service's Fire Lab in Missoula, MT. At my urging, Bruce Kilgore—who transferred from the National Park Service to partner with George Curtis—collaborated with George on a report on the fuels reduction and prescribed fire treatments that George and his assistants had been doing for many years (Kilgore and Curtis 1987).

After George retired, Ron Hvisdak picked up the torch to carry on George's work. Ron and his crew thinned a forest near Eureka, MT, and they were ready for the Camp 32 Fire when it approached in 2005. The fire burned the thinned forest in a patchy stand-replacement pattern on the west side of a forest road leading toward Eureka. However, when burning embers jumped the road and ignited a surface fire, it soon settled down and was extinguished by Ron's fire crew. The story and accompanying color photographs were published by the *Missoulian* on September 20, 2005.

Jan van Wagtendonk with mentor Harold Biswell near a prescribed fire in 1970, in Yosemite National Park. U.S. Geological Survey photo.

The Biswell Legacy

Harry Biswell educated students, ranchers, and even National Park Service personnel in California about prescribed burning. Through his pioneering work, Biswell inspired a legacy of fire ecology with lasting impacts to this day. For example:

- Jan van Wagtendonk, one of Biswell's graduate students who conducted many prescribed burns in Yosemite National Park, wrote a review of Biswell's work (Wagtendonk 1995).
- Bruce Kilgore, one of Biswell's early students, published a review of the 1963 Leopold report on sustaining wildlife habitat in the national parks and was involved in the first deliberate burning in Sequoia-Kings Canyon National Park. He became a scientist with whom I worked at the Forest Service's Missoula Fire Lab.
- Ron Wakimoto, a Biswell student, helped to conduct prescribed fire in Glacier National Park. He also helped my son Nathan and me to conduct the largest prescribed fire we had on our forested property in Montana.

These Biswell students and more have been active members of the Association for Fire Ecology, which was inspired by Weaver's and Biswell's groundbreaking work.

Forest Service firefighters conduct a prescribed fire in October 2018 on 340 acres of open-grown mixed-conifer forest on the Shasta-Trinity National Forest in California. USDA Forest Service photo by Liz Younger.

BISWELL: THE SECOND BOMBSHELL

Weaver laid the groundwork for a more outspoken advocate for controlled burning, who in 1947 became a professor of forestry and plant ecology at the University of California in Berkeley. Harold Biswell earned a Ph.D. in forest ecology at the University of Nebraska and spent several years with the Forest Service in the South, where he gained experience in controlled burning. When he was departing for the professorship in California, the head of Forest Service Research and Development warned him to stay out of controlled burning when he moved west (Carle 2002). Biswell ultimately ignored that advice.

In 1945, the California legislature authorized State foresters to issue burning permits for chaparral and other dense brushlands to improve accessibility and forage for livestock and wildlife. By the early 1950s, Biswell had developed a method of firing the bottom of south-facing brushlands in early spring, when the north-facing slopes were still too moist; the fire could be controlled at the ridgetop. Ranchers and wildlife biologists liked the results, but when Biswell started experimental burning among ponderosa pines in the Sierra Nevada, fire control and forestry officials grew alarmed.

Biswell and Weaver became known to some as "The Two Harolds." After their first meeting in 1951, they began a long and productive relationship, reviewing each other's projects and manuscripts and commiserating about their detractors. When angry State and Federal fire control officials demanded that the University of California dismiss Biswell, many supporters rose to defend him, and Biswell and Weaver persevered in their efforts. They gained a cadre of collaborators and allies who put their techniques into action throughout much of the West (see the sidebar).

Biswell was hired by the California Department of Parks and Recreation to train its rangers and resource managers in prescribed burning, and he started burning programs at many parks throughout California. Biswell also introduced and trained undergraduate and graduate students and other research scientists in the art of controlled burning, engaging ranchers and wildlife specialists as well (Weise and Martin 1995). Biswell's book on prescribed burning in California became the authoritative source of knowledge in the field (Biswell 1999). Both he and Weaver lived to see the Forest Service reverse its policy in the 1970s and embrace prescribed burning in fire-dependent forest types.

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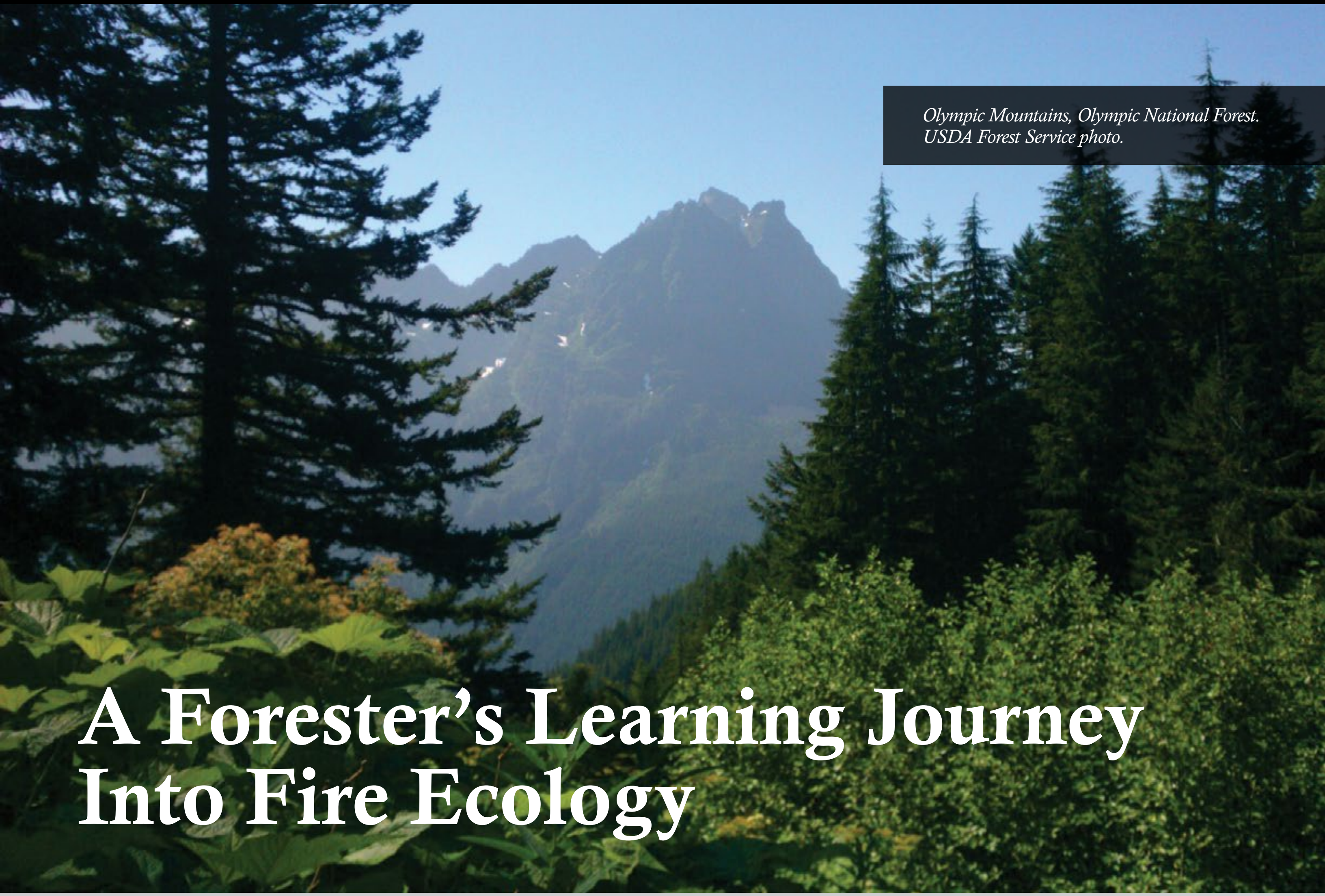


Olympic Mountains, Olympic National Forest. USDA Forest Service photo.

A Forester's Learning Journey Into Fire Ecology

Stephen F. Arno

When I was 16 years old and could drive, I started exploring forests in Washington's Kitsap County, a large peninsula on the west side of Puget Sound. Much of the peninsula has a shallow layer of soil underlain by "clay-rock" (basalt) as a result of being scoured and compacted by the gigantic continental glacier during the last Ice Age.

EARLY LESSONS

I saw many stumps from early 20th-century logging that told the story of the original Douglas-fir forest. The bark on these 4- to 5-foot-thick (1.2- to 1.5-m) stumps was still covered with char from before the trees were logged. On many stump tops, I also saw a sequence of scars and healing in the tree rings, a clue to the history of fires.

Then, where old-growth Douglas-fir trees remained at nearby Illahee State Park and a few other places in Kitsap County, I noticed that some still had char on their outer bark. A few had a seam or even an inverted V-shaped wound, reinforcing my earlier observations.

In 1961, I started studying forestry at Olympic Junior College, and I was immediately attracted to Dr. Roland Rethke's classes in forestry and botany. Doc Rethke had earned his Ph.D. from the prestigious Botany Department at the University of Washington; but rather than taking a position at a major university, he chose the junior college near his home so he could interact with freshman and sophomore students. We all regarded him highly for that choice.

In addition to teaching botany and forestry, Doc Rethke gave us a brief primer in plant and forest ecology. I was interested in writing about what I'd seen in the forests, and Doc Rethke encouraged me to pursue that as I learned more.

Steve Arno was a research forester for the Forest Service, Fire Sciences Laboratory, Rocky Mountain Research Station, Missoula, MT.

SEQUOIA-KINGS CANYON NATIONAL PARK

In summer 1962, I fought a few wildfires in western Washington, but what soon unfolded was entirely different. While beginning my forestry studies at Washington State University, I became a seasonal student trainee in the National Park Service, expecting to advance to a full-time position upon graduation.

In summer 1963, I worked at Sequoia-Kings Canyon National Park in California, where I quickly learned about the importance of fire in sustaining forests. My first hands-on lesson in fire ecology took place in June, when some of us seasonal rangers were assigned to help on a spring burn of brushland hillsides on a ranch immediately below the park. Inspired by renowned fire ecologist Harold Biswell, the prescribed fire was intended to create forage for livestock and better habitat for wildlife.

We were greenhorns attached to a small, experienced crew on a ridgetop 50 feet (15 m) wide. Sounding like a freight train, the fire charged toward us up a southwest-facing slope through dense brush 15 to 20 feet (4.5–6 m) high. Brushland burns like this were not supposed to slop over the ridgetop, and our job was to stop the roaring blaze.

I was dumbfounded when the conflagration arrived and threw burning embers across our fireline onto the north slope. An angry rattlesnake's sudden emergence nearly at my feet didn't help my composure. But it was an ordinary experience for the crew, which quickly dowsed the spot fires. The burn worked according to plan.

During my summer at the park, I noticed that all the old giant sequoias and even many old ponderosa pines had obvious fire scars from long ago. The role of wildland fire in perpetuating the sequoias was well known by then, and with the recent publication of the Leopold Report—which recommended restoring fire to the national parks (Leopold and others 1963)—plans to do just that were slowly getting started.

As a student trainee park ranger, I quickly learned about the importance of fire in sustaining forests.

As a student trainee park ranger, I enjoyed leading nature hikes, sometimes with 50 visitors. I also enjoyed presenting campfire programs in the open amphitheater, with even more visitors. At first, I used films that the park had on file, but I was soon using my own color slides instead. Even summer nights are chilly at Cedar Grove in Kings Canyon, so visitors in shorts and T-shirts used my small campfire to warm themselves during the presentation.

The park naturalists and I would demonstrate the extreme flammability of old ponderosa pine needles and cones by scooping them up from the ground and placing them inside the rock fire ring. We would load dry branches on top, then light the fire with a wooden match. I don't believe that fire ever failed.

OLYMPIC NATIONAL PARK

It was unusual for a seasonal ranger to give campfire programs, but I liked this visitor contact so much that I asked to be switched to being a trainee naturalist in some western national park. The National Park Service assigned me to Olympic National Park for the 1964 field season. In addition to leading nature walks, presenting campfire programs, and manning visitor centers, seasonal naturalists could informally investigate park ecosystems.

On my days off, I was constantly exploring the forest and learning about the role of fire in the process. On one trip, a high school buddy and I waded the Queets River in the rainforest to see the famous thousand-year-old Queets Fir; with a diameter of more than 14 feet (4.3 m), it was the Nation's largest Douglas-fir. I saw the obvious signs that this giant remnant of the original forest was being crowded out by shade-tolerant western hemlocks. By 2000, the Queets Fir had broken off in a storm and was nearing death. Today, visitors can see nothing but its rotting hulk.

I also visited the Hoh River's rainforest and reported what Forest Service founder Gifford Pinchot had seen in the

South Fork Skokomish Trail through old-growth forest, Olympic National Forest. USDA Forest Service photo by Kelsey Dyer.

1890s (Pinchot 1899): the few remaining giant Douglas-firs were being replaced by hemlocks, and there was no Douglas-fir regeneration except on logged private land outside the park's boundary. I'm sure that this was no surprise to my boss, the park's chief naturalist.

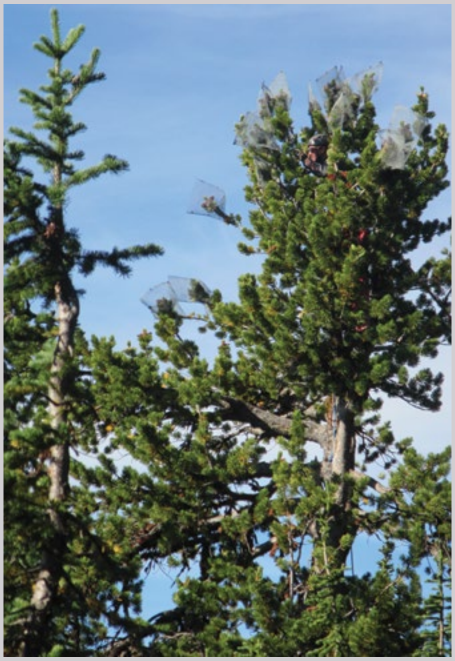
The more I saw, the more the Olympic Peninsula's fire ecology began to reveal itself. I had already hiked through an old burn on the westside trail to Black and White Lakes and seen the sharp contrast between the old-growth subalpine forest and the burn from about 20 years before. The old-growth forest had a sparse undergrowth of shade-tolerant plants, few deer or elk tracks, and hardly any birds. The burned forest was the polar opposite, loaded with tall fruit-bearing shrubs, including elderberries and mountain ash, a favorite of bears and songbirds. I also encountered old burns in high-elevation south-slope Douglas-fir forests, where I saw the same postfire scenario, with plentiful Douglas-fir saplings.

In about 2000, I chanced upon the site of the Beaver Fire from the 1980s in the park's Skokomish River drainage, a short distance up the trail from Staircase Ranger Station. In this low-elevation south-slope burn, Douglas-fir saplings 15 to 20 feet (4.6–6.1 m) tall were overtopping the young hemlocks. Several old-growth Douglas-firs had survived the wildfire and evidently supplied seeds for the burned area. By contrast, the unburned area past the fire control line again held only old Douglas-firs with encroaching hemlocks and hardly any wildlife forage or fruit.

In recent years, the fire management officer at Olympic National Park has initiated a program of allowing some nonthreatening lightning fires to burn on the park's west side, which is far away from the megalopolis on Puget Sound. The park has even used prescribed fire in some areas accessible by road.

While working at the park, I backpacked and camped all over the high country with fellow park naturalist Bob Taylor in the drier rain shadow zone of the northeastern Olympic Mountains. These trips were a boon to my education in many ways. For one thing, this quadrant of the Olympics is the only place where whitebark pine grows. Later, I discovered that whitebark pine depends on fire to regenerate; it has a complex symbiotic relationship with both the jaylike Clark's nutcracker and tree squirrels, and its large nutlike seeds—comparable to those of pinyon pines—are often a critical food for bears.

The Maple Fire in 2018 in the Hamma area of the Olympic National Forest. USDA Forest Service photo.



Whitebark pines on the Flathead National Forest in Montana. USDA Forest Service photo by Erika Williams.

Bob and I found that many of the hardy whitebarks, which grow at the upper limit of trees, were infected and slowly dying from white pine blister rust. This crippling disease was accidentally introduced in about 1910 on western white pine seedlings—nursery stock—shipped from Europe to Vancouver in British Columbia. It soon spread down the West Coast into Oregon and northern Idaho, Montana's Glacier National Park, and other parts of the inland Northwest.

Ironically, like many noxious weeds, blister rust is endemic to Europe and not much of a problem there. However, it eventually kills all but one of the five-needle pines in North America. The exception is the 4,000-year-old Great Basin bristlecone pine, which grows mostly at elevations of 10,000 to 12,000 feet (3,000–3,700 m) on arid mountains east of the Sierra Nevada. In recent visits to the northeastern Olympics, I've found much more whitebark pine mortality from blister rust.

FORESTRY SCHOOL

In fall 1963, I moved to Pullman in the southeastern corner of Washington to attend Washington State University, which finally had an accredited Forestry Department. I didn't want to attend the prestigious Forestry School at the University of Washington in Seattle because I couldn't imagine studying forestry in the big metropolitan area. By contrast, Pullman is a small town and the tuition was cheaper.

At Washington State University, I learned something about how to write articles of interest to a broad audience. I also learned much more about fire ecology. A small group of us took weekend trips south to Oregon's Wallowa Mountains, where fire-resistant old-growth western larch shone golden yellow in the fall.

Dr. Richard Dingle, who earned his Ph.D. at Yale, taught the silviculture classes at Washington State University. He had us write essays with a very detailed explanation of how we would treat a hypothetical stand that had insect, disease, and overcrowding problems or was being converted to a less desirable forest type, such as coastal Douglas-fir being replaced by western hemlock. Doc Dingle was highly intelligent and a demanding critic. His many comments and criticisms helped me and my fellow students frame our recommendations in technical writing, which served all of us well who went on to careers in forestry.

I also sought out the famous Dr. Rexford Daubenmire at Washington State University. Arranging to meet with him in his office, I gave him a short draft paper I had written about forest ecology in the Olympic Mountains. When I revisited Daubenmire, he wisely told me not to write any more ecology articles until I had learned about the subject in his class on synecology (the study of how plants and animals interact with their environments). I was crestfallen but later appreciated the fact that he had taken time to read my confused draft and given me excellent advice.

In 1964, I took Dr. Daubenmire's synecology class. One component of synecology deals with forest succession—how shade-tolerant trees replace fire-dependent trees like ponderosa pine and western larch unless the process is interrupted by fire, logging, or other major disturbances.

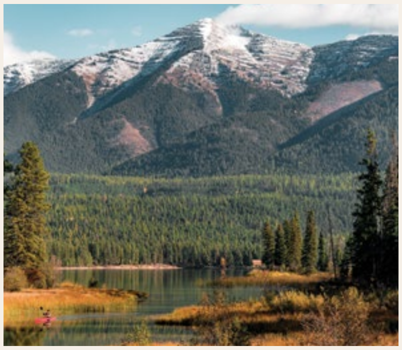
In 1965, I enrolled in graduate school at the University of Montana and moved to Missoula, MT, with my newlywed wife Bonnie, who had acquired a teaching job there. I sought out Daubenmire's equivalent, Dr. Jim Habeck in the Botany Department. Even though I was in the Department of Forestry, scorned by some of his colleagues in botany, Jim agreed to serve on the committee for my master's degree. He treated all students with respect, conversing at length with both undergraduate and graduate students. Jim had a wealth of knowledge in the published literature, and he also made keen observations in the field, like an old-time naturalist.

NEW UNDERSTANDING OF FIRE

In 1965, when I arrived in Missoula to do graduate work, the biggest recent blaze had been the 31,000-acre (12,500-ha) Sleeping Child Fire in a high-elevation lodgepole pine/subalpine fir forest. In 1967, the Sundance Fire in nearby northern Idaho blew up across most of its 56,000 acres (22,600 ha) in a 24-hour period. At the same time, the Trapper Peak Fire in northern Idaho scorched 16,600 acres (6,700 ha).

Whitebark pine seedling outplanted in a high-elevation burned area on the Flathead National Forest in Montana. Seedlings resistant to white pine blister rust were chosen, and a burned area was picked to remove competition with more shade-tolerant subalpine firs. The 55-acre area included lands on the Swan State Forest affected by the 2015 Squeezer Fire. State and Federal partners planted 13,250 whitebark pine seedlings in 2018. USDA Forest Service photo.

Sleeping Child Fire in 1961 on the Bitterroot National Forest in Idaho. USDA Forest Service photo by Ernst Peterson.



Flathead National Forest in Montana. USDA Forest Service photo by Your Forests Your Future.

Snapshot of Fire Ecology in the Rockies

For many years, I studied the fire history of old-growth forests consisting of ponderosa pine, western larch, and inland Douglas-fir in the Rocky Mountains. For centuries, surface fires prevented the highly competitive Douglas-fir from gaining dominance by killing its saplings in far greater numbers than the pine or larch. That equilibrium changed drastically with the advent of fire suppression.

I also examined high-elevation Douglas-fir savannas and adjacent dry forests originally dominated by old-growth Douglas-fir and younger lodgepole pine, including the amazingly dry Lamar Valley in the northern part of Yellowstone National Park.

Despite its 6,500-foot (2,000-ha) elevation, Lamar Valley receives only an average of 15 inches (38 cm) of precipitation per year. It provides a critical winter range for deer, elk, moose, and bison as well as the grizzly bears and wolves that prey on them. Scavengers, including ravens, eagles, and coyotes clean up the remains, waiting impatiently for the grizzlies and wolves to finish.

Historically, frequent grass fires—at intervals of 20 to 25 years—kept the conifers back. Some Douglas-firs on the savannas attained large sizes over the course of four centuries, protected from the grass fires by thick bark. A few of them measured 4 to 5-1/2 half feet (1.2–1.8 m) in diameter.

In the late 1960s, I picked up misconceptions about the role of fire in the Northern Rockies. I was keenly aware of the big burns in 1910 and 1919, and the large fires of the 1960s were fought on a vast scale using smokejumpers, airtankers, and other modern technology. Like many others, I thought that historical fires in the region tended to grow rapidly and destroy large areas of forest.

Then, in 1971, I joined a small team of Forest Service scientists to search Montana's mature and old-growth forests to record tree ages, species composition, evidence of past fires, and more. The project was modeled on a 1968 publication by Rexford Daubenmire, my former professor at Washington State University, classifying forest habitat types for eastern Washington and northern Idaho. Habitat types are based on the most shade-tolerant tree species, the ones that crowd out other species over long periods time without disturbances such as fire or logging—basically, the "climax" forest type.

Bob Pfister led the project, working with specialists in the Forest Service's Northern Regional Office in Missoula to propose and develop a comparable habitat-type classification for Montana forests. In effect, the Montana habitat-type classification was a first step in ecology-based forestry, and it soon became popular with most foresters in Montana (Pfister and others 1977).

I used to sit next to Pfister in Daubenmire's synecology class, and our friendship no doubt helped me become one of the three professionals assigned to do the field work. The three of us and our assistants fanned out across Montana's forests over three summers, getting advice from local foresters.

Analyzing data from the nearly 1,000 sample stands, we were surprised to find that about 70 percent of them had experienced fires long ago. The fires didn't kill fire-resistant trees like ponderosa pine and even some thin-barked trees like lodgepole pine. This discovery shattered my early conception that fires in the Northern Rockies were typically big and severe.

At Washington State University, I learned how to write articles of interest to a broad audience.

Later, I learned from fire scars and maps of fire coverage going back to the late 19th century that many large fires had been light understory burns in most areas and mixed-severity or crown fires only in some. That made sense: historically, a fire often burned for 2 or 3 months under variable weather conditions in both open and dense forests. Large fires weren't necessarily as severe as they were becoming in the late 20th century.

EVIDENCE FROM STUMPS

In fall 1971, when my wife and I purchased a 40-acre (16-ha) tract of ponderosa pine forest containing old-growth trees, I was confronted with another eye-opening discovery. Loggers were removing old ponderosas next to our property. Inspecting the stumps, I saw clear fire scars from as many as eight different fires.

While I was pondering the scars, Miron Heinselman visited the Forest Service's Missoula Fire Sciences Laboratory. Heinselman, an expert in fire scar analysis, was interested in the stumps, and he confirmed that the scars resulted from many different fires that could be dated by counting the annual growth rings. After counting the rings, I concluded that the fires dated to as early as 1700. Harold Weaver's 1943 revelation of frequent fires in the ponderosa pine forests of Oregon and Washington clearly applied to western Montana as well (Weaver 1943).

Later, I inspected cross-sections from the pitch-impregnated stumps of ponderosa pines that had been logged in the 1880s on the same site. The loggers had apparently left the younger trees that were later felled adjacent to our property because they were too small at the time.

In the older stumps, I saw as many as 25 scars from frequent fires, some of which matched the sequence of intervals on the fresh stumps. This allowed me to estimate dates for fires going back to the early 1500s.

By the 1980s, the University of Arizona's Tree Ring Research Laboratory had developed methods for cross-dating tree rings. Cross-dating was in widespread use to determine more accurate fire chronologies as well as whether a fire had scarred the tree in spring, summer, or fall. Emily Heyerdahl and Penny Morgan have since published articles on cross-dated fire histories throughout the inland Northwest and how they could be used to estimate the season when fires occurred and to document climatic changes (Heyerdahl and others 2008a, 2008b; Morgan and others 2008).

INVESTIGATING FIRE HISTORY

Assigned to the Fire Sciences Lab for part of my job in 1973, I started to expand investigations of fire history to include forests at all elevations. By the mid-1970s, I was studying the effects of fire and its potential applications to forest management. The Forest Service had established a Wilderness Fire Program on the nearby Selway-Bitterroot Wilderness through the masterful planning of national Director of Fire and Aviation Management Bud Moore and the Fire Lab's Bob Mutch, Orville Daniels, Dave Bunnell, and Dave Aldrich.

Forest Service recognition of planned fire was changing. The Wilderness Fire Program was even approved by Bill Worf, the Forest Service's recreation and lands officer in the Northern Regional Office. Worf was a recreation advocate but also a fierce protector of wilderness and roadless areas.

In 1974, Bob Mutch invited me to join him in inspecting the aftermath of the first significant wilderness fire, a 1973 blaze that worried fire managers when it spread beyond the small area that had been approved for fires. As a result, the Fritz Creek Fire approximately doubled in size. But it stayed within the wilderness, and the expanded area burned provided a better opportunity to assess its effects in contrasting terrain and vegetation.

On the wilderness burn, while climbing the trail up the steep south-facing slope toward Bad Luck Point, I passed through a mixture of ponderosa pines and grasslands. The Fritz Creek Fire had burned the grasses and flowering plants, which had vigorously resprouted. Some young pines were scorched, but the old ones were merely charred at the base.

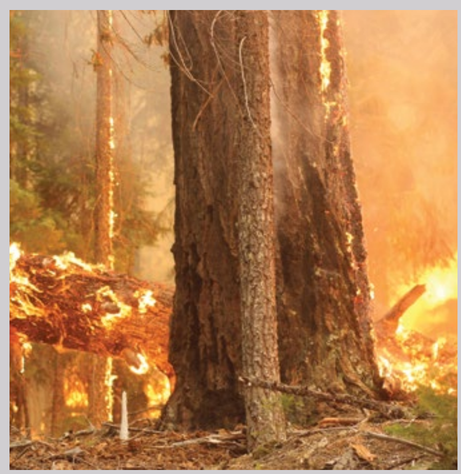
On the opposite north-facing slopes, strips of mature Douglas-fir forest suffered no more than scorched lower limbs. In adjacent forest swaths, however, the fire had raced upslope through the crowns, killing the trees. In other places, including the narrow creekside riparian strip, the fire had intermediate effects. The fire's crazy-quilt pattern of burning was a revelation.

My studies of fire history in forests at low, middle, and high elevations yielded more surprises. Historical fires defied simple explanations. Their patterns of burn intensity and their effects on trees were quite variable. Later, I observed the aftermath of wildfires and found that many left some patches of forest and undergrowth entirely unburned. By the late 1970s, other researchers in the greater Northwest were studying fire history and reaching similar conclusions about fire's historical role.

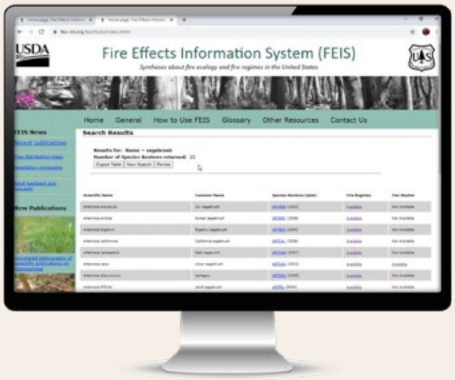
LEARNING AT THE FIRE LAB

In 1974, when I was assigned full time to the Fire Sciences Lab, my learning curve accelerated. In some university departments, rivalry for funding among the faculty creates tension, whereas Fire Lab scientists and technicians are willing

The Mark Twain Stump on the Sequoia National Forest in California in 1936, showing fire scars accumulated over many centuries. USDA Forest Service photo by W.H. Maxwell.



Mixed-severity fire activity on the August Complex Fire on the Mendocino National Forest in 2020. With more than a million acres (400,000+ ha) burned, the August Complex was California's largest in recorded history, yet many parts of the actively suppressed megafire burned at low to moderate severity, with many surviving trees. USDA Forest Service by Mike McMillan.



Fire Effects Information System

Based on experience or analysis, the Forest Service knows that some kinds of activities have no significant environmental impacts and no need for extensive environmental review under the National Environmental Policy Act. A categorical exclusion or an environmental assessment can cover such projects. Researchers and line officers have long recognized the need for fire ecology research at a time when they require more ecological information and expert advice to defend their ecological restoration projects in court.

In response, the Forest Service's Missoula Fire Sciences Laboratory developed the Fire Effects Information System under the leadership of Jane Kapler Smith (Smith 2010). The online compendium contains a wealth of knowledge about how fire affects each plant and animal species across the West and, indeed, across the Nation. It continues to be updated as new information appears.

Although the Fire Effects Information System is a gold mine of collective knowledge that is readily available online, many professionals in natural resource management haven't heard of it. For lack of sufficient institutional memory, new staff often must learn what retirees already knew and left for them to use in great and easily accessible detail.

collaborators. We also had research agreements with several universities, getting professors and graduate students involved in cooperative studies and expanding our collective knowledge of fire's effects on wildlife habitat, vegetation, soils, and other resources.

Some of the graduate students who worked for me, notably Bob Keane, later became scientists with a breadth of knowledge far surpassing my own. One of Keane's many contributions to fire science and wildland fire management was a literature review on the effects of fire exclusion (Keane and others 2002). Helen Smith helped me greatly with a long list of studies and became an ecologist at the Fire Lab in charge of a high-elevation experimental forest and the facilities and studies there.

Leaders of our Fire Effects Program gave us considerable latitude to pursue our research interests. At first, I studied fire history from the lower edge of the ponderosa pine zone to high elevations in the whitebark pine/subalpine fir forest type based on fire scars and tree ages. Prior to 1900, a large percentage of high-elevation forests had burned in mixed-severity fires, confirming our findings in the earlier habitat type research (Arno 1976).

Bob Pfister commissioned me to classify the stages of forest development after past stand-replacing fires, which in those days weren't as severe as today's megafires. Denny Simmerman and I found many places where a fireline was located adjacent to the unburned stand and near a former clearcut scarified by a dozer, as well as other areas with little ground disturbance. The burned sites had "biological legacies" of standing snags, fallen trees, and vigorous resprouting of willow, mountain maple, and herbaceous plants important for wildlife habitat (Arno and others 1985). The old undisturbed forest served as hiding cover for wildlife but offered little forage. Scarified clearcuts had damaged soils and invasive weeds.

On the National Forest System, logging today is mostly lighter on the land, leaving some healthy trees and snags and making selective cuts or small clearcuts where most needed.

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Returning Fire to the Land: Two Projects

Stephen F. Arno

In the 20th century, especially after the Big Blowup of 1910, the Forest Service led efforts to virtually eliminate fire from forests. By the 1970s, however, with the emergence of ecosystem-based insights into land and resource management, the folly of fire exclusion was becoming increasingly apparent.

For example, early insights came from the noted ecologist Aldo Leopold. While hunting deer in northern Mexico's Río Gavilán watershed, Leopold (1937) found "a picture of ecological health" superior to the national forests and parks in the United States. One reason was the lack of fire control in Mexico: low fires still played their natural role across the landscape, "whereas our own landscapes, sedulously protected from fire … are a wreck" (Leopold 1937).

BURNING SLOWLY ACCEPTED

Prescribed burning differs from controlled burning in that it requires advance planning for acceptable short-term and longer term weather conditions, for the moisture content

Prescribed fire in 2011 in ponderosa pine on the West Fork Ranger District, Bitterroot National Forest. USDA Forest Service photo.

Steve Arno was a research forester for the Forest Service, Fire Sciences Laboratory, Rocky Mountain Research Station, Missoula, MT.

of litter and other fuels, and for contingencies to stop a fire that escapes its planned control lines. This systematic burning approach is now routinely used in accessible areas, usually after thinning and removing excessive fuels. However, returning fire to wilderness and backcountry areas poses a difficult challenge.

In 1924, as a Forest Service line officer at the time, Aldo Leopold was instrumental in establishing the first wilderness area in the country on the Gila National Forest in southwestern New Mexico. The West's largest contiguous ponderosa pine forest spans 275 miles (443 km) across the high plateaus and mountains of Arizona and New Mexico. In 1943, Harold Weaver, joined in 1960 by Charles Cooper, published conclusive proof that complete fire suppression harms southwestern ponderosa pine (Cooper 1960; Weaver 1943). Accordingly, designating wilderness areas raised concerns about perpetuating natural ecosystems. The Gila National Forest is dominated by virgin ponderosa pine, and evidence that this forest type is fire dependent prompted questions about whether fire suppression would damage the Gila Wilderness ecosystem.

Some private timberland owners continued using silvicultural techniques reminiscent of light burning. In 1944, for example, in the northwest corner of Montana, the J. Neils Lumber Company acquired thousands of acres of ponderosa pine and western larch timberland. The company's foresters applied shelterwood cuttings that saved healthy old trees for seeding, with areas beneath them burned. In 1957, the Saint Regis Paper Company bought out J. Neils and continued the same practices. Later lumber companies acquired the Saint Regis holdings and abandoned this method of forest management in favor of cutting the big trees.

By the early 1960s, concerns about perpetuating native ecosystems were gaining national attention. Secretary of the Interior Stuart Udall appointed a committee of the Nation's top biological scientists to evaluate wildlife management in the national parks. The resulting Leopold Report, informally named for committee chairman Starker Leopold (Aldo Leopold's son), emphasized that good wildlife habitat cannot be preserved but needs periodic disturbance by natural forces, which—in most cases—would be fire (Leopold and others 1963; Kilgore 2007).

Prescribed fire in 2020 on the Lolo National Forest in Montana. USDA Forest Service photo.

Prescribed burning requires advance planning for acceptable short-term and longer term weather conditions.

By the late 1960s, the well-publicized Leopold Report helped return burning to California's premier national parks, Sequoia-Kings Canyon and Yosemite.

The Leopold Report also encouraged fire managers in the Forest Service to finally abandon the 10 A.M. Policy and return natural (typically lightning-ignited) fire to wilderness areas. The first "prescribed natural fire" programs were established in the 1970s on New Mexico's Gila Wilderness and the Selway-Bitterroot Wilderness in Idaho and Montana.

Forest Service research forester Russell LeBarron recommended selective cutting to favor big, healthy trees and prescribed fire in central Idaho's extensive ponderosa pine forests, where foresters were widely employing the practice in the 1950s. By the 1970s, many foresters and research scientists were supporting similar practices, including Robert Martin, project leader for the Silviculture Laboratory at the Forest Service's Pacific Northwest Forest and Range Experiment Station in Bend, OR. The lab developed prescribed fire prescriptions and ecological information on fire effects in eastern Oregon.

By the late 1970s, many ecologists recognized that natural disruptions of ecosystems by fires, floods, and hurricanes played a historical role in maintaining them. Scientists and many practitioners also understood that civilization had severely disrupted historical fire regimes.

However, ecologists and others concerned about returning fire to forests often disagree on how it should be done. Some favor allowing all fires to burn freely, despite historically unprecedented fuel buildups and the continuity of dense forests. Others advocate thinning dense forests and commercially harvesting some timber, followed by prescribed burns. The latter approach has proven less costly overall than waiting for the inevitable destructive wildfire; as its proponents put it, "You can pay now or pay much more later."

However, 70 years of fire exclusion have created many barriers to restoring fire in any manner. I will illustrate some of the challenges facing forest restoration by describing some difficult projects in western Montana. Many professionals have been working on forest restoration all across the West (see the sidebar), and many have encountered similar difficulties, despite often promising results.

Horse logging in 1950 on the Kaniksu National Forest in Idaho. USDA Forest Service photo by W.E. Steuerwald.

BITTERROOT DEMONSTRATION PROJECT

Jim Lotan retired from the Forest Service as a leading fire ecology researcher and started a horse-logging business in western Montana. While I was still with the Forest Service's Fire Sciences Laboratory in Missoula, I helped set up a demonstration area for forest restoration on the Bitterroot National Forest, and I contacted Lotan to do the horse logging on snow- and ice-covered ground.

The road into the project area was extremely steep and narrow, and we couldn't afford a contractor to plow the road, so I chained up all four wheels of my old snowplow pickup to do the job myself. I would often plow at night in the bitter cold, trying to cast off 8 inches (20 cm) of new-fallen snow, with a tight turnaround at the top and bottom of the steepest grade. The fire management officer on the ranger district loaned me a Forest Service radio in case of emergency, and he kept in close touch from his house below.

I marveled at how Jim Lotan and a helper were able to skid logs down steep snow- and ice-covered skid paths while keeping the logs from crashing into men or horses. He was also able to haul his team of two horses in a trailer up and down the icy road every day without getting stuck. Hauling horses

Restoration Scientists and Practitioners in the West

Scientists and practitioners of forest restoration using prescribed fire and other techniques are found across the West. To give an idea of the breadth of their activities, a select few are listed below (there are many more).

- Ann Bradley with The Nature Conservancy in New Mexico.
- Retired Professor Wally Covington and several associates at Northern Arizona University.
- The Colorado Forest Service.
- Professors in natural resources and Charles Kay, a professor of political science, at Utah State University.
- Professor Scott Stephens at the University of California in Berkeley, who leads the Fire and Fire Surrogates Study across the West.
- Professor Jerry Franklin at the University of Washington, who—together with associates at Oregon State University and elsewhere—is leading the way in restoring a semblance of old-growth forests, including old-growth Douglas-fir, which is dying out in the large protected areas west of the Cascades.
- Large forest landowners Bob Playfair and his daughter Patti in Colville, WA, who have led the Northeast Washington Forest Vision 2020 Collaborative Project in conjunction with the Colville National Forest and Vaagen Brothers Lumber Company and who have carried out numerous prescribed fires on their own land.
- State Forestry Extension Service offices across the West.
- Retired Professor of Fire Ecology Penny Morgan at the University of Idaho.
- Consultant Bob Gray and the Rocky Mountain Trench Ecosystem Restoration Program in southeastern British Columbia, which includes Banff, Jasper, Yoho, and Kootenai National Parks in Alberta and British Columbia.
- The Association for Fire Ecology, over 100 members strong.
- Robert Keane and other members of the Whitebark Pine Ecosystem Foundation in both the United States and Canada.

and feeding and watering them are extremely expensive, but Lotan was glad to do it in return for the meager proceeds from the skidded timber.

I found a log hauler who was used to the very steep roads built before the mid-1950s and willing to haul out the horse, farm tractor, rubber-tired skidder, and steel-track cat logging units and transport them to a nearby mill (now closed). Self-loading trucks with a single trailer for "short logs" (about 16.5 feet (5 m) long) are very maneuverable.

Another advantage of a self-loading truck is the ability to unload logs if the truck slips off a road. That happened once on the steep stretch of road. The forest engineer, who inspected the steep stretch every day, saw the heap of logs stacked in the snow berm. That created another problem. The engineer canceled our hauling permit until after spring breakup, which was several months away. I begged him to reconsider after testing the road, and he reluctantly agreed.

Before he arrived, I scraped the steep stretch of road with the plow and then made multiple passes up and down with plow raised to increase traction, aided by a few hundred pounds of sand bags in the bed of the pickup. I managed to scarify the ice-covered road with my spiked chains on all four wheels. When the engineer arrived to conduct the test, his skepticism was obvious, so I was surprised and relieved to get the okay to resume hauling.

In retrospect, it amazes me that I had to invest so much time, equipment, and energy to complete this demonstration project. But I found that later projects faced similar challenges.

In the following spring and summer, the district ranger and her staff from the Bitterroot National Forest were glad to accompany me in showing off the results. Many Bitterroot Valley residents were skeptical of the Forest Service because of the agency's controversial clearcutting and terracing practices in the 1960s and 1970s. Still, several groups of residents came to view the restoration treatments.

Several of us testified to the need for a fuels treatment, and many people remembered the 1977 Pattee Canyon Fire.

THE PATTEE–BLUE PROJECT

Long after I retired, I joined together with friends in trying to convince district rangers on the Lolo National Forest's Missoula Ranger District to thin out the Douglas-firs encroaching on open ponderosa pine forests. At particular risk was the enormously popular Pattee Canyon Recreation Area, a 3,200-acre (2,000-ha) site with a picnic area just east of Missoula, MT. We urged the Forest Service to treat about 1,200 acres (490 ha) by removing small Douglas-firs and restoring low-severity fire to the open pine forest. Similar areas needed treatment on Blue Mountain west of Missoula, and the Pattee-Blue Ecosystem Restoration Project was born.

Project Rationale

My graduate school mentor and long-time friend Dr. Jim Habeck had studied land survey records in the area from the late 19th century. The surveys used "witness trees" to mark property corners, recording the distance to each witness tree, along with its species and size. It was a gold mine of information on the original forest. Fortunately, it is illegal to cut a witness tree, so Habeck identified and remeasured the witness trees or their remains throughout the Pattee Canyon Recreation Area and in an even larger area west of town.

Based on fire history studies throughout most of the ponderosa pine zone in western Montana, Steve Barrett and I had found that fires consistently occurred at average intervals of 5 to 10 years. We also collected fire histories from a site in Pattee Canyon and sent the increment cores from each sample tree to the University of Arizona's Tree Ring Research Laboratory. The lab cross-dated the cores and their fire scars, generating a fire history for Pattee Canyon similar to what Barrett and I had found elsewhere.

Habeck documented the shift from an original open ponderosa forest to one dominated by dense Douglas-fir ingrowth. This should have worried residents of Pattee Canyon, where many high-priced homes are built on the canyon's steep north slope—and where a narrow and winding two-lane road is the primary access and

Restoration project, before (left) and after (right), in overgrown ponderosa pine on the Ninemile Ranger District, Lolo National Forest. The project, conducted through a Habitat Improvement Partnership, included thinning and prescribed burning. USDA Forest Service photo.

egress. In 1977, powerlines in high winds ignited a wildfire that swept through much of the canyon but spared the north-slope homes. Another wildfire swept into the canyon in 1985, and similar wildfires followed. Yet newcomers and long-time Missoula residents alike seemed oblivious to the threat of wildfire.

Project Planning

The situation became a perpetual worry for Maggie Pittman, the Missoula district ranger responsible for managing the recreation area, and her successor, Dave Stack. Pittman chose Pattee Canyon for a test site, but her plan faced problems. The Pattee Canyon Recreation Area isn't part of the Lolo National Forest "timber base" (where timber sales are relatively easy to complete). Moreover, no one living in the Missoula area had seen a restoration treatment on the scale needed, and many environmentally sensitive residents, remembering controversial timber sales from the 1960s and 1970s, did not trust the Forest Service. At least 500 visitors used the recreation area every day throughout the year, and many were highly protective of their "backyard" environment.

Pittman's strategy was to start with a small treatment area of 210 acres (85 ha). Her staff marked large trees to be removed, mostly dying ponderosa pines and Douglas-firs badly infected by dwarf mistletoe. Also marked for removal was the understory of Douglas-fir invading the ponderosa pines, except for thickets that offered screening for picnic tables.

A skilled communicator, Pittman held a well-attended public meeting and show-me presentation at the recreation area in 1986. Several of us testified to the need for a fuels treatment, and many people remembered the 1977 Pattee Canyon Fire. Other public meetings followed to discuss the proposed project. When people saw that mostly Douglas-firs would be removed and mostly ponderosa pines would remain, most agreed with the plan, although some wanted the forest to remain "natural." As controversial as the proposal turned out to be, Pittman was glad to have planned to treat just 210 acres (85 ha) instead of the entire 1,200-acre (480-ha) tract.

In spring 1987, district staff began to prepare an environmental assessment, as required by the National Environmental Policy Act of 1969. They also printed public notices and a request for comments in the local newspaper and sent mailings to concerned groups. A total of 19 people responded with concerns. However, Pittman's communication skills paid off in the end, and even the fiercest critics agreed on the need for the proposed project.

Thinning in ponderosa pine as part of the Trapper Bunkhouse Stewardship Project on the Bitterroot National Forest in 2011. USDA Forest Service photo.

Initial Project Work

In summer 1989, the Forest Service decided to proceed with commercial tree removal on 42 acres (17 ha). Units of equal size were to be logged every 5 years, with the encroaching thickets of understory trees removed and a plan in place for low-intensity prescribed burns in spring. The plan called for reducing the average number of trees per acre to about 4 or 5 percent of the pretreatment forest, mostly by removing understory thickets.

A local logging contractor, Craig Thomas, took on the work. As a logger for Anaconda Forest Products and its successors, Thomas had long experience with people ardently opposed to any tree cutting anywhere except for within about 100 feet (30 m) of their forest homes. Thomas's operations had been vandalized over the years by fierce logging opponents, and he had installed security measures to protect his employees and withdrawn from engaging critics and protestors.

In April 1990, I joined the contractor and Jim Lotan in the initial project work: cutting trees and skidding them with a team of horses. Horse logging in spring on ground that is typically wet is not really low impact, but the public believed it to be and accepted it as such, probably because it conveys a romantic image and so many people love horses. A modern four-wheel drive tractor with a logging winch or even a big rubber-tired skidder without chains causes much less damage.

Although work had begun, opposition to the project remained. Before Dave Stack arrived as the new district ranger, Pittman held a long meeting with the logging contractor, and they were confronted by citizens deeply concerned about the heavy logging equipment required as the project proceeded.

Growing Acceptance

As logging contractor, Craig Thomas turned out to be the perfect salesman for the Pattee-Blue project. He attended a symposium on protecting people and homes from wildfire at the Forest Service's Fire Laboratory in Missoula. The evolving project forced Thomas to learn communication skills, and District Ranger Pittman was an excellent role model. She taught Thomas how to avoid getting angry and how to deescalate deliberate provocations by activists.

Moreover, a series of destructive wildfires in the West proved to be a wakeup call for many. In 2000, the Valley Complex Fire on the Bitterroot National Forest in Montana burned almost 300,000 acres (120,000 ha), inviting comparisons to the Big Blowup of 1910. The Valley Complex signaled the beginning of a raft of megafires—fires that burn 100,000 acres (40,000 ha) or more. In 2002 alone, record fires included Rodeo–Chediski in Arizona (468,638 acres (187,455 ha)), Hayman in Colorado (137,760 acres (55,104 ha)), and Biscuit in Oregon (499,550 acres (199,820 ha)). All three State records have since fallen.

By 2003, area residents had been greeted by several local big fires ignited by lightning, including the Black Mountain blaze south of Missoula (which destroyed several homes) and the Mineral-Primm Fire in a large area around Primm Meadow. Many fires caused by accident or set by arsonists happened as well, an outburst of wildfires occurring all over the inland West.

By this time, Thomas had established good relations with Pattee Canyon residents and recreationists, who would even sit next to him at public meetings

A series of destructive wildfires in the West proved to be a wakeup call for many.

hosted by the Forest Service. With help and encouragement from me and my frequent coauthor Carl Fiedler, Thomas reflected on his experiences in a book that includes humorous anecdotes and stories about restoring fire-dependent ponderosa pine in western Montana (Thomas 2009) (see the sidebar).

When Dave Stack arrived to replace Maggie Pittman as Missoula district ranger, he greatly expanded the size of the restoration treatments in Pattee Canyon. Of necessity, the Pattee-Blue project became very complicated; the environmental analysis for the project resulted in findings that led to a contract more than 12 inches (30 cm) thick in order to cover all bases.

However, timber removals and thinning in Pattee Canyon revealed an old-growth ponderosa pine with a diameter of 4-1/2 feet (1.4 m) and gigantic low-hanging branches, a pleasant surprise for the public.

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2015 Thompson-Divide Complex Fire, Montana. USDA Forest Service photo.

Restoration Work in a Montana Gulch

Peter Stark is the bestselling author of the groundbreaking history "Astoria" (Stark 2015). Local logging contractor Craig Thomas met Stark at a public meeting on the Pattee-Blue Ecosystem Restoration Project hosted by the Forest Service in the 2000s. Stark and his wife had just purchased a 40-acre hideaway in thick forest just north of Missoula, MT. In a book on his own experiences in the area, Thomas (2009) told the story of Stark and his family forest.

Stark recognized that he might be trapped in his future house by the inevitable wildfire that would blow through his forest tract. His property was in a narrow gulch served by a one-lane road with few pulloffs.

So he hired my son Matthew to begin thinning and fuels reduction work, which Matthew had done for other nearby landowners. Stark used some of the dense, slow-growing western larches on his property to make tongue-and-groove flooring for his new house, helping to create market demand for formerly worthless small timber.

I helped with forest restoration work in the same small gulch, twice joining a group of volunteers from the Society of American Foresters and Sierra Club. Local Sierra Club leader Bob Clark brought us together to spend several hours thinning, cutting up, and hand-piling small trees growing in thickets.

We foresters ate sack lunches with the Sierra Club group and hoped that our joint exercise would show the impracticality of hand-thinning thickets of small trees and disposing of the materials. The exercise in hard labor probably convinced some of them, but an accelerating stream of new residents buy lots and build homes in the wildland-urban interface every year.

Restoring a Family-Owned Ponderosa Pine Forest

Stephen F. Arno

As a research forester, my learning curve in fire ecology increased after my wife and I purchased a 40-acre (16-ha) tract of ponderosa pine forest in the Northern Rockies. Like millions of others, we were inspired by the first Earth Day in 1970 to move into the western woods. Most bought small plots, and those who purchased 10 acres (4 ha) or more usually subdivided their lots to help finance the home they were eager to build. We did the opposite and soon added 20 acres (8 ha) of adjoining land, giving us 60 acres (24 ha) in all.

OVERGROWN PONDEROSA PINE

Our property had a thick second-growth forest that grew after the original big ponderosa pines were logged in the mid-1880s. Very old ponderosas show some obvious clues—smooth orange bark peeling off in big flakes around the tree's base, a sparse canopy of contorted and dead limbs as well as a dead treetop, and charred fire scars at the base shaped like upside-down Vs.

Most of our property had a few hundred small trees per acre, whereas

Crew at work in 1935 in an open old-growth ponderosa pine forest on the Lolo National Forest in Montana. The original ponderosa pine forests in the Northern Rockies probably looked like this before logging. USDA Forest Service photo by K.D. Swan.

Steve Arno was a research forester for the Forest Service, Fire Sciences Laboratory, Rocky Mountain Research Station, Missoula, MT.

the original stand—judging from my stump counts—had about 30 to 40 large overstory pines per acre and a small number of young understory trees. That is consistent with 1890s photographs and detailed reconstructions of similar ponderosa pine stands.

The 90-year-old stumps were (and still are) intact because the base and anchoring roots were impregnated with pitch in response to frequent wildland fires. The copious pitch also entangled and "drowned" bark beetles that attack pines. As shown in historical photos, most of the small trees in the original stand were ponderosa pines, which are more fire resistant than competing Douglas-firs.

In 1971, the second-growth forest had tall and spindly ponderosa pines 8 to 10 inches (20–25 cm) in diameter; their millimeter-thick annual rings revealed that they had grown about 1 inch (2.5 cm) in the previous 20 years. Some second-growth pines were larger, but they had sparse canopies due to the overcrowded conditions and top-kill by engraver beetles.

The stand also had thousands of 20- to 30-year-old pine seedlings infected with a rust disease that permanently deforms them. The diseased seedlings probably resulted from the elimination of frequent surface fires, which had burned through ponderosa forests for millennia until about 1900.

Douglas-firs ranging from seedlings to trees 10 inches (25 cm) in diameter were crowding out the pines on this rocky and relatively dry property. In addition, the property had many dead tall shrubs and trees. In most places, I couldn't see farther than 50 yards (46 m) through the dense growth—a familiar condition in many western forests today.

As a forester, I wanted to manage our property, which didn't have enough commercial timber to interest a logging contractor. Yet the property needed a tremendous amount of work:

- Saving the biggest and best-looking pines;
- Removing the rest for pulp logs or firewood and pile-burning the resulting slash (branches, tops, and dead material); and
- Using a light surface fire to reduce the buildup of old pine needles, cones, and branchlets on the ground.

HANDS-ON LEARNING

My only low-cost, low-impact option for restoring a healthy ponderosa pine forest was to access the property via the rough one-lane road that passed through its southern edge to reach a recently constructed tarpaper shack a quarter mile (0.4 km) beyond. Our property is on glacial till—a mixture of granite boulders, sand, and patchy layers of clay ejected from the mountain canyon above us by a glacier during the last Ice Age. Most of the narrow road was hemmed in by 100- to 400-pound (45–180-kg) boulders pushed aside by the bulldozer that carved out the road.

Still, there were places where the road crossed overgrown skid trails from 19th-century horse logging. I used a prybar to remove boulders and a chainsaw to reopen the trails. That let me penetrate and thin out the forest. Within a couple of years of starting the work, I hired a contractor to build a road into the upper part of the property where our well and house would be situated. This road opened up more of the land for thinning.

Despite the poor soils, ponderosa pine grows pretty well on our property: some of the pine stumps from the 1880s were from trees more than three feet (0.9 m) thick. About half of our 60 acres (24 ha) get leakage (subirrigation) from two irrigation ditches that settlers chiseled through the rocky terrain in the 1880s to divert canyon stream water to pastureland below. This part of the property has taller and faster growing trees, so we planted western larches near the ditches because they are beautiful and valuable timber trees. The dry half of the property relies entirely on the meager 16 inches (41 cm) of average annual precipitation, and big ponderosa pines take longer to grow.

Dense ingrowth of young ponderosa pines in western Montana on the Ninemile Ranger District, Lolo National Forest. USDA Forest Service photo.

In most places, I couldn't see farther than 50 yards through the dense growth.

THINNING AND BURNING

Removing felled trees and disposing of other vegetation took time. With help from my family, I hooked up the sawlogs to an old tractor so we could skid them along hand-cleared "truck trails." We deposited them in roadside piles, where a self-loading log truck could haul them to a mill. We burned countless piles of slash and deadwood in small openings between the thinned-out trees.

I purchased one of the all-purpose harvesting winches widely used by small landowners in Europe, which have become popular in the United States. The winch has a heavy-duty blade about 4 feet (1.2 m) wide. When mounted on a farm tractor's three-point hitch, the blade can be jammed into the ground to prevent tractor tipover when pulling in logs from as far away as

150 feet (46 m). The winch cable has a clutch to safely apply pulling power to logs that get stuck behind a stump or rock and also for falling trees away from powerlines, fences, and so forth.

After a few logs are brought up to the tractor using the winch's cable and the "choker chains" that grab the logs, the blade is raised a few inches so the logs can be safely skidded to a roadside or cleared area (landing) where the log truck picks them up. When the logs are unhooked at the loading spot, the winch blade can be tilted in order to stack the logs in a neat pile.

Eventually, our forest was open enough to apply surface fire. The road, truck trails, and irrigation ditches served as firelines. On property boundaries, we scraped away vegetation to create more firelines. When necessary, we watered the strip along the inside edge of the control lines using an all-purpose poly water tank and a gasoline-powered pump that is easy to load into a pickup truck. If a wildfire approached our house, we could quickly load the 350-gallon tank into our 3/4-ton pickup and wet down any burnable material, including litter and cured grass close by.

Eventually, our forest was open enough to apply surface fire.

FOREST MAINTENANCE

I learned how difficult it is to restore a healthy forest with large ponderosa pines that are widely spaced and of various ages and sizes. Part of the difficulty lies in keeping down the number of competing Douglas-firs, which regenerate prolifically but don't do well as large trees on such warm and dry sites.

I also learned that restoring a ponderosa pine forest isn't a one-time procedure. Just like in historical stands, pine needle litter accumulates in massive amounts every year, and excess saplings and occasional dead or dying overstory trees have to be removed. Periodic prescribed burning is the only way to prevent accumulations of surface litter, resprouting brush, and ingrowth of small trees.

When a small family forest is your universe, you can watch for trees under attack by bark beetles or disease or with fading crowns. You can also note where expanding canopies warrant more thinning before crowding slows the growth of trees and makes them more vulnerable to bark beetles or disease. Every few years, depending on the size and quality of the site, the landowner can pick out enough trees to fill two or more trucks with logs. Controlled burning should be repeated every couple of decades. ■

Log decks from the Trapper Bunkhouse Stewardship Project on the Bitterroot National Forest. Completed in 2012, the project thinned overgrown ponderosa pine forest. USDA Forest Service photo.

Restoring Fire-Adapted Forests: Collaboratives and Other Local Resources

Stephen F. Arno

Dozens of citizen-led collaborative groups involving loggers, conservation activists, and ordinary citizens help government agencies and private landowners promote forest restoration and reduce hazards from wildfire and outbreaks of insects and disease. Through new authorities, Federal agencies can work with partners—notably with State departments of natural resources—to restore fire-adapted forests on Federal lands. Private forest landowners can find local, State, and Federal support for taking steps to reduce wildfire risk on their own lands. Forest managers and landowners can take advantage of markets for the small-diameter materials that need to be removed.

QUINCY LIBRARY GROUP

The best-known collaborative began meeting in 1993 in Quincy, CA, in the town's public library. As Senator Dianne Feinstein (D–CA) recalled, "The Quincy Library Group members chose the public library because they couldn't yell at each other."

Aftermath of a collaborative forest restoration treatment in ponderosa pine in the Highway 50 corridor in California's Sierra Nevada. The treatment was part of a series of collaborative cross-boundary projects under the National Cohesive Wildland Fire Management Strategy. USDA Forest Service photo by Paul Wade.

Steve Arno was a research forester for the Forest Service, Fire Sciences Laboratory, Rocky Mountain Research Station, Missoula, MT.

In 1998, the group's efforts led to the Herger-Feinstein Forest Recovery Act, which authorized forest restoration on a total of 1.5 million acres in mostly ponderosa pine/white fir stands on three national forests in northeastern California. The management involves selective harvesting, prescribed burning, forest thinning for pulpwood, and chipping fuels and hauling them to cogeneration plants that burn the chips to create electric power (Fiedler and Arno 2005).

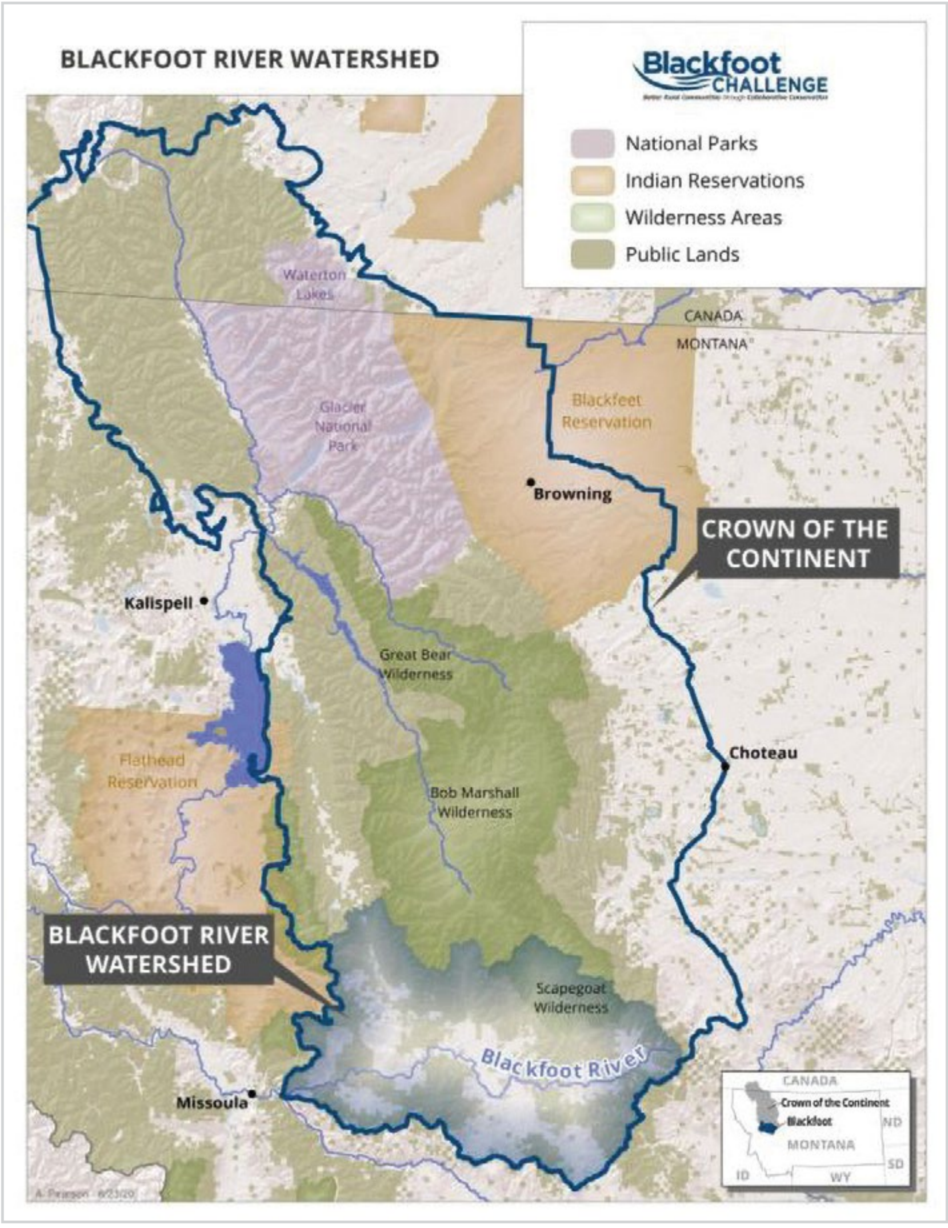
Unfortunately, due to Federal budget deficits, Herger-Feinstein wasn't renewed—nor, for the same reason, was the Healthy Forests Restoration Act of 2003. The result will be more severe wildfires, soaring suppression costs, and higher State and Federal spending overall. In 2021, the Dixie Fire burned across much of the area in the northern Sierra Nevada. Costing $610 million over 3 months to contain, the Dixie Fire was the most expensive in California history, according to State officials (McDonald and others 2021).

Former Forest Service Chief Dale Bosworth, joined by Jerry Williams, the agency's former national Director of Fire and Aviation Management, have pointed out that Congress has never authorized a comprehensive cost/benefit analysis of fuels treatments at the scale needed to keep megafires from raging across the landscape (Bosworth and Williams 2018). Presumably, it wouldn't be hard for the General Accounting Office or some other Federal accounting entity to accomplish this analysis, especially in view of the many findings by economists in the last 15 years that fuels management yields great economic benefits. Fire behavior experts like Mark Finney at the Forest Service's Fire Sciences Laboratory in Missoula, MT, reached similar conclusions long ago (see, for example, Finney's work on the Wildland Fire Investment Planning System; also, Ager and others 2021).

BLACKFOOT CHALLENGE

The Blackfoot Challenge cooperative, also chartered in 1993, might be the earliest community-based collaborative in the Rocky Mountains. Northwestern Montana has experienced rapid unplanned growth in the wildland-urban interface, and residents of the beautiful 1.5-million-acre (600,000-ha) Blackfoot River Valley set a goal of retaining its ranching tradition. The valley was the route that Captain Meriwether Lewis took in 1806 with members of the Lewis and Clark Expedition on their way to rejoin Captain William Clark's party and head back down the Missouri River to St. Louis, MO.

Many historians think that Lewis crossed the Continental Divide at a low spot now called Lewis and Clark Pass, an easy 2-mile (3.2-km) hike from a trailhead on Alice Creek, east of Lincoln, MT. Lewis was guided to the pass by American Indians who had used it for millennia on their "Road to the Buffalo." The pass is a wind funnel resulting in an interesting variety of plant and tree life: hunched-over Douglas-firs and lodgepole pines, along with aspens, spruces, and other dwarf trees. Meadows and bare rocky areas



The Blackfoot Challenge focuses on the Blackfoot River Valley in the south (blue shaded area) of the broader Crown of the Continent landscape (blue outline). The collaborative comprises private and public partners across a landscape with both private and public lands.

A rider leads a pack horse carrying camera equipment in Still Valley Montana. USDA Forest Service photo by K.D. Swan.

Effects of Fire Exclusion: Photographic Evidence

In the 1980s, I collaborated with George Gruell, a wildlife habitat specialist for the Forest Service, in studying areas where we had old photos of forest and grassland landscapes. Most of the old photos showed open-grown or patchy forest, and Gruell wanted to know what presettlement fire history was tied to those conditions. He took repeat photos of 19th- and early-20th-century landscapes along the eastern escarpment of the Rockies and in the mountains of central Montana; his photos were 70 to 120 years later than the original photos (Gruell 1983).

Along the Rocky Mountain Front, where the easternmost range of the Northern Rockies abruptly drops off at the western edge of the Great Plains, Gruell's photo retakes show a marked invasion and thickening of woody vegetation, resulting in today's dwarf woodland of stunted Douglas-fir, limber pine, juniper, and diminishing aspen groves due to wildland fire suppression. On the mountains farther east, the retakes show expansion of early ponderosa pine and Douglas-fir forests.

Congress gave Federal agencies more flexibility by passing legislation in the 2000s and 2010s that granted stewardship contracting and Good Neighbor Authority.

have a variety of subalpine and even alpine flowers and grasses.

One of the Blackfoot Challenge's priorities is to restore the drainage's mixed-conifer forests to a more sustainable and fire-resistant structure. Methods include encouraging landowners to investigate conservation easements, which offer tax benefits and other monetary incentives in exchange for giving up some rights to subdivide their property.

OTHER COLLABORATIVE INITIATIVES

A collaborative in Utah has established guidelines for restoring aspen groves important for deer and elk habitat and the declining population of migratory songbirds. Before fires were suppressed, aspen groves resprouted rapidly from massive underground root systems after they burned, but now they are shaded out by conifers.

Another cooperative called Northeast Washington Forest Vision has helped the Colville National Forest conduct more than two dozen projects for thinning dense stands, removing shade-tolerant understory trees, and carrying out prescribed burns. In the process, they helped create nearly 200 jobs in this rural part of Washington State by providing more wood to sawmills and pulpmills and by transporting fuel chips to a cogeneration plant. This cooperative is also helping to restore old-growth forests of ponderosa pine and western larch.

In Douglas-fir forests that border semiarid grasslands in southwestern Montana, a variety of cooperators helps the Bureau of Land Management (BLM) thin the trees that George Gruell's photo retakes showed have encroached upon the historic sagebrush/grassland (Gruell 1983; see the sidebar). After removing large firs infected with dwarf mistletoe and other pathogens, BLM contractors reseeded the treated area with young conifers. The BLM followed up with prescribed burns. This process reduced wildfire hazard in dense stands while improving habitat for sage grouse, monarch butterflies, deer, elk, and moose.

NEW FEDERAL AUTHORITIES

Congress has recognized the challenges of forest restoration and reducing wildfire hazard in the heavily logged forests of the inland West, where traditional timber sales no longer attract many bids. Because both major political parties acknowledge the need for investing in fuels and forest health projects, Congress has expanded programs and funding to help Federal agencies, the States, and private forest landowners improve forest conditions. In particular, Congress gave the Forest Service and BLM more flexibility by passing legislation in the 2000s and 2010s that grants the following new authorities:

- ***Stewardship contracting*** allows Federal agencies to offer long-term contracts of goods (such as wood fiber) for services (such as ecological restoration across landscapes).
- ***Good Neighbor Authority*** (GNA) allows State foresters to help understaffed Federal agencies design forest restoration treatments.

One of my sons manages the GNA for Montana's forestry operations covering three national forests. Field operations use snowmobiles; and State, Forest Service, and U.S. Fish and Wildlife Service employees don snowshoes to consult with each other about unit boundaries and mark individual trees for cutting.

SERVICE FORESTRY

My other son is in charge of the Service Forestry Program in Montana. Every State has service foresters you can find by searching the State division of forestry or department of natural resources website. The service foresters ask private forest landowners about their goals and objectives and then offer advice on planning the management of their forests. They can help landowners set up a long-term stewardship or management plan.

Service foresters offer information about the State's required best management practices, such as not skidding logs across streams. They can recommend harvesting systems best suited to a site's conditions and the landowner's objectives. Service foresters can also offer advice on getting a grant from the Forest Service or other entity as part of a cost-share agreement for thinning and slash disposal to reduce hazardous fuels. In addition, the service forester can supply a list of reliable contractors.

MARKETS FOR LOW-VALUE WOOD

Wood from western forests can be used and recycled in countless ways while restoring forests to a sustainable condition and reducing wildfire hazard. The Consortium for Research on Renewable Industrial Materials outlines research comparing wood for building with steel, aluminum, concrete, brick, fiberglass, plastic, glass, and other building materials. Pound for pound, wood is stronger than steel and other structural materials; producing wood-based construction materials emits fewer greenhouse gases, and wood structures have the added advantage of storing carbon.

"Engineered wood" made from low-value wood products can be traced back to the invention of plywood in the early 20th century. Fiberboard made from compressed sawdust is used in low-cost furniture. Oriented strand board (OSB) consisting of wood chips glued in presses has largely replaced plywood. Joists supporting floors are now mostly made from OSB and small corner braces of plywood. Cross-laminated timber (CLT), developed in the 1990s, is made from small boards that are dried, arranged in perpendicular layers, and glued under pressure. CLT in panels, pillars, and beams is used in mass timber buildings of ever-growing heights.

Composite decking like Trex is made under high compression from 95-percent recycled wood fiber, sawdust, and plastic. Extremely hard and essentially fireproof, it is vastly superior to wood decking. HardiePlank and other brands of wood fiber/cement siding are comparable to composite decking and are also highly fire resistant.

Logging slash, instead of being burned, can be chipped and used for cogeneration of electric power or for heating a kiln that dries out freshly cut lumber. Debarked logs are chipped and sent in rail boxcars or semitruck vans to mills that produce a great variety of paper products. Chips are used as mulch in horticulture; and when slash or woody yard waste is ground up and mixed with other ingredients, it can produce organic compost that improves soils and nutrient content in gardens.

WOOD FOR HEAT

Through the Missoula Fire Lab, the Society of American Foresters, and my sons' work in ecological restoration, I got to know the Forest Service's Dave Atkins, a tireless innovator. Among other accomplishments, Dave established the Fuels for Schools program, which helps schools save on heating costs by burning chipped forest slash in high-efficiency, ultralow-emission furnaces. The program has expanded to two dozen or more institutions, including a college and a hospital. The school in Darby, MT, was able to hire two more teachers thanks to cost savings from using chipped wastewood as its principal heating source rather than petroleum-based fuels.

State service foresters can help private forest landowners get a grant from the Forest Service or other sources for thinning and slash disposal to reduce hazardous fuels.

Outdoor wood burners, which are tiny furnaces that burn round chunks of firewood up to 30 inches (76 cm) long, are popular with rural woodland homeowners in cold, snowy climates. Connected to homes and shop-garages via underground piping, the wood burners can produce heat for up to 24 hours until they have to be stoked with a new load of small-diameter wood. Dead and dying trees that have no other value—and are plentiful today across many western landscapes—serve as an ideal fuel, and these outdoor furnaces are marketed by many large woodstove dealers. One of my sons has used an outdoor wood furnace for years. They are a godsend for

Wood chips fuel the boiler for a school in Alaska. USDA Forest Service photo.

homeowners not connected to electric power, and they reduce the cost of backup propane heat. The furnaces require minimal maintenance and eliminate the ash, soot, and debris associated with indoor wood burning.

But I do not mean to disparage modern, high-capacity indoor woodstoves, with an internal catalytic converter to capture heat from volatile gases that produce excessive ash, soot, and smoke in traditional woodstoves and chimneys. On our family forest, we have had an indoor woodstove for more than a decade, burning primarily seasoned ponderosa pine at an average rate of seven cords a year to heat a 3,000-square-foot (280-m^2) two-story home with an open stairwell and passive cold-air return vents in distant upstairs rooms. The woodstove requires only once-a-year chimney cleaning from the low-pitch roof. A key to drying wood and keeping it dry in winter is stacking it in an open firewood shelter instead of outside covered with plastic tarps.

LOCAL INITIATIVES AND PARTNERSHIPS ARE KEY

Thousands of communities in the West are at growing risk from catastrophic wildfires. The solution is to restore ponderosa pine and other western forest types to the more open conditions they were in a century ago, with fewer trees per acre. That takes fuels and forest health treatments at the scale of the actual wildfire risk, which can be expensive.

If land managers and forest landowners can sell more of the fuels that need to be removed, then they can afford to do more treatments at the needed scale. The Forest Service is constantly searching for and promoting new uses and markets for the low-value woody materials that need to be removed. In addition, the agency is working with State, private, and other partners to put local collaborative structures in place to restore fire-adapted forests in the West.

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The Wildland-Urban Interface: Learning To Live With Fire

Stephen F. Arno

In the late 1960s, Americans witnessed a string of shocking events, including a massive oil slick off Santa Barbara, CA; the assassinations of presidential candidate Robert F. Kennedy and civil rights leader Reverend Martin Luther King, Jr.; massive urban riots sometimes put down with brutal force; and a storm of controversy about the Vietnam War.

One way to escape the chaos was to "get back to the land," a movement inspired by the first Earth Day on April 22, 1970. In the years that followed, millions of Americans decided to leave cities and suburbs and build a home or summer retreat in the woods. Forest landowners who had previously produced timber now subdivided their lands into lots for sale to the new migrants, transforming rural areas into what has become known as the wildland-urban interface (WUI) (see the sidebar).

Rental cabin on the Idaho Panhandle National Forest. Millions of Americans have bought plots of forest land and built similar cabins—or large homes—for seasonal use. Many are located in fire-prone areas, and thousands of homes burn on average each year. USDA Forest Service photo.

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Bedroom community near wildlands in Utah. Adobe stock.

What Is the Wildland-Urban Interface?

By one definition (Martinuzzi and others 2015), the WUI has at least 16 homes per square mile, and it comes in two types:

- In the wildland-urban intermix, homes are scattered in the woods, with at least half of each property in forest or other wildland vegetation.
- In the wildland-urban interface, homes are in compact bedroom communities that adjoin a large area of wildland vegetation. Less than half of each property is wooded or otherwise naturally vegetated.

In each case, the WUI is made up primarily of single-family residences. If employed, the residents either telecommute or commute to work. Their jobs, which tend to be urban rather than rural in nature, are mainly in commercial centers ranging from small towns to major cities. The residents depend on nearby commercial centers for goods and services.

FIRE-PRONE WOODLAND HOMES

In 2010, the National Interagency Coordination Center in Boise, ID, in its wildland fire annual reports, began tracking the number of structures burned each year in wildfires nationwide. The number has ranged from a low of 788 structures (including 338 residences) in 2010 to a high of 25,790 structures (including 18,137 residences) in 2018, the year of the catastrophic Camp Fire in California. On average each year, 4,568 residences burned in wildfires from 2010 to 2020, and the number has been rising.

The growing wildfire risk to homes followed the spread of communities into fire-prone landscapes since the 1970s. By 2010, the Western United States had about 11.3 million homes in the WUI (Martinuzzi and others 2015). More than a third of the 30.5 million homes in the West were in the WUI; in the Forest Service's Northern Region (Idaho, Montana, and North Dakota), more than 4 in 10 homes were located in the WUI.

Many of the new forest residents in the WUI migrated from the Midwest, Northeast, and South, drawn by the romantic dream of living close to high mountains and abundant public lands for outdoor recreation. Many migrants are unaware of how different western forests are from forests in the East, which have wetter summers, much higher humidity, and a preponderance of broadleaved trees, which are less combustible than western conifers.

Residents of the West are also moving from towns, cities, and suburbs into the forest. In some western counties, more than half of all new homes are built in and adjacent to the woods. Like immigrants from other regions, most urban and suburban westerners are unfamiliar with what it means to live in a fire-prone forest and are unwilling to make their homes and environs fire resistant. The States of Utah and California and the city of Flagstaff, AZ, have led the way in adopting plans and regulations for making WUI homes fire resistant, but few other governments are following their example.

The reasons why WUI homeowners do not take steps to make their homes and properties more fire resistant are many:

- Land developers often oppose government regulation, as do residents who regard it as an intrusion on private property rights.
- Most homeowners moved to the woods for a sense of privacy and seclusion. They like the dense fire-prone brush and thickets of small

Home in the wildland-urban interface near Salt Lake City, UT, burning in a 2017 wildfire. USDA Forest Service photo.

trees that shield them from their neighbors.

- Some reject open fire-adapted woodlands on their own lands as ugly, even when they agree that open stands of healthy trees on public lands are attractive.
- Many who lead busy lives commuting to work and caring for children or grandchildren want to reserve their precious free time for travel or recreational activities.
- Many resist the arduous work of creating fire-resistant homes and properties or lack the equipment and knowhow, unaware that such services are available at a reasonable cost.

Many WUI homeowners simply refuse to take the risk of wildfire seriously—their attitude is, "It won't happen to me!" The reason has to do with Government assurances starting in the early 1900s that wildland firefighters will come to the rescue. People expect smokejumpers, airtankers, and hotshot crews to extinguish any wildfire, regardless of circumstances. Homeowners, along with firefighters who worked in the 1950s and 1960s, often fail to realize that unstoppable running crown fires can quickly develop in today's dense forests.

RISKS TO FIREFIGHTERS

The WUI now covers an area across fire-prone western landscapes that is far too large for firefighters to protect. In 2010, almost 7 percent of the entire Pacific Coast region (California, Oregon, and Washington) was in the WUI, including more than 6 million homes scattered across the region (Martinuzzi 2015). Montana alone had more than 300,000 homes in the WUI scattered across the State at a time when the State's total population was 1 million.

In spring 2009, with Montana in severe drought, Governor Brian Schweitzer cautioned people living in the WUI to take Firewise measures to protect their homes and properties from wildfire during the severe fire season looming ahead. "Don't look for the government to bail you out," he warned.

The vast number of homes in the WUI creates a nightmare for wildland firefighters, one reason why the cost of fire suppression has ballooned. Instead of establishing firebreaks and firelines to corral a wildfire, fire crews are often sent to protect empty homes. Even for houses with unsafe access and vulnerabilities like cedar shake roofs

Engine crew attacking a spot fire threatening homes on the 2018 Delta Fire near Redding, CA. Bureau of Land Management photo by Jim Bartlett.

A smokejumper preparing to leap out of an aircraft. USDA Forest Service courtesy photo by Cole Barash.

Misleading Messages About Fire

In the 1990s, when I worked at the Missoula Fire Sciences Laboratory, some of us were asked for an interview by the producer of a documentary about wildland fires for national public television. When the journalist arrived, we gave her an illustrated presentation about the ecological role of wildland fire in western forests. We described how the Forest Service was trying to return fire to the land, in conjunction with thinning and related practices. She followed up with good questions.

After leaving us, the journalist toured the smokejumper base next door and watched practice jumps. Then she got an introduction to the huge fire equipment cache nearby, with its specialized fire engines. Finally, she got a tour of the aerial depot, with its airtankers outfitted with all the necessary gear.

Months later, we saw the production on public television. To my surprise, there was scarcely any mention of fire's natural role in the forest. Instead, the hour was filled with smokejumpers and airtankers fighting their heroic battle against wildfire, lore calculated to please and titillate a broad audience of viewers. The legacy of captivating Americans with messages about fire suppression might be the biggest roadblock to the realistic management of wildland fire and forest fuels in the United States.

and high-hazard fuels, fire managers are reluctant to withhold protection.

Firefighters have lost their lives taking major risks to save vulnerable houses, notably on the 2015 Twisp River Fire in Washington. The leader of the Lolo Hotshots in Montana made news within the local fire community when she pulled her crew out of a hazardous situation. Since then, other crew leaders have done likewise. Bold actions like this will no doubt save firefighters' lives, but they are still rare.

The vast number of homes in the WUI creates a nightmare for wildland firefighters.

OBSTACLES TO ECOLOGICAL RESTORATION

The fire-related risks associated with the growing number of homes and communities extend beyond the WUI and the wildland fire community. The enormous increase in numbers of people and homes in the WUI downwind from remote public forests makes it harder for administrators to approve the use of lightning fires in wilderness areas than it was a few decades ago.

Moreover, projects in degraded forests overcrowded with small trees can restore open fire-adapted woodlands and reduce wildfire risks to communities and ecosystems alike. However, the ever-expanding WUI and the population boom in valleys near mountain forests make it harder for forest managers to conduct restoration projects on public lands.

Some homeowners object to thinning trees, equating it with abusive logging and afraid that it will degrade views from their properties. Others are upset by the temporary roads proposed to remove trees. Potential smoke pollution from slash fires, broadcast burning, and lightning ignitions in remote areas is another issue. Some contend that publicly owned forest land should just be left alone—until a fire starts, when the fire should be put out.

THE FIRE-RESISTANT HOUSE

The responsibilities of a forest landowner are much greater than those of a suburban homeowner. If forest residents want to mitigate the risk of wildfire, they need to learn what to do, which typically involves—at a minimum—ensuring good access (and egress), eliminating hazardous fuels on or near the home, and clearing a large defensible space around the home.

Forest landowners can hire responsible contractors or others to carry out the work. Every State's forestry extension service has contact information online, provides free expert advice through onsite visits, and offers information about reliable contractors and government cost-sharing programs that help finance the work.

Forest homeowners also need to make their homes firesafe. High-hazard items near the house include dry grass and pine needles, piles of wood or other combustible materials, and landscaping with bark chips or juniper shrubs. A safety zone around the home and outbuildings consists of concrete; gravel; bare mineral soil; or a green, well-watered lawn. Any propane tanks need to be mounted well away from the buildings on a concrete pad. Soffit vents should be covered inside with very fine wire mesh to prevent firebrands from entering the house. Noncombustible drapes or blinds can protect against radiant heat starting the interior of the house on fire through the windows.

Cedar shake roofs might be aesthetically pleasing; until recently, some WUI subdivisions actually required them. Shake roofs were originally touted as lasting 40 to 50 years, but many start deteriorating in half that time. Moreover, cedar makes ideal kindling. Any cedar on the roof, wood siding anywhere on exterior walls, or a wooden deck on the home or outbuildings is an invitation to airborne firebrands.

Aftermath of the 2018 Camp Fire in Paradise, CA. Trees remained but most homes were reduced to ashes. Houses built in accordance with California's building code for high-fire-hazard zones, adopted in 2008, stood a much better chance of surviving. USDA Forest Service photo.

A home in the wildland-urban interface at risk from a wildfire in 2011 on the Deschutes National Forest in Oregon. USDA Forest Service photo.

Ironically, historical preservation law requires shake roof on some Forest Service and National Park Service buildings, including the towering roof of the Old Faithful Inn at Yellowstone National Park. Firefighters risked their lives during the 1988 Yellowstone Fires amid stifling heat and blinding smoke to spray water on burning firebrands that landed in droves on the roof.

I am a family forest landowner myself, with 60 acres (24 ha) of ponderosa pine forest near Missoula, MT. When my wife and I built our house in the 1970s, we didn't choose a cedar shake roof, but we did use cedar siding. Despite preservative treatments, the siding became badly cracked and full of knotholes within 20 years, exposing places for burning embers from wildfires to land.

HardiePlank and other brands of wood fiber/cement siding are comparable to composite decking and are also highly fire resistant. This type of siding is about two-thirds wood fiber and one-third cement, with a simulated wood grain. It comes in a choice of baked-on colors, eliminating the need to repaint it for at least 20 years. Its surface is so hard that woodpeckers can't cling to it and drill nest holes, like they do in wood-sided buildings.

On our forest home, we replaced the cedar siding with HardiePlank. We chose siding already coated with a fresh cedar color, and it hasn't faded or chipped in more than 15 years. The new siding and finely screened soffit vents, along with our mineral-surfaced roofing, gives the house good protection from burning embers lofted by wildfires.

Composite decking like Trex is made under high compression from 95-percent recycled wood fiber, sawdust, and plastic. It is extremely hard and essentially fireproof. Requiring minimal maintenance, Trex is vastly superior to wood decking but requires more support from wood joists than conventional decking.

Two or three times a year, we have raked enough pine needles, cones, and dry grass from close to the house and two outbuildings to fill our pickup truck for two or three trips to a fuel-cleared landing where I could safely burn them. Measures like these illustrate the responsibilities of forest homeowners to keep their properties relatively safe from wildfire.

LOLO PEAK FIRE

A wildfire approached our home in 2017. Ignited by lightning in mid-July about 10 miles (16 km) southwest of Missoula, MT, the Lolo Peak Fire burned across almost 54,000 acres (21,900 ha) on the Lolo and Bitterroot National Forests until it was finally contained in September. Much of the fire burned in the WUI, threatening hundreds of homes and forcing thousands to evacuate.

The responsibilities of a forest landowner are much greater than those of a suburban homeowner.

Greg Poncin, the incident commander, endured hours of angry questioning in phone calls and in meetings I attended in three local communities. My wife and I, along with understanding friends, were horrified by the bile directed toward Poncin and the local district ranger, typical of people frightened by a WUI blaze and unprepared for it, even though they live in fire-prone landscapes.

Our home lay in the fire's path, and we were among the evacuees for 8 days. However, a well-timed and well-executed burnout and backfire kept the fire from destroying all but two houses not made firesafe. Daily smoke advisories were issued for the entire region. Such is the price paid by homeowners for living in the WUI, particularly when Federal land managers lack the social license and financial means to conduct prescribed fire and fuels management on any meaningful scale.

OUR CHOICE: PAY NOW OR ANGUISH LATER

Our wildfire problem might be compared to the devastating coronavirus of 2019. The United States and many other countries failed to act promptly to slow its spread and suffered accordingly. In fact, the pandemic might have spurred even more construction in the WUI because people wanted to move away from crowded areas with high rates of coronavirus transmission. They wanted their own parcel of forest with room to roam.

As the WUI continues to attract millions of new residents, the challenges of controlling "bad fire" and applying "good fire" (prescribed fire and fuels management) will only grow. Most WUI residents are either unaware of the risk of uncontrollable wildfires, indifferent to it, or both. They prefer to take their chances, not realizing that nothing can be done at the last minute to save their expensive properties, vehicles, boats, horses, and pets, let alone their houses and irreplaceable belongings—and even their lives.

Somehow, perhaps through public service advertisements on television and local radio, WUI residents need to learn the ghastly fates of unprepared homeowners. The stories should explain what happened and why—because of the surrounding dense forest, flammable landscaping, a flammable house, a poor access road, and so on. The reasons include failing to keep abreast of news about wildfires when fire danger is high; failing to stay close enough to home to transport horses or extra vehicles to a safe place outside the WUI; and failing to plan ahead for a quick departure with personal valuables.

In California, television news has shown how even two-lane paved roads can be blocked by burning trees and stranded vehicles. Such obstacles on the road can keep first responders from rescuing people, making it nearly impossible for fire crews to reach communities and save lives and homes.

Such sobering messages need to end with information about how homeowners can obtain free property inspections, detailed expert advice, and access to cost-sharing programs for reducing fire hazards and making homes and properties firesafe.

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Fire Management today

GUIDELINES for Contributors

Fire Management Today (FMT) is an international magazine for the wildland fire community. The purpose of FMT is to share information and raise issues related to wildland fire management for the benefit of the wildland fire community. FMT welcomes unsolicited manuscripts from readers on any subject related to wildland fire management.

However, FMT is not a forum for airing personal grievances or for marketing commercial products. The Forest Service's Fire and Aviation Management staff reserves the right to reject submissions that do not meet the purpose of FMT.

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Submit manuscripts in Word (.doc or .docx). Submit illustrations and photographs as separate files; do not include visual materials (such as photographs, maps, charts, or graphs) as embedded illustrations in the electronic manuscript file. You may submit digital photographs in JPEG, TIFF, or EPS format; they must be at high resolution: at least 300 dpi at a minimum size of 4 by 7 inches. Include information for photo captions and photographer's name and affiliation at the end of the manuscript. Submit charts and graphs along with the electronic source files or data needed to reconstruct them and any special instructions for layout. Include a description of each illustration at the end of the manuscript for use in the caption.

For all submissions, include the complete name(s), title(s), affiliation(s), and address(es) of the author(s), illustrator(s), and photographer(s), as well as their telephone number(s) and email address(es). If the same or a similar manuscript is being submitted for publication elsewhere, include that information also. Authors should submit a photograph of themselves or a logo for their agency, institution, or organization.

STYLE

Authors are responsible for using wildland fire terminology that conforms to the latest standards set by the National Wildfire Coordinating Group under the National Interagency Incident Management System. FMT uses the spelling, capitalization, hyphenation, and other styles recommended in the U.S. Government Publishing Office Style Manual, as required by the U.S. Department of Agriculture. Authors should use the U.S. system of weight and measure, with equivalent values in the metric system. Keep titles concise and descriptive; subheadings and bulleted material are useful and help readability. As a general rule of clear writing, use the active voice (for example, write, "Fire managers know…" and not, "It is known…"). Spell out all abbreviations and identify acronyms on first use.

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Tables should be logical and understandable without reading the text. Include tables at the end of the manuscript with appropriate titles.

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